JOURNAL OF INDIAN SCHOOL OF POLITICAL ECONOMY

A Journal Devoted to the Study of Indian Economy, Polity and Society

Vol. XXIV **January-December 2012** **Nos. 1-4**

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DOCUMENTATION

WATER RATES TO BE CHARGED FOR WATER SUPPLIED FROM THE RESERVOIRS ON THE RIVERS AND STREAMS IN MAHARASHTRA FOR IRRIGATION, INDUSTRY AND HOUSEHOLD USE (For period 2013-16): Suggestions

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This paper is in response to the circular by the Water Rate Fixation Authority of Maharashtra, inviting suggestions for the period 2013-16. The paper suggests the principle for determining the water rate in flow irrigation, saying that the water rate should be based on the maximum value product per unit of water provided. For this purpose it suggests the sources of information for calculation. It also suggests the basis for water rates for industry and household use.

In order to arrive at the rates for water supplied from the reservoirs on the rivers and major streams in the state of Maharashtra, three basic sets of data are required: (A) The volume of water impounded in each reservoir at the beginning of the Rabi season, the additional flow into the water till the beginning of subsequent June, the water sent out of the reservoir through the main canals and pumps, if any, during the 8 months from October every year, and the volume of water in the reservoir in the beginning of June every year. In addition, it is necessary to know the volume of water sent out from the main canals into the distributaries and from the distributaries to the minors in each of the three seasons, Rabi, Summer and subsequent Kharif. (B) The original total capital cost of each project, the years since water was being provided from the system to users and the estimated remaining life time of the system, the annual operation and maintenance cost of the reservoir and the distribution system (which will include the salaries and allowances of the staff and other material expenses), the cost of salary and allowances of the staff below the level from which the Water Users Association will be responsible for purchase and distribution of water. It is also necessary to note the frequency of major repairs to the dam, the reservoir and the main canals and distributaries during its life time in the light of past experience. (C) The area under every crop under irrigation during the year and the per hectare material expenses of each of the types of crops - seasonal, annual and perennial - grown under irrigation as well as under unirrigated condition in and around the particular project area as well as the actual per hectare output of each crop, under irrigation and unirrigated, and its price in the open market during the harvest season.

These basic data are needed to help the Authority to arrive at an estimate of the net return per hectare meter of water provided to each crop in each season, which will help the authority to fix the water rate under the individual project.

(A)

1. The measurement of evapo-transmissional losses, plus theft, of water impounded in the reservoir and sent out to the fields is relevant not only for improvement of the distribution system to minimise such losses, but also to assess the area that can be irrigated in a season in any year under different crops. While the measurement of the extent of loss in transmission through the main canal and the distributory is necessary in order to estimate the quantity of water that can be supplied

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*The author's report on the Economics of Irrigation in the Water-scarce Regions - a case study in Maharashtra, based on an enquiry into Pravara and Nira left-bank Canal areas, sponsored by the Central Water Commission, was submitted to the central and state governments and published in full in *Artha Vjnana* in March 1989. This report (Reprinted, in part, in the Documentation Section in this volume) will illustrate the propositions made in the present submission.

to the minors, when the system under each minor is under the control of a Water Users Association, which will buy water at the head of the minor, the measurement below this is necessary in order to know the amount of water that can reach the field from the water course.

2. Theft apart, the loss in the main canal as well as the distributory during a season will depend on the temperature and humidity in the area during the period, the nature of the soil on which the system stands and the frequency with which water is let out into the system from the reservoir during the season. The data in Annexures 2.11 and 2.2 in the report, Maharashtra Water Resources Regulatory Authority (MWRRA) (2012), show the extent of loss in each of the three years' recorded for a number of irrigation systems in the state. The Table shows not only significant variations from year to year during the period of only 3 consecutive years but also variations from system to system in different parts of the state. While these variations need understanding in order to improve the efficiency of delivery, it is important to realise that, under the observed circumstances, state or even regional averages are not very meaningful for the purpose of determining the irrigable area in a season and therefore the water rate to be fixed in the particular project area. The MWRRA, beginning its work some three-four years ago, has unavoidably used state averages in discharge of its task. However, it is necessary to realise that such calculation has to be done separately for each project. Indeed, the seasonal crop pattern and the water for it as well as the water rate has to be fixed for each project separately and not for all crops for all projects in the state with the help of a state-average calculation.

3. Since the discharge of water into the main canal and out of the distributories of the main canal are available (or should be available) for each round of water discharge during a season, It should be possible for the authority to obtain this data routinely for every project every year. This is necessary for determining the volume of water actually discharged as well as to be discharged to the minors which are required to be under the control of the Water Users Associations. The routine receipt of such data from each project would inform the Authority of the present and the emergent operation of the system including the frequency of supply, the interval between the supply times and the volume of water supplied each time. The data should be made available to the Authority directly.

4. As for the loss of water in the minor and the water course, it is necessary to carry out measurements in every irrigation system, not only in a select few, since water rate should be fixed for each system separately. One important point to pursue is ensuring the required rate of flow of water into the water course at the outlet head. In Maharashtra, the outlets are required to be designed for one cusec discharge of water into the water course. But this is rarely the case. It is almost always less, and is never uniform. In the early years of the Maharashtra Water and Land Management Institute (WALMI), Aurangabad, the then Director, Mr. Dhamdhere, carried out a comprehensive survey of all outlets into field channels of the Mula Irrigation System and found not a single outlet with a design of one cusec discharge. It varied between half a cusec to less than one. If volumetric water supply to each field is to be designed and ensured in every system and every field, then this has to be promptly implemented. The Authority should ask the irrigation department to complete this within the next three years in every one of our flow irrigation projects on the ground. This is absolutely important for the task in hand of the Authority.

5. It is not necessary, in my view, to find out how much water is used by the plants in the irrigated fields and how much percolates down. The frequency of water supply in the season should be decided on the basis of the type of soil being

irrigated and the crop to be grown, in order to ensure moisture in the root zone of the plant and avoid unnecessary seepage.

6. It is also necessary to find out on a regular basis the extent of loss of stored water in the reservoir through evaporation and seepage during each season. This will help the Authority to assess the quantity of water so lost in the summer season and therefore the cost of water for irrigation in that season. Like everything else, this should also be available to the Authority on a regular basis every season and not only for a few years to calculate an average.

7. These three sets of data will tell the Authority what quantity of water, discharged from the reservoir, will reach the field in the project area. This will be necessary to determine the water rate.

(B)

8. The next set of data required relate to the annual cost of water impounded and sent to the fields. The two components of this total cost are: (i) capital cost, and (ii) current or annual cost, called Operation and Maintenance Costs (O&M costs). The Present proposal ignores the capital cost. I think this is unfortunate. Even if the state government decides not to recover the capital cost from the users of canal water used for irrigation, it is necessary, for every project, for the government and the Assembly to know the extent of annual subsidy to the farmers (and other consumers) in a project area. In order to estimate the annual capital cost of a project which has already been completed, the Authority should obtain the total actual capital cost of the completed project, the estimated life time of the project and the rate of interest to be charged for the recovery of this capital cost. For projects already completed and in operation, it is not necessary for the Authority to go into the past years of the operation of the project. The simplest rule may be to divide the total capital cost of the project by the number of years of estimated life to arrive at the simple average per year capital cost and deduct from the total the cost for the years completed till now. This the state has already borne and the question need not be raked up. The remaining capital cost is to be recovered in the remaining years of the life of the project.

9. There is an interest rate involved in this: since the money is to be recovered in annual installments over a large number of years there is an interest cost of delayed recovery of parts of the capital. The interest to be charged should be the rate of interest charged by the lender of the money to the state government, be it the Central government or the loan taken from the public for the state's capital expenditures. Whichever interest is relevant for the project should be taken to be the rate of interest at which the annual recovery is to be calculated. It is useful to remember that if the past interest is higher than the present day interest rate at which the state borrows money, then the present day interest rate should be used for this calculation. For, the state can repay its past loan and incur new debt for the relevant amount at the current lower rate. But if the past rate is lower than the current rate of interest, the lower of the two should be used.

10. The uniform annual recovery of the capital cost at the relevant rate of interest over the remainder of the life of the project can be calculated with the help of simple readymade tables showing recovery of a rupee's present capital over x number of years at y rate of interest.

11. There may be major repair works of some capital structure or other of the project. For this the same method of calculation should be used from the date of incurring the cost for the estimated life duration of this major repair work. This annual cost should be added, for the years of its life, to the long term annual capital cost of the project.

12. Now we turn to the annual operation and maintenance cost (O&M cost) of the project. It includes the salaries and allowances of the persons - engineer down to the casual labour - engaged in this task on the particular project. The Authority's first set of proposals excludes some part of the total salary paid to certain types of staff (like Sixth Pay Commission's recommended scale, etc.). The justification for this is not provided in the report. It is not clear to me. If the Authority feels that the new salaries of any class of the employees of the project are too high, it should recommend alternative staff at lower salaries for the project. The material costs of any repair and maintenance work are also to be taken into account.

13. There is one item of the O&M cost that the Authority includes in its calculation that should not be included, in view of the policy change in regard to the operation of the project. The Authority includes the salary of the staff engaged for work below the distributory level and the cost of maintenance of the minor and the water courses. There has been a policy decision that water is to be sold at the distributory level (at the head of the minor) to the Water Users Association (WUA). This Association should have all farmers that own or operate land in the command area under the minor as its members. The WUA should be responsible for the distribution of water to its members' fields as well as for the repair and maintenance of the minor and the water courses. Under such circumstances, the staff for this purpose (the *patkari*) should -and would - be an employee of the WUA and not of the state government. It is only then that the WUA can have proper control over the work of the *patkari*. Similarly, the task of repair and maintenance of the minor as well as the water courses should be the responsibility of the WUA. These costs should be borne by the WUA and therefore these charges should not be included in the total O&M costs of the project by the Authority. The WUA will recover these costs from its members along with the cost of water supplied by the canal authority.

14. The same should be the approach to the cost of distribution of water (including the electricity cost) lifted by a Lift Irrigation Scheme or an industrial user or a village drinking water supply scheme, from the reservoir or it's canal.

15. Thus, the Authority will have two parts of its cost of supply of water to the user, the annual capital cost and the annual O&M cost. While it is ultimately the Government and the Legislature that will, in such publicly implemented projects, decide whether and to what extent the capital cost is to be recovered, the Authority should do the necessary calculation and compare the costs per acre-inch (or hectare-meter) of water supplied, along with the net additional benefit, in money terms, from the use of such water, in order to judge if charging any part of the capital cost is sustainable for the users. In my view, the industrial users of such water should be made to pay the entire cost of the water taken by them. So should the villages and towns taking water from the reservoir or its canal.

16. In the light of the above line of reasoning, it appears unnecessary to have the three-fold categorisation of the so-called "fundamental parameters", namely, Affordability, Accessibility and Quantity and Timeliness of Supply and the weights assigned, arbitrarily, to these for the different major category of users of water (see section 12 of Annexure 1.2 of the Approach Paper). These are matters that should not be pre-judged and put into a formula before allocation of costs. The cost of water should be uniform. It is for the state to decide, what part of the cost, to whom and when, is to be exempted. The Authority can make suggestions to the effect, as has been suggested above in regard to the Capital

Cost. The government should know to whom, when and by how much subsidy, in the nature of exemptions, is being given or is to be given.

17. Given these two total costs, namely the annual capital and the O&M costs, the per unit of water cost at the head of the minor may be calculated by dividing the total cost by the volume of water let out into the minors. This is necessary in order to later suggest the water rate.

(C)

18. We now turn to the calculation of returns from the use of water in the reservoir to compare it with the cost of provision of water in order to have a basis for the charge the user should pay. *In regard to irrigation, it is basic to calculate the best return, in value terms, per unit of water that can be obtained in crop production. Often, what is sought is "more crop per drop", meaning more output, in physical terms, per unit of water. That is not what is relevant. Surely, all crops under irrigation will produce higher yield per hectare than under unirrigated condition. But, when multiple crops can and will be produced by farmers in a season/year under irrigation, it is necessary to see what combination of crops, subject to the available quantity of water, will give the highest return. This is possible only when the crop productions are compared and combined in terms of additional value produced. The present Approach Paper does not appear to do so.*

19. In order to know how much of water would be required for irrigating the total command area under a minor, it is necessary to know the types of crops that are or can be grown under irrigation in each season, the material input costs (per hectare) required for growing each crop, the average per hectare yield of each crop under irrigation as well as under unirrigated condition in the area, and the price at which the crop is sold in the regulated (or unregulated market) nearby. [This is one reason why the exercise entrusted to the MWRRA should be done separately for every project. Broadly, the crops best grown under irrigation in the four districts of the Vidarbha region, for example, will be quite different from the use pattern in the western Maharashtra region; and, so on.] And, finally one must know the quantity of water required for irrigating every crop, during the season, at the field level and the number of irrigations, with intervals, normally required.

20. The crops actually grown or likely to be grown, while varying from region to region, are the seasonal cereals like jowar, bajra, wheat and rice, the various types of pulses and oilseeds, two seasonals like long staple cotton, and annual crops like sugarcane and banana, and also orchard crops like grapes, pomegranates, and other fruit crops. For each project, such crops should be identified.

21. It is not easy to find out from available data the actual yield rates of each of these crops in any particular year. For a crop like sugarcane, which is largely processed into sugar in co-operative sugar factories, there is a fairly reliable source for this information. The MWRRA should seek the help of each such factory in the neighbourhood of a flow irrigation project and ask the factory to give it the data on the quantity of sugarcane harvested by the factory from the members' flow irrigated fields during each particular year and the total area from which this was harvested. Since the factory harvests the cane of its members and records it for the purpose of making payment to farmers, this data would be available from the factory every year. The factory should be requested to give the final price paid for the quantity every year as well.

22. For other crops, the task is not so easy. For cotton, long and short staple separately, there is record of arrivals, both quantity and the area from which it was harvested and the price paid for the quantity, with the agents of the monopoly procurement scheme in each regulated market in the

cotton producing areas. We need such data from the markets that serve the irrigated areas. This, by proper arrangement with the agency, should be available every year.

23. For most other crops this facility is not there. Therefore, the MWRRA has to take recourse to more than one source for the data on per hectare yield and price. One source is the results of the annual crop-cutting survey undertaken by the agricultural department of the state. These, of course, do not relate to particular project areas or even districts, but are sampled for estimate for the state as a whole. But, on request, the state agency can give the Authority data on average yield rates of individual irrigated crops, not for individual projects or districts, but for broad regions, like western Maharashtra districts, Khandesh districts, Marathwada districts, Vidarbha districts, districts of eastern Maharashtra and Konkan. Since these are not sampled for such smaller regions, they have to be used with caution. But, it is important to remember that these data are available every year and should be so obtained.

24. Another source of data for this are the respective agricultural universities in the regions. For a variety of purposes, they generate such data on their farms under irrigated conditions, and can share these with the Authority. And, finally, the agricultural department has in the past generated such results for assessing the yield potential of various crops and the quantity of water required for irrigating such crops. These are not regular annual data, but collected at some time or the other for the purpose in hand. Nevertheless, they will be useful for assessing the value productivity of the individual crops in the region (not necessarily in a particular project area) as well as the quantity of irrigation required to irrigate every crop.

25. These yield and water use data from various sources should enable the Authority to arrive at an acceptable figure of yield of different crops under irrigation in different regions of the state and yield per acre-inch (or hectare-meter) of water used, from time to time. It is desirable to keep a continuous track of such data to know if any changes are taking place in this due to varietal changes, widely accepted, or other reasons.

26. So far as prices of the products are concerned, apart from the sources for sugarcane and cotton every year, mentioned above, the Authority will have to depend on the average or median auction price for such crops in the immediate three post-harvest months of the crop from the relevant regulated markets every year. It is not proper to take just one price in one month, but get the daily average or median price in the market for the three post-harvest months over which farmers bring their produce to the market. The prices from the markets nearest to a project area should be used for obtaining the prices of the produce relevant to the particular project.

27. Prices of products change from year to year due to general inflationary conditions. Furthermore, the relative prices of the different crops do not remain unchanged from year to year due to changing production conditions. This is the reason why a single year's price data for different crops should not be used to arrive at the relative value productivity of different crops grown in the project area. It is desirable to calculate the relative prices of the crops every year and arrive at an average of the relative prices of the individual crops grown under irrigation in a project area with the help of annual data for 10 to 15 consecutive years in the past. Indeed, the Authority should, with these annual data prepare a moving average of the relative price for 10 or 15 years by adding new years and deducting as many in the beginning past years.

28. Once these relative prices and their moving averages are established, the Authority should take a particular product's latest actual price and obtain the current relative prices of the other crops

by using the average relative price relation in order to estimate the value of the yield of crops under irrigation in the latest year. This method is useful to avoid the occasional suddenness of change in relative market price while providing for a steady change or trend in it, if any.

29. Having arrived, in the above stated manner, at the value of output of every relevant crop under irrigation in a project area and the quantity of irrigation water used to produce it, the Authority will be in a position to arrive at the value generated per acre-inch (or hectare-meter) of irrigation water for every crop. This should provide the basis for allocation of water to the irrigated fields in different projects. Of course, water is not to be given to a single crop producing the highest value per unit of water in every season. Farmers are sure to grow different crops in a single season. The Authority should take the help of agronomists as well as of the knowlegeable farmers of the area to arrive at a combination of crops that can/should be grown in the area in the season, subject to the most economic use of water. This will help the Authority to arrive at the quantity of water to be released at the minor-head every season to the entire command area under the minor. What crops the water-receiving farmers grow in the season will be their own choice. What the Authority will assess is the type of cropping that would give the highest return per unit of irrigation water to the economy in the project. If the farmer/farmers decide to grow more water-using crop then they will find themselves short of water. But that is their choice, not that of the irrigation authority.

30. The above calculation is being suggested on the basis of the gross value of output per unit of water. One may say that not every crop may have the same proportion of this value as material cost of production. If so, the total returns to labour, land and water would be different. Therefore, it may be useful to deduct the material cost, (i.e., the cost of seed and all other materials used in producing the crop) from the gross value of output calculated. Then one can compare the net social return to a unit of irrigation water and work out the best crop combination in a season on that basis. This raises the question of the source of data for such material costs for every crop under irrigation in the project area.

31. These data are not as easily accessible. One major and reliable source of such information is the survey into the cost of production of the major crops, carried out every year, by the government of India in every state. But, the sample of farmers for the purpose relates to only the farmers growing the major crop in which the government is interested. These major crops are the major cereals, cotton, sugarcane and a few others. But, the data relating to the sample farmers collected in each year includes the costs incurred for every crop grown by the sample farmer, besides the major crop concerned. These data are collected from the sample farmers for three consecutive years after which some other major crop is taken up. But, for many or even most crops data are available for material inputs (quantity and value) for most of the years. The difficulty is, these data are not routinely tabulated. If the Authority will request every agricultural university in the state, (who routinely carry out the survey in their regions and are the custodians of the basic data), to extract such data relating to the relevant irrigated crops in each farm for each year, it will provide the most useful basis for such information. The Authority can ask for the data from the present year onwards, without going into the past, to save expense and time. These data will provide the basis for estimating the material cost in case of every crop, to be deducted from the estimated gross value of output.

32. The other such data that can be obtained is the data for such crops grown by the agricultural universities on their farms. The data from them should be the physical units, like labour days, manure, fertilizer, etc. Of these, the data relating to the material inputs should be converted into

values for specific project areas using the prices of these prevalent on the farms in the region. (The labour data may be used for other purposes discussed below). These and the earlier set of data from the cost of production surveys would help the Authority to arrive at the material costs of production of the different crops for every year.

33. After the material expense of each crop under irrigation is established, it can be deducted from the estimated value of the gross produce of the crop under irrigation to obtain the return to labour, land and water from the crop. This net social return may then be divided by the quantity of water required at the field level to produce the crop, in order to arrive at the net return per acre-inch (or hectare-meter) of water. The same procedure as described in paragraph 29 above to determine the most appropriate cropping pattern under irrigation giving the highest net return to the total quantity of irrigation water supplied in the command area may be followed.

(D)

34. Having arrived at the return to a unit of irrigation water in the project, the task before the Authority is to fix a price to be charged for the water to be supplied. Since the policy is that the WUAs in every minor are to buy water in bulk, the authority shall decide the quantity of water to be provided to the association in every season, the frequency of it in very season and the water price to be charged of the WUA. It is pointless to think in terms of the individual crops for the purpose. The crop pattern for the most economic use of water has already been decided. The farmers are left free to decide what crops they will grow with the quantity of water to be made available in the season to their plots. The price of water should be uniform for all purposes. It is pointless to discriminate between marginal, small, medium and large farmers for the purpose. Each will receive water in proportion to his land under irrigation in the command.

35. The major task is to decide on the price to be charged, and this involves a decision about the cost to be covered, the total cost including capital and O&M cost or only the O&M cost. For this purpose the Authority should first see the difference between the value of the gross produce of every crop under irrigation in the area and under unirrigated condition. This latter data can be found from the same sources from which the irrigated produce data are obtained, as mentioned earlier. It is of course important to remember that the difference in yield under the two conditions is not entirely due to water; more or less of labour may also be involved. Taking account of these, the Authority can find out what proportion of the net return due to water should be charged, whether the entire total cost of water or only the O&M costs or something in between. Giving these figures separately in its recommendations will help the government to decide whether and to what extent they would wish to subsidise the users. It is best that, whatever the subsidy, it is uniform for all farmers.

36. The method of arriving at the cropping pattern in the command area that gives the highest return to the given quantum of irrigation water may raise some legitimate doubts about the possible exclusion of some crops in the design. Let me give two examples. Earlier studies by the state's agriculture department on requirement of irrigation water for different crops show that an acre of (annual) sugarcane crop requires 180 acre-inches of water during the year, and an acre of hybrid jowar in the Rabi season 18 acre-inches. This means, 10 acres of Rabi jowar can be irrigated with the help of the quantity of water given to one acre of sugarcane. But the gross value of produce of one acre of sugarcane was just about half of the gross value of 10 acres of hybrid jowar. What is true of hybrid jowar is also more or less true of most other seasonal crops, with the exception of paddy. The working out of the most profitable crop combinations in a project area in terms of returns to water, therefore, may result in

sugarcane being ruled out in designing the flow water amount and frequency to a field in the project area. For the many existing flow irrigation projects, in western Maharashtra in particular where sugarcane to-day accounts for more than three-fourths of the total irrigation water, this may be a very unwelcome proposition, to say the least. But, there is an answer to this problem.

37. The first Irrigation Commission of Maharashtra (1962) had recommended that farmers in the command area of any irrigation project should not only be permitted but encouraged to sink dug wells/ shallow tube-wells in the command area to recycle the water seeping underground from the canal system as well as in their fields, for use. The state government has now made this obligatory. The WUAs should be asked to sink such wells either on their own or with the help of their members in order to supplement the canal water supply to their fields for any more water- consuming crops (like sugarcane, banana, and paddy). This will enable better use of water in our irrigated areas and better distribution of irrigated crops. The Authority and the government should not put any charge for the exploitation of such ground water. It was a misguided decision taken in earlier times to charge 5% water rate from such wells extracting ground water. The present proposal of giving this up is therefore welcome. But, there is no point in the state bearing a subsidy on that account, as is stated in the report of the Authority. The water rate to be charged need not carry any such subsidy. The farmers or their Associations will incur the necessary capital and running cost to exploit the ground water.

38. The exploitation of such ground water in the command area under every minor and water course will provide opportunity for some/many member-farmers to grow a crop like sugarcane. It may not be as widespread in a command area as to-day; but it would be adequate to sustain a reasonably efficient brown-sugar manufacturing factory near the project. (And a number of such brown sugar manufacturing co-operative factories can own a single white sugar processing factory that can run the year round). The fear of complete loss of sugarcane will be largely misplaced. And, the total water supplied to the command area will be much greater and better utilised.

39. If the Association devises methods that can do with less water for irrigating a crop (like drip irrigation, etc.), there can and should be no objection to this. The Association can either reduce its requirement of water from the project or use the saved water for more higher water consuming crops. No incentives are required for this.

40. The basic points that the Authority must insist upon are as follows:

(i) The WU Association should not only have all land owners/operators in the command area under the minor and its water courses as its members but also sign an agreement with each one of them stating the quantity of water to be delivered to the plot in each watering and the number of waterings in each season to be provided. It is needless to remind ourselves that with an assured one cusec discharge from the outlet into the watercourse, the farmer's water requirement can be calculated taking the area of his plot under the outlet into account and the water can be diverted to his field for a duration that will ensure the quantity required.

(ii) The Authority should calculate the loss of water in the reservoir due to evapo-transpiration in the summer season and then calculate the return to the volume of water let out in the summer season and compare it with the return in the Rabi season. If the return in summer is lower for the given volume than in Rabi, then it should consider greater delivery of water in Rabi rather than save it for summer. If however the total command area is being fully provided with water in Rabi, then the Authority might examine alternative use of water in Rabi by new lift irrigation schemes from the main canal on the upper side of the canal which does not receive flow water. It is inadvisable to waste water through evapo-transpiration in summer rather than give it to larger area for lifting in Rabi season.

(iii) The Authority should state in its agreement with the Association, which should be signed before the beginning of the Rabi season, that the water shall be provided to the Association as per agreement, and failure to do so for any round will involve a payment of a penalty by the Canal Authority to the WUA. This penalty should be laid down by the Authority. Similarly, If normally there is an agreement to provide some water in summer, but thanks to rainfall shortage, the reservoir is expected to run short of water for summer, the agreement must state the quantity of water that can be provided to the WUA in summer in the stated number of irrigation turns. The Association shall make pro-rata reduction of water to every user and this must form a part of the agreement of the Association with its members.

(iv) The WUA shall pay the entire water rate to the irrigation authority before the end of the particular season. Failure to do so would mean cessation of supply from the beginning of the next season. Any disruption of supply as a result of failure of timely payment of dues shall be at the cost of the WUA, and no penalty would be payable by the irrigation authority for this.

41. The rate to be charged per unit of water supplied in each season shall be revised at the beginning of every three-year period, since the O&M expenses will change. The capital cost or any part of it, if charged, will not change, except for the major repairs that have longer life and are not included in the O&M expenses.

For Lift Irrigation Schemes from the Main Canal or Reservoir

42. The water per unit of water charged to the WUAs shall be charged to the Lift Irrigation schemes lifting water from the reservoir or the main canal. The utilisation of water to be lifted under the scheme shall be estimated in the same manner and a similar agreement shall be signed by the Lift Irrigation Association with its members on the one hand and the Authority supplying water on the other. The logic of water use shall be the same as for the flow schemes and shall not be left to the will of the lift association. The cost of pumping water, the capital cost of carrying it to the highest level, and distributing it to members shall be borne by the Lift Irrigation Association and recovered from its members. The water supplying Authority shall ensure that no more than the permitted volume of water is lifted by the lift scheme in every turn. The Authority should ask for a copy of the detailed electricity bill for each season for purposes of scrutiny.

For Industrial Use

43. For Industries lifting water from the reservoir or canal from the reservoir, the full cost, including the full capital cost and the O&M cost should be fully recovered. There should be no concession in this matter.

44. The industry shall be required to reprocess all water used by it for both industrial and other purposes, including human uses, obligatorily. The new industries seeking water should design systems for the purpose right from the beginning.

Only after physical verification of such reprocessing devices shall water be supplied to the industry and after the first year a detailed verification shall take place. The industry shall, from the second year, receive only so much of water net of the entire reprocessed water, at the specified cost. Failure to use the entire water deserving to be reprocessed should result in denial of any water to the industry, with one month's notice.

45. *For industrial units already taking water from any reservoir or canal, notice should be given to devise reprocessing all water let out by the factory as well as from other uses, within one year. Failure to do so should result in stoppage of supply of all water to the unit. In the light of past experience, it is only by enforcing very strict discipline that industrial units can be made to behave.*

Household use in villages and towns

46. Like in case of industry, the domestic supply of water to villages and towns should be, to start with, made at cost, that is, the capital and O&M cost per unit of water. This is the cost at the point of lifting water from the system. The distribution cost, besides the cost of water purchased, should be charged to the consumers by the village or town authority.

47. In case of towns and cities as well as in case of villages, the quantity of water supplied per head of population at this minimum cost should be the quantity of water required by an average person for drinking, bathing, washing, cooking and for the toilet. The authority should estimate the total water needed for the estimated total population of the village or town (of course changing every year) on this basis. While this total quantity of water should be supplied at cost, any more water than this should be charged at three or four times this per unit cost. This will make the village/town authority to require the households to devise ways of economising in the use of water supplied. The municipality of a town should ask its households to install purifying devices to process the water from the bathroom and the kitchen to make it fit for flushing toilets as well as washing vehicles and gardening. Of-course, this would be possible for houses around which municipality asks land to be kept free of construction. It is only the toilet water that should go into the drainage system. In case of big housing complexes, as well as large hotels, even the toilet water and the solid waste should be put into gobar-gas plants and the water from it should be used for gardening and toilets. This will economise in the use of water. But, since the canal/reservoir Authority cannot enforce this, the only way is to charge three to four times the basic cost of its water which might persuade the municipality and the populace to economise in the use of reservoir water.

48. The determination of the quantity of water from the reservoir and the canal system to be supplied to the irrigated command area in the manner specified above might, in some situations, result in some water in the reservoir being found surplus. This water should be used to irrigate unirrigated areas adjacent to the canal system, in the manner specified above. The Authority should also ask for additional flow irrigation schemes in the same river to use the surplus water, rather than wait for expensive electricity. In designing new irrigation systems, the crop water requirement should be calculated in the above manner, to reduce wastage of precious water on less economically productive crops. We can see the advantage of this approach: much larger areas of the region can benefit from irrigation under such design than the present method where a relatively small area under sugarcane absorbs the bulk of the impounded water. (It is needless to point out that under many flow irrigation projects to-day

the tail-end canal areas are often deprived of any water). With larger area under irrigation, larger number of farmers shall benefit. Agriculture will be stabler in the region. Finally, these expanded areas under irrigation will employ a larger number of labour days during the year than the present sugarcane-based cropping pattern in flow irrigated western Maharashtra. And, still, there is scope for sugarcane in these systems, leading to most economic use of the impounded water, from the seeped part of it.

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INTERFACE OF INCOME, HEALTH AND ENVIRONMENT: AN ECONOMETRIC INVESTIGATION

A. L. Nagar, Amit Shovon Ray, Aparna Sawhney, Sayan Samanta

This paper is dedicated to the memory of late Professor Lawrence R. Klein who died very recently at the age of ninety four years. He was the most affectionate and loveable person, professor and guide of his students and research associates. Professor Klein was the founder of construction of large economy wide policy modeling. His earlier works like the Klein-Goldberger model for the U S economy and the Klein -Ball model for the U.K. economy provide good illustrations. His later involvement in most of the policy models for various economies along with his research associates across the world is well known. The subject of modeling structure of an economy was truly at the heart of Professor Klein. In fact, the present paper was also motivated by him at an early stage. Professor Klein was awarded the Nobel Prize for his contributions to econometrics and economic model building.

This paper analyses interrelationships between per capita income, health and respirable particulate air pollution in a simultaneous equations framework for the Indian economy during the last 25 years. Four structural equations are postulated to explain changes in four endogenous variables (per capita GDP, life expectancy, incidence of respiratory diseases, and respirable particulate matter) in terms of several exogenous variables represented through indices of physical infrastructure, social infrastructure and air pollution. These indices are constructed by the principal components method. The model is postulated in loglinear form and estimated by the two-stage least-squares method using data for the Indian economy during 1980-81 through 2004-05. Although highly simplified, our model provides key insights into the nature of economic development in India. First, the respirable particulate pollution has had a high cost on income and health. The reduced form shows that a 1% increase in the air pollution index led to a decrease of 8% in per capita income, a decrease of 0.7% in life expectancy, and an increase of 19% in the number of cases of respiratory diseases. Second, the social infrastructure plays a more vital role in development than the physical infrastructure. While physical infrastructure is important for economic development it ranks last of our preference ordering, so there is need to pay more attention in providing for better social infrastructure and reducing particulate pollution.

1. INTRODUCTION

Unidirectional relationships between income growth, health and environment, taking two at a time have been extensively studied and are well documented in the economics literature.[1] However, it is true that these are interdependent variables.[2] The variation in them should be jointly explained in terms of some exogenous variables in the framework of a simultaneous equation system.

In the present paper, we postulate a four

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The authors are grateful to Professor R.A.L. Carter and several discussants of an earlier draft of the paper presented in seminars held at the National Institute of Public Finance and Policy, New Delhi, and Jawaharlal Nehru University, New Delhi. The comments from discussants have vastly improved the paper. We are also grateful to the editor of this journal for detailed editorial comments on the paper which have been quite useful in improving earlier draft of the paper. Any remaining errors are the responsibility of the authors.

equation structural model to jointly explain variation in (1) Per Capita Gross Domestic Product (GDPPC) (2) Life Expectancy (LE) (3) NOCRD (Number of Cases of Respiratory Diseases per 1000 people) and (4) PM10 (Respirable Particulate Matter), in terms of several exogenous variables. The exogenous variables have been grouped together by the principal component method and are represented by indices, such as (a) PI (Physical Infrastructure) (b) SI (Social Infrastructure) and (c) API (Air Pollution Index).[3]

We suppose that the four endogenous variables included here aptly describe and represent the indicators of economic growth (GDPPC), health (LE and NOCRD) and environment (PM10). We discuss the motivation for the choice of endogenous variables in section 2. Section 3 describes the exogenous variables and the method of construction of the indices PI, SI and API. The conceptual framework for the structural model is given in section 4. We use time series data for the Indian economy 1980-81 to 2004-05 to estimate the parameters of the structural equations by 2SLS method.[4] The numerical results of estimation are given in section 5. Finally, section 6 presents the conclusion and some inferences from the estimated model.

We find that most of the endogenous and exogenous variables show an upward rising trend and are non-stationary (see the diagrams in Appendix B). However, it should be noted that the 2SLS method provides asymptotically optimal estimates of the parameters in a structural equation model and statistical tests of significance remain valid in the presence of non-stationary variables provided the residuals from the estimated equations do not possess unit roots. [Hsiao, 1997].

We use the MacKinnon [1991] test at 5% level of significance and find that the residuals from the structural equations corresponding to GDPPC, NOCRD, and PM10 are stationary but the one corresponding to LE possesses unit root. However, we should note that in a structural equation system, any single equation provides only part of the explanation of the system [Carter and Nagar, 1977]. Therefore, in order to check for the co-integration of the variables, one should look at the derived reduced form residuals, rather than the residuals from the structural equations [also see Hsiao, 1997]. The MacKinnon test on reduced form residuals reveals that they are **all** stationary and hence the reduced form provides co-integrated relations.

2. MOTIVATION FOR THE CHOICE OF ENDOGENOUS VARIABLES

The four endogenous variables of income per capita or gross domestic product per capita (GDPPC instead of *Y*), life expectancy (LE), number of cases of respiratory diseases (NOCRD) and respirable particulate matter (PM10) used in our model represent the typical indicators of economic, health and environmental performance. Our choice of variables is also guided by data availability considerations.

We assume that per capita output growth prominently (although not entirely) describes economic development. Notwithstanding the many limitations of this variable as an indicator of economic development, it has been widely accepted in the literature as a good proxy which correlates well with many other dimensions of economic development. **LE** (life expectancy at birth) reflects long term health condition of the people. In the health economics literature, **LE** has often been used as the principal outcome variable to measure health. One may, of course, argue that **LE** does not have an immediate effect on economic development, but in the long, or medium term, we may expect economic development **(GDPPC)** and **LE** to move together, reinforcing each other. Therefore, we include **LE** as another endogenous variable.

Morbidity due to airborne/ respiratory diseases has immediate implication for health and productivity of people and, in turn, for aggregate income, or, GDPPC. Since exposure to PM10 is associated with a range of respiratory allergies and diseases (like asthma, bronchitis, other lung and cardio respiratory diseases), we focus on morbidity effect of inhalable particulate matter (that adversely impacts labour productivity). Therefore, we include **NOCRD** (number of cases of respiratory diseases) as an endogenous variable in the model.[5] The incidence of respiratory diseases is lower when the population has better immunity, diet, living conditions, and invests in defensive measures (which reduce exposure to air pollution, like living in cleaner neighbourhoods, using air filters, traveling in closed vehicles, etc.), all of which can be associated with higher income. Thus in lieu of these multiple variables reducing the incidence of morbidity of the Indian population during the period of the study, we use the proxy variable of GDPPC.

We include PM10 as the fourth endogenous variable to capture environmental effects of air pollution. While this is likely to be determined by the level of economic development, it would have significant impact on morbidity rate directly and on GDPPC indirectly.

3. THE EXOGENOUS VARIABLES AND THEIR INDICES

Physical and social infrastructures are important determinants of economic development and health of the people. Economic development largely depends on transport and communication facilities, and on the availability of adequate power supply. Therefore, in this exercise, we choose to include the following components for PI: surfaced road density (kms per 1000 sq km of geographical area). *SRD*; railway route length (kms per 1000 sq km) *RLT*; fixed line and mobile telephone subscribers (per 1000 people) *FLMS*; electricity capacity installed (thousand kw) *ECI*; internet users (per 1000 people) *INTU*; air transport freight (million tons per km) *ATF*; port traffic transport (thousand tons) *PTT*.

The health status of the people is influenced by availability of facilities for education and healthcare, access to safe drinking water and nutrition, etc. Therefore, we include the following indicators of **SI**: combined gross enrolment ratio for primary, secondary and tertiary schools; *GER*; total number of schools *NOS*; number of hospital beds per 1000 people *NOB*;[6] number of doctors per 1000 people *NOD*; number of nurses per 1000 people *NON*; immunisation of DPT *IMMDPT*; percent of population with access to safe drinking water *ACCDW*.

It is undoubtedly true that measurement of ‘environment at the macro level, for the country, is meaningless. Given our choice of the specific pollutant of PM10, we construct an air pollution index **API**, which captures the pollutant’s causal factors. The main sources of atmospheric particulate pollution are vehicular exhausts, road and construction dust, incomplete combustion of fuel, industry emissions and also burning of garbage. Since data on road dust, construction dust, emissions from diesel generator sets and burning of garbage is not available, we use the proxy of urban population. For construction of API, we include only 13 factors (based on the availability of time-series data): electricity production from hydroelectric sources (% of total). *EPH*[7]; finished steel production *STEEL*; copper metal production *COPMTL*; aluminum ingots production *ALMNM*; cement (all kinds) production *CEMENTS*; petroleum refinery goods production *PRP*, soda ash and caustic soda production *SACS*; sugar production *SUG*; paper and paper boards production *PAPER*; coal production *COAL*; fertiliser (nitrogenous and phosphatic) production *FER*; total urban population *URBPOP*; number of vehicles per 1000 people *NOV*.

We use the principal components method to construct the indices PI, SI and API (see Appendix A for details). Appendix B provides values of PI, SI and API for the period 1980-81 to 2004-05 and represents them graphically in Figures 1-3. The principal components are reported below.

Using the method described in the Appendix A and data for the Indian economy 1980-81 to 2004-05 the three indices are as follows:

$$PI = \underset{(17.24)}{0.35SRD} + \underset{(18.23)}{0.37\,RLT} + \underset{(11.82)}{0.24\,FLMS} + \underset{(17.24)}{0.35\,ECI} + \underset{(8.37)}{0.17\,INTU} + \underset{(11.33)}{0.23\,ATF} + \underset{(15.76)}{0.32\,PTT}$$

$$SI = \underset{(16.34)}{0.33\,GER} + \underset{(18.32)}{0.37\,NOS} + \underset{(2.48)}{0.05\,NOB} + \underset{(16.83)}{0.34\,NOD} + \underset{(16.83)}{0.34\,NON} + \underset{(12.87)}{0.26\,IMMDPT} + \underset{(16.34)}{0.33\,ACCDW}$$

$$API = \underset{(-8.92)}{-0.24EPH} + \underset{(9.29)}{0.25STEEL} + \underset{(6.69)}{0.18COPMTL} + \underset{(8.92)}{0.24ALMNM} + \underset{(9.29)}{0.25\,CEMENTS} + \underset{(8.18)}{0.22PRP} + \underset{(9.29)}{0.25\,SACS} + \underset{(9.67)}{0.26SUG} + \underset{(9.67)}{0.26\,PAPER} + \underset{(9.29)}{0.25COAL} + \underset{(9.67)}{0.26\,FER} + \underset{(9.67)}{0.26\,URBPOP} + \underset{(9.29)}{0.25\,NOV}$$

The quantities within brackets (under each coefficient) indicate percent share of contribution of individual indicators in the index. For example, the sum of coefficients in PI is 2.03. Therefore, the percent share of contribution of SRD in PI is obtained as

$$\frac{(0.35)}{(2.03)} \times 100 = 17.24\% \quad \text{and so on.}$$

PI, the index of physical infrastructure is composed of the indicators of energy, transport and telecommunication. Improvement in infrastructural services has a direct effect (through the intermediate inputs) and an indirect effect (through efficiency enhancing) on economic growth. It may be interesting to figure out the relative contribution of energy, transport and telecommunication in PI. We note that transport (sum of contributions of SRD, RLT, ATF and PTT) contributes about 62.5%, telecommunication (sum of contributions of FLMS and INTU) contributes a significant 20.19%, whereas, energy (ECI) contributes a lower share of 17.24% to PI.

SI, the social infrastructure index reflects the status of the society in fostering the well-being of its individual members. The index computation uses conditions and facilities that promote human development in all its dimensions - education, health, nutrition, sanitation and equality among gender, class, caste and income groups. One could conceivably draw a long list of variables to identify social infrastructure. In this study, we look at three sets of variables to capture social infrastructure, essentially dictated by data availability.

First, we consider access to education, and use as proxy enrolment rates (GER) and number of schools (primary, secondary and higher secondary) (NOS), the latter as a measure of total capacity available for enrolment, which have a weight share of about 35% in SI. Next, we consider health infrastructure captured by the numbers of hospital beds (NOB), doctors (NOD), nurses (NON) [number of hospital beds per thousand people NOB, number of doctors per 1000 people NOD; number of nurses per 1000 people *NON*] and child immunisation rate against DPT (IMMDPT) contributing about 49% to SI index. Finally, we introduce a measure of sanitation as reflected in access to safe drinking water, i.e., percent of population with access to safe drinking water (ACCDW) contributing about 16% to SI. Clearly, these three sets of variables correspond to three very important dimensions of social infrastructure. Needless to mention that the underlying variables capturing each dimension could be expanded to a considerable extent. But this was not possible due to data constraints.

API, the air pollution index reflects that the number of vehicles per 1000 people, coal and production of selected industries directly contribute about 90%, urban population contributes about 9.7% to API. Since hydroelectric power generation is a clean means of generating power, EPH has a negative contribution of -8.92% to API.

4. CONCEPTUAL FRAMEWORK FOR THE MODEL

Ideally, one should conceptualise a simultaneous equations framework which enables measurement of feedback effects and establishes interdependence of per capita income, health and environment.[8] We consider physical infrastructure services (PI), social infrastructure services (SI), and industrial structure and consumption pattern of an economy to be the key underlying *exogenous* drivers of the three endogenous variables - per capita income, heath status and environmental quality - interfacing and interacting with each other. For the sake of symmetry in nomenclature we call the underlying industrial structure and consumption pattern (which essentially determines the level of pollution generated in the economic system) as environmental infrastructure (EI). PI represents public physical infrastructure services, and consists of transport and communications infrastructure, while SI consists of health and education infrastructure. The segregation of the two types of public infrastructure services is useful in distinguishing their relative importance in determining income and health outcomes in the model.

It is pertinent to note here that since income both depends on and determines PI, SI and EI; it is difficult to term these as truly "exogenous". For instance, the availability and quality of water determines the level of output and income (through agricultural production), and at the same time the extent and nature of agricultural production in turn determines the quantity and quality of water.[9] While PI directly affects income, SI is expected to influence health status, which in turn affects productivity and hence output and income. Indeed, income also affects health status in a simultaneous equation framework. Environmental quality affects both health and income; while income is expected to affect the level of environmental quality, the latter being a function of underlying EI. We represent this mutual interdependence in terms of a simplified schematic diagram, with endogenous variables in squares and exogenous variable in circles.

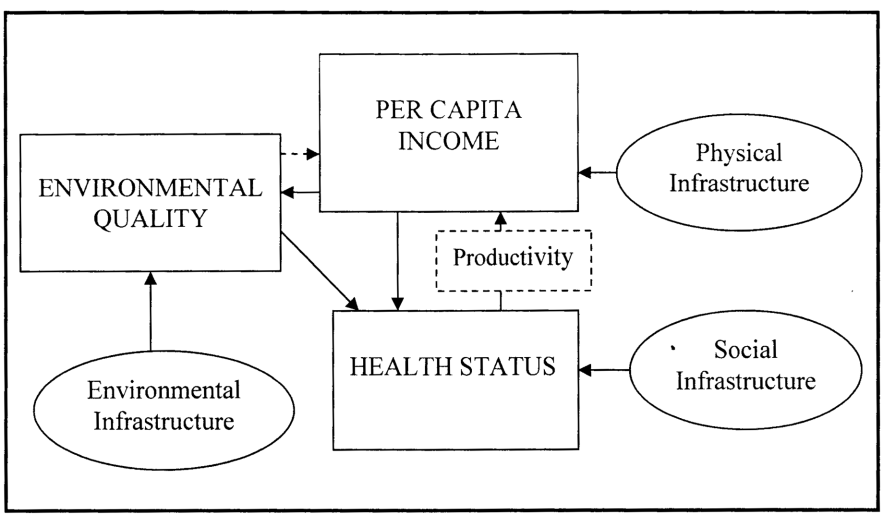

Diagram 1. Interface between Income, Environment and Health

As depicted in the schematic diagram (see Diagram 1 above), our focus is the endogenous nature of the relationship among income, health and environmental pollution. In our structural model for India these three variables will be determined simultaneously over the 25-year period from 1980-81 through 2004-05. Our macro model attempts to capture the interrelationship between some of the key performance measures of these variables. While per capita income is a readily measurable single variable, health and environment are composite variables which cannot be described in terms of any one single variable. The health status of the people may be described in terms of mortality/ morbidity rates, life expectancy, etc; while environmental quality may be described in terms of air and water quality in the country, the magnitude of forest cover, biodiversity, etc. We keep this in mind while developing our econometric model specification.

In our study here, we consider respirable particulate pollution to be responsible for morbidity that impacts human productivity and hence national output. Our choice of pollutant is guided by its widespread significance in adverse health impact in India. It is widely recognised that " *....acute respiratory infections are one of the chief causes of lost life-years in India. ... whereas pollution due to SPM (suspended particulate matter) is widespread in most cities, only a few of them have a high concentration of* SO_2*, or* NO_x*"* [TERI 1998; Pp. 196 and 175]. Suspended particulate matter with diameter less than 10 microns, PM10, in particular is responsible for most of the respiratory diseases in India. Observational epidemiologic studies in India as well as outside have provided persuasive evidence of adverse health impact from inhalable or respirable particulate matter [Pope and Dockery, 2006; Ostro and Chestnut, 1998; Agarwal et. al., 2006].[10] Inhalable particulates PM10[11] can penetrate the thoracic region of the lung, and the adverse health effects include premature mortality, chronic bronchitis, restricted activity days for adults, lower respiratory illness for children, asthma symptoms, acute respiratory symptoms, hospital admissions, emergency room visits. A recent analysis of hospitalisation and emergency visits for chronic obstructive pulmonary diseases, asthma and emphysema in the city of Delhi indicated that high pollution of PM10 is directly associated with frequency of asthma and chronic obstructive pulmonary disease patients [Agarwal et. al, 2006].

In our model PM10 increases morbidity, which in turn adversely impacts per capita income. Thus, although environmental quality can have a direct feedback effect on income (say, due to reduced productivity of degraded natural resources), in our model PM10 pollution does not directly impact per capita income (hence a dotted arrow from environmental quality to economic development in the diagram above). Given the nature of pollution under consideration, environmental quality has an indirect feedback into income through health status. Thus, while our empirical model accounts for the two-way relationship between per capita income and health status, there is only a one-way direct feedback from per capita income towards environmental quality.

The Model

We construct a structural model, in which income is determined by labour productivity and physical infrastructure PI.[12] While PI directly determines income, social infrastructure SI determines income only indirectly through labour productivity. Labour productivity is considered to be simply a function of health. Health is considered as a function of income, SI and environmental quality. Environmental quality in this model is represented by respirable particulate matter PM10, and is a function of the EI (determined by industrial output structure, consumption of pollution generating goods), and income. Thus our model is specified as follows:

$$Y = Y(LP, PI) \quad (1)$$
$$LP = LP(H) \quad (2)$$
$$H = H(Y, SI, PM10) \quad (3)$$
$$PM10 = PM(Y, EI) \quad (4)$$

In equation (1) income per capita *Y* is a function of physical infrastructure *PI* and labour productivity *LP*, which is an unobserved (latent) variable. Since the unobserved *LP* is a function of observable health *H* (eqn 2), we can re-write the first equation as follows:

$$Y = Y(H, PI) \quad (1')$$

In estimating our model, we use two health outcome indicators life expectancy *LE* and number of cases of respiratory diseases *NOCRD* in order to capture the health impact of respirable particulate level PM10. So *H* is a vector with two components *LE* and *NOCRD*. Equation 3 for *H* can be written out in its fuller form for each of its two components as follows:

$$LE = LE(Y, SI) \quad (3')$$
$$NOCRD = N(Y, PM10) \quad (3'')$$

The last equation of the model for respirable particulate PM10 is re-written as a function of income and specifically atmospheric pollution index API (replacing EI):

$$PM10 = P(Y, API) \quad (4')$$

Thus our model is now recast with the four equations (1′), (3′), (3") and (4′), which can be estimated since these are in terms of observable variables (having dropped the latent variable of labour productivity). These four equations form the basis of our simultaneous equation system used in section 5.

5. THE STRUCTURAL EQUATIONS AND THE RESULTS OF ESTIMATION

We formulate a log-linear structural model based on the set of four equations (1′), (3′), (3") and (4′), and simultaneously determine changes in ln GDPPC, ln LE, ln NOCRD and ln PM10 in terms of exogenous infrastructure variables. Our exogenous variables are actually represented through the three infrastructure indices PI, SI and API. We estimate the equation system for the Indian economy for the period 1980-81 to 2004-05. During this period the Indian government adopted major changes in its economic policy from an inward looking regime of controls to a more outward oriented and market driven approach, and implemented several institutional reforms in environment and health policies.[13] Liberalisation and changes in trade pattern can improve environmental quality - either through the import of relatively pollution-intensive goods from other countries (often from developing countries); or through the import of cleaner technology from developed countries. The structural changes resulting from the new policies adopted in the Indian economy are captured in the three ‘exogenous’ indices used in the model. Four structural equations postulated are as follows:

$$\ln \text{GDPPC} = \alpha_1 + \alpha_2 \ln \text{LE} + \alpha_3 \ln \text{NOCRD} + \alpha_4 \text{PI} + \varepsilon_1 \quad \text{(i)}$$

$$\ln \text{LE} = \beta_1 + \beta_2 \ln \text{GDPPC} + \beta_3 \text{SI} + \varepsilon_2 \quad \text{(ii)}$$

$$\ln \text{NOCRD} = \gamma_1 + \gamma_2 \ln \text{GDPPC} + \gamma_3 \ln \text{PM10} + \varepsilon_3 \quad \text{(iii)}$$

$$\ln \text{PM10} = \delta_1 + \delta_2 \ln \text{GDPPC} + \delta_3 \text{API} + \varepsilon_4 \quad \text{(iv)}$$

The **first** equation relates **ln** GDPPC with **ln** LE, **ln** NOCRD and **PI** apart from the random error ε_1. Our hypothesis is that the health condition of the people (represented by LE and NOCRD) and availability of physical infrastructure, (viz., transport and communication facilities and power generation capacity installed) have a direct impact on per capita GDP. While GDPPC and LE have a long-run positive relationship, NOCRD has a negative relationship with GDPPC. Indeed, sickness of the people reduces the productivity level and hence their income. Physical infrastructure is, of course, a necessary ingredient for economic growth and per capita GDP and has positive relationship.

The **second** equation relates **ln** LE with **ln** GDPPC and social infrastructure index SI and random error ε_2. We assume that there is feedback effect between LE and GDPPC, i.e., higher level of the per capita income should be accompanied with higher life expectancy, and vice versa. Availability of social infrastructure (in terms of facilities for education, health care systems, sanitation, safe drinking water, etc.,) should have a positive impact on life expectancy.

The **third** equation of the model relates **ln** NOCRD with **ln** GDPPC and **ln** PM10 along with random error ε_3. We include only the number of cases of respiratory disease reported annually and ignore respiratory associated deaths (where PM10 may not be the only cause of deaths). Although long term exposure to particulate atmospheric pollution can also reduce life expectancy by altering lung function and making people more susceptible to chronic obstructive pulmonary diseases [Cropper et al., 1997], study of such effects would need tracking of a sample population through time in order to elucidate the chronic impact of long term exposure. However, in the context of the present macro model we do not include PM10 in the LE equation. Indirectly, the air pollution index does impact LE in the interdependent equation system.

The **fourth** equation of the model relates **ln** PM10 with **ln** GDPPC and API and includes the random error ε_4. It is pertinent to note that apart from the factors used to determine API (like industrial production, urbanisation, vehicular traffic) the annual ambient particulate pollution is determined by the technology of production (use of cleaner inputs and processes), level of particulate pollution abatement, stringency of environmental regulations and enforcement, as well as buffering capacity of the region (like tree cover and wind patterns which dissipate particulate pollution to some extent). However, given the lack of systematic annual data on these factors, we assume that higher income goes hand-in-hand with the economy's ability to use cleaner technology, increase pollution abatement, implement and enforce more stringent pollution standards. Hence, we use GDPPC as a proxy variable for these factors. Increasing liberalisation as implemented in India over 25 year period of the present study, has made cleaner technology more readily available in many sectors of the economy. The postulated structural model has been estimated by the two-stage least squares (2SLS) method using the data for the Indian economy (1980-81 to 2004-05).

The following results have been obtained by the two stage least squares method used for estimating our structural model:

$$\mathbf{ln\ GDPPC} = \underset{(0.00)}{-16.89645} + \underset{(0.00)}{6.471494}\ \mathbf{ln\ LE} - \underset{(0.02)}{0.184414}\ \mathbf{ln\ NOCRD} + \underset{(0.00)}{0.036691}\ \mathbf{PI}: \bar{R}^2 = 0.99 \tag{5}$$

$$\ln LE = \underset{(0.00)}{3.288567} + \underset{(0.00)}{0.086830}\ \ln GDPPC + \underset{(0.00)}{0.015292}\ S1: \bar{R}^2 = 0.99 \tag{6}$$

$$\ln NOCRD = \underset{(0.00)}{-46.13876} - \underset{(0.00)}{3.906045}\ \ln GDPPC + \underset{(0.02)}{2.778491}\ \mathbf{ln\ PM10}: \bar{R}^2 = 0.94 \tag{7}$$

$$\mathbf{ln\ PM10} = \underset{(0.00)}{24.36485} - \underset{(0.00)}{2.172702}\ \mathbf{ln\ GDPPC} + \underset{(0.02)}{0.156605}\ \mathbf{API}: \bar{R}^2 = 0.84 \tag{8}$$

(The figures in parentheses below the coefficient estimates are the p - values)

Our estimation vindicates our broad hypotheses depicted in the schematic framework. While physical infrastructure does appear to be important in determining GDP per capita, it is also directly influenced by improved health outcomes like higher longevity and lower morbidity (from respiratory diseases). Health outcomes in our estimated model, in turn, are determined by the level of per capita GDP. Interestingly, as hypothesised, our model does indicate that long term health status (life expectancy) is positively affected by social infrastructure and immediate health outcomes like morbidity from respiratory disorders are influenced by environmental/ atmospheric quality. Finally, air pollution is observed to be determined by GDP per capita and environmental infrastructure.

Reduced Form Estimations

The interface between income, health and environment is only part of the story emerging from our study. Going beyond the structural model, we went on to obtain the reduced form equations, derived from the 2SLS estimated structural equations as follows:

$$\textbf{ln GDPPC} = 9.078827 + 0.812952\ PI + 2.192675\ SI - 1.777927\ API \quad (9)$$

$$\textbf{ln LE} = 4.076882 + 0.070589\ PI + 0.205682\ SI - 0.154377\ API \quad (10)$$

$$\textbf{ln NOCRD} = 2.213702 - 1.732228\ PI - 4.672125\ SI + 4.223510\ API \quad (11)$$

$$\textbf{ln PM10} = 4.639265 - 1.766302\ PI - 4.764029\ SI + 4.019510\ API \quad (12)$$

The signs of all coefficients are according to prior expectation. The short run elasticities of the endogenous variables (GDPPC, LE, NOCRD, and PM10) with respect to PI, SI, and API are easily calculated from the derived reduced form in a straight forward manner. The absolute values of these elasticities are seen to increase over time (because the values of the indices PI, SI, API show a rising trend). The actual and estimated values of **ln GDPPC, ln LE, ln NOCRD and ln PM10** are summarised in Table 1.

We should note that each of the endogenous and exogenous variables in the structural model is in fact, nonstationary, as they show an upward rising trend graphically. However, it has been shown by Hsiao [1997] that the 2SLS method provides asymptotically optimal estimates of parameters in a structural system of equations and all statistical test procedures remain valid in the presence of nonstationary variables, provided the residuals do not possess unit roots. If $\hat{\varepsilon}_t$ represents the 2 SLS residual, at time t, in a single structural equation, let us use the test regression $\Delta\hat{\varepsilon}_t = \alpha\hat{\varepsilon}_{t-1} + \text{error}$; and test the null hypothesis H_0 ($\alpha = 0$) against the one-sided alternative H_1 ($\alpha < 0$). We find that H_0 is rejected at 5% level of significance [MacKinnon critical values; cf. James G. MacKinnon, 1991] in case of the first, third and fourth structural equations (and, therefore, the residuals from these equations are stationary); but the residuals from the second structural equation are nonstationary (as H_0 cannot be rejected).

We should note that in an interdependent system of structural equations any single equation provides only a part of the explanation of the entire system [also see Carter and Nagar, 1977]. Therefore, to examine cointegration relationships among variables, we should look at the reduced form residuals rather than residuals from individual structural equations [also see Hsiao, 1997].

In order to test for unit roots in the residuals from the reduced form, we use the test regression. $\Delta\hat{v}_t = \theta\hat{v}_{t-1} + \text{error}$; where $\hat{v}_t$ is the reduced form residual, at time t, for a given reduced form equation. If H_0 ($\theta = 0$) cannot be rejected, we conclude that the reduced form residuals possess a unit root. Otherwise, if the one-sided alternative hypothesis ($\theta < 0$) holds the residuals are stationary. Using MacKinnon test, see MacKinnon, [1991] we find that H_0 is rejected for all four reduced form equations (for ln GDPPC, ln NOCRD and ln PM10 at 5% significance and for ln LE at a level of significance little higher than 5%). In other words, the residuals in the reduced form equations are stationary. Thus, the above reduced form equations show the cointegration equations.

6. SALIENT FEATURES OF THE METHOD OF ANALYSIS AND SOME INFERENCES DERIVED FROM THE MODEL DESCRIBING THE STRUCTURAL RELATIONS OF PER CAPITA INCOME, HEALTH AND ENVIRONMENT

The following salient features of the method of analysis should be noted.

i) Johnston and Dinardo [1997], Pp. 248-250, have shown by examples that ... omitting relevant variables from the equation is more serious than including irrelevant ones, because in the former case the coefficients will be biased , the disturbance variance over estimated and conventional inference procedures rendered invalid, whereas in the latter the coefficients will be unbiased, the disturbance variance properly estimated and the inference procedures valid ...

Hendry [1986] proposed the *general to simple* approach, according to which one may begin with including several exogenous variables in the equation and even impose higher order lag structure on the equation; then estimate the coefficients in the equation and test their significance. The variables with insignificant coefficient estimates may be excluded. The process is continued till one arrives at a manageable equation with statistically significant coefficients.

Whereas it is good to include as many exogenous variables as possible in a structural equation, is it always advisable to exclude those with statistically insignificant coefficients? Individually, the variables with insignificant coefficients may have no real and significant effect on the dependent variable under consideration, but in large structural model it is always possible to find a 'group' of statistically insignificant variables which form an important economic factor with significant effect on the dependent variable under consideration.

ii) The physical and social infrastructure and air pollution are, in fact, important determinants of the endogenous variables per capita GDP, life expectancy, number of cases of respiratory diseases and PM10 of the present structural model. In general, for larger models one should be able to identify several relevant economic factors which determine the endogenous variables.

iii) The total set of exogenous variables of the structural equations system may be divided into subsets of exogenous variables. The first subset consisting of those exogenous variables which are required to be interpreted 'individually' for their effects on the endogenous variables (like the policy variables, etc.); and the other subsets of exogenous variables which represent the given state variables such as economic, social, environmental, etc., factors and may be replaced by suitable indices.

iv) The indices have been constructed as weighted averages of all (and not only the first few) principal components of the variables of the particular subset. It should be possible algebraically, to express them as weighted averages of the exogenous variables of the subsets. The coefficients of the exogenous variables indicate their relative position, or the rank, according to the contribution they make in explaining the total variation in the over all index.

v) The indices have been exogenously determined. Therefore, the total number of exogenous variables in the equation system is now, considerably reduced. (In the present model we have only four exogenous variables, viz., P1, S1 and AP1 and the one corresponding to the intercepts term. In fact, each equation of the system is now 'exactly identified'. This facilitates unique determination of the structural parameters from the knowledge of the reduced form parameters. In general, by an appropriate choice of the number of economic factors, we can reduce the number of exogenous variables (without imposing a '*priori* restrictions) and manage the identifiability of the structural systems.

7. CONCLUSION AND DERIVED INFERENCES

Our macro model provides a broad view of the effects of changes in physical infrastructure, social infrastructure and air pollution index on the per capita income, life expectancy, respiratory morbidity and respirable particulate matter in a simultaneous equations framework in the Indian economy during the last 25 years. While our simplified model does help us to enumerate and vindicate the macro-relationship between income, environment and health for the Indian economy, we have done it as an illustration for a specific type of pollutant, namely respirable particulate matter. There is scope to build more comprehensive environmental quality indices that reflect surface water quality, groundwater quality, soil pollution, etc. that directly feed back into economic development and health.

It is also pertinent to point out here that many of the variables included in PI, SI and API may not be truly *exogenous* in a larger model where policy shocks and trade regime may be used as the only exogenous factors in the time series analysis. Some of the factors used in our construction of the three indices here like transport and communication facilities, education and health infrastructure, vehicular traffic, industrial production, etc., may be treated as endogenous variables in a larger model. The two weaknesses of our current exercise, namely, selection of single pollutant to represent environmental quality and endogenous nature of some factors used in the indices, stem largely from the constraint of time-series data availability. Indeed, most of the empirical work on environment and development use cross-sectional data to bypass this issue.

Although our model is highly simplified, nonetheless the empirics from our estimation provide at least two critical insights on the nature of economic development experienced in India:

First, the high cost of particulate pollution: The enormous cost of atmospheric respirable particulate pollution to the Indian economy is evident from the elasticities of the endogenous variables with respect of API. For example, for the most recent years (2003-04 and 2004-05), we find that a 1% increase in the air pollution index (API) would lead to a decrease of about 8% in the per capita income (GDPPC), a decrease of about 0.7% in the life expectancy (LE), an increase of about 19% in the number of cases of respiratory diseases and an increase of about 18% in the levels of respiratory particulate matter (PM10).

Second, the relative importance of SI vis-à-vis PI: The absolute values of the elasticites of endogenous variables with respect to SI are invariably greater than those with respect to PI. As the Agenór succinctly observed "there is a potential trade-off between health and other services that governments can provide - such as education, security, legal protection, and infrastructure services", and while "there is complementarity between health and infrastructure services in production at the same time there is substitutability through government budget constraint for the optimal allocation of government expenditure in a growing economy" [Agenór 2008, Pp. 1408-09]. Our estimation results here indicate that social infrastructure plays a more vital role in economic growth, health and environment than the physical infrastructure in the growing Indian economy. For example, for the most recent years (2003-04 and 2004-05) a 1% improvement in the social infrastructure would lead to about 6% increase in per capita income, 0.6% increase in life expectancy, 13% decrease in the number of cases of respiratory diseases and a 13% decrease in the level of respiratory particulate matter, as against a 3% increase in per capita income (GDPPC), a 0.3% increase in life expectancy (LE), a 7% decrease in the number of cases of respiratory diseases (NOCRD) and a decrease of 7% in the levels of respiratory particulate matter (PM10) for the same amount of increase in the physical infrastructure. Therefore, it is most important that we pay adequate attention to provide more social infrastructure facilities and pay substantially to reduce air pollution. Physical infrastructure, although important, comes in the last of our preference ordering.

Table 1
Actual and Estimated Values of ln GDPPC, ln LE, ln NOCRD, and ln PM10 from the 2SLS Derived Reduced form

Years	Act ln GDPPC	Est ln GDPPC	Act ln LE	Est LE	Act ln NOCRD	Est ln NOCRD	Act ln PM10	Est ln PM10
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1980-81	8.6718	8.438	3.9864	3.9754	0.9738	1.5907	4.7387	5.3159
1981-82	8.7075	8.4217	3.9938	3.9769	0.9868	1.7777	4.7953	5.4062
1982-83	8.7157	8.4682	4.0013	3.985	1.1859	1.8222	4.797	5.3568
1983-84	8.7682	8.8199	4.009	4.0194	1.2989	1.1642	4.7686	4.6256
1984-85	8.7893	9.0883	4.0169	4.0464	1.3964	0.7228	4.733	4.0894
1985-86	8.8125	9.1839	4.0252	4.0602	1.2991	0.6931	4.7154	3.9443
1986-87	8.8332	8.8746	4.0337	4.035	1.5648	1.5306	4.772	4.6805
1987-88	8.8495	8.4436	4.0422	3.9959	1.6404	2.6665	4.7737	5.6953
1988-89	8.9282	8.3943	4.0506	3.9966	1.6677	3.0021	4.7454	5.8853
1989-90	8.9725	8.5522	4.0587	4.0152	2.1832	2.8442	4.7098	5.6065
1990-91	9.0065	9.0199	4.0666	4.0614	2.3524	1.9607	4.6972	4.6311
1991-92	8.9996	9.2678	4.0743	4.0936	2.4584	1.6848	4.7331	4.1832
1992-93	9.0309	9.7967	4.0818	4.1446	2.5279	0.6101	4.7627	3.0529
1993-94	9.0697	9.9461	4.0892	4.1614	2.6216	0.3917	4.7298	2.7642
1994-95	9.1217	10.5868	4.0962	4.2213	2.6082	-0.8211	4.6716	1.4271
1995-96	9.1747	9.7808	4.1031	4.154	2.5503	1.2836	4.6731	3.3177
1996-97	9.2326	9.0091	4.1096	4.0889	2.6635	3.1673	4.6057	5.0805
1997-98	9.262	8.5424	4.1158	4.05	2.6619	4.3271	4.5686	6.154
1998-99	9.3078	8.3498	4.1216	4.0345	2.768	4.8941	4.5513	6.6288
1999-00	9.3497	8.1562	4.1271	4.0235	2.8182	5.6112	4.5562	7.1591
2000-01	9.3757	8.8009	4.1324	4.0829	2.9627	4.2854	4.5157	5.7757
2001-02	9.4158	9.1264	4.1376	4.1162	2.9912	3.7135	4.4633	5.1121
2002-03	9.4392	9.4535	4.1428	4.1467	3.0499	3.1079	4.4347	4.4343
2003-04	9.506	9.7643	4.1498	4.1781	3.126	2.6198	4.3644	3.8218
2004-05	9.5585	10.6007	4.1504	4.2518	3.1648	0.8986	4.2709	2.0265

NOTES

1. Economic literature recognises health as an important productivity-augmenting factor of human capital that drives growth of income [Barro 1991, Fogel 1994, Schultz 1997]. The empirical literature, establishing the positive relationship between health and growth, is based on evidence at both macro level [Barro and Lee 1996, Benhabib and Speigel 1994, Bhargava et. al., 2001, Bloom et. al., 2001] as well as micro level [Dinda et. al., 2006, Glick and Sahn, 1998]. Of course, there is another strand of argument that takes into account ageing of population as a consequence of better health, which may adversely affect economic growth. Therefore, an inverted U-shaped relationship between life-expectancy and economic growth has been suggested by Cipriani [2000], Croix and Licandro [1999], Zang et. al., [2001]. Macro studies on health and growth in Indian context have found that per capita GDP has a positive impact on health status, in particular infant mortality rate [World Bank, 2004]. A two-way positive relationship between growth and health has been established at the state level [Gupta and Mitra, 2003] as well as at the country level [Mahal, 2005]. Similarly, an inverted U-shaped relationship between per capita income and environmental pollution has been investigated extensively, popularly called the Environmental Kuznets Curve (EKC). The EKC indicates that in the initial stage of economic development, environmental pollution increases with increase in per capita income, but after a critical income level as GDP per capita increases, the increase in demand for environmental quality (termed income effect of growth) and more stringent environmental regulation and enforcement (termed regulatory effect) offset the degradation experienced with economic growth. The EKC hypothesis has been studied with cross-national data as well as single economy through time [for example Roca et. al., 2001, Pp. 85-99; Managi and Jena, 2008]. However, most empirical studies with EKC model are unreliable due to the problems arising from the presence of unit root type non-stationarity [Müller-Fürstenberger and Wagner, 2007]. With regard to health and environment linkages, there are macro and micro studies establishing a negative impact of atmospheric pollution on health impact in India, [Mukhopadhyay and Forssell, 2005, Cropper et. al., 1997, CPCB 2000].

2. While improvement in health status of the people raises their productivity level and incomes, higher income provides for improvements of health care systems and environmental amenities like clean air, water, and nature parks. However, the process of rising national incomes is invariably linked with growth of industries, changes in agricultural patterns, technological innovations, changes in consumption patterns, urbanisation, etc., which lead to environmental degradation due to pollution from various kinds of hazardous gases and waste disposals from industries and households. Air, water and land pollution and large-scale deforestation adversely affect human health and productivity levels of individuals, and eventually incomes.

3. The indices so constructed should be termed 'economic factors' jointly determining the endogenous variables. In the present case the model has been postulated in log linear form and, therefore, the reduced form coefficients provide the elasticities.

4. During this period, India witnessed remarkable changes in income as well as environmental quality. By the early 1990s, the air pollution from industry and vehicles, in particular, reached appalling levels. While the first Indian environmental legislation on atmospheric pollution dates back to the Air Act of 1981, the air quality standards for respirable particulate matter (particulate matter of size less than or equal to 10 microns, PM10) were set later in 1994.

5. It is needless to say that there could be other channels of morbidity, apart from respiratory diseases that could affect health and productivity. We focus only on NOCRD partly due to data constraints and partly on grounds that our model is limited to only aspect of environmental stress, namely, particulate pollution which is directly linked to respiratory diseases.

6. Only public infrastructure for health and education is included.

7. Whereas, the thermal power - coal and oil based - represents about 70% of the total power production, and consumes about three-fourth of the total domestic coal, the hydroelectric power accounts for barely a quarter of the total electricity produced. The electricity produced from other sources (like natural gas, nuclear and oil) is negligible. Therefore, we choose EPH as complementary of thermal and other sources.

8. In a structural specification of this sort, one may argue that educational outcomes should also feature as an important endogenous variable especially linking with income and also with health. However, this has not been attempted here.

9. We acknowledge that many of the exogenous variables included in PI, SI and API may not be truly exogenous in a larger model.

10. Although the high correlation or association does not necessarily vindicate a causal relationship, we can still view pollution as an aggravating factor for adverse health effects.

11. Inhalable or respirable particulate matter consists of solid and liquid particulates in air such as diesel soot, road and agricultural dust, particles from manufacturing processes, plus particles produced through photochemical reactions of pollution gases such as sulfur and nitrogen oxides that are byproduct of fuel combustion. In 2004 the American Heart Association in a scientific statement concluded that "studies have demonstrated a consistent increase in risk for cardiovascular events in relation to both short and long term exposure to present-day concentrations of ambient particulate matter." [Pope and Dockery, 2006, p. 722]

12. Our conceptual model is similar in spirit to the Agenór [2008] endogenous growth model of health and infrastructure, where output Y is a function of public infrastructure services G_I, private physical capital K_p, and effective labour defined as the product of the quantity of labour and productivity A. Y can be read as output per capita since population size is normalised to unity:

$$Y = G_I^{\alpha} A^{\beta} K_P^{1-\alpha-\beta}$$

where, productivity *A* depends linearly on the supply of health services *H* and α, β, ε (0.1). If the production function is linear homogeneous in public infrastructure services, private physical capital K_p, and effective labour and if the worker population ratio is constant, then the quantity of labour does not appear as an additional argument in eq (1) in the text. Since Agenór's focus is on the government investment on infrastructure and health, (G_I is spending on roads, power plants, etc., and G_H is spending on health), which together affect health services H and effective labour. Household instantaneous utility being a function of consumption C (of output) and health services H, and government spending being equal to the income tax revenue, the model provides for growth maximising tax rate and composition of government spending on health versus infrastructure.

13 In India, piecemeal liberalisation was initiated in the mid-1980s, and pursued more systematically since 1991-92.

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APPENDIX A

Construction of Indices

In general, suppose $x_1, ..., x_p$ are p indicator variables on whom T observations (x_{it}'s) are available for i=1, ..., p and t=1, ..., T. We transform the variables as

$$X_{it} = \frac{x_{it} - \bar{x}_i}{S_{x_i}}$$

where

$$\bar{x}_i = \frac{1}{T}\sum_{t=1}^{T} x_{it} \quad \text{and} \quad s_{x_i}^2 = \frac{1}{T}\sum_{t=1}^{T}(x_{it} - \bar{x}_i)^2.$$

The covariance matrix of the standardised variables, X_{it}'s, is, in fact, the correlation matrix R of the indicator variables.

Let $\lambda_1 > \lambda_2 > ... > \lambda_p$ be the eigen values of R in descending order of magnitude, and the corresponding eigen vectors be

$$\alpha_1 = \begin{pmatrix} \alpha_{11} \\ . \\ . \\ . \\ \alpha_{1p} \end{pmatrix}, \ldots, \alpha_p = \begin{pmatrix} \alpha_{p1} \\ . \\ . \\ . \\ \alpha_{pp} \end{pmatrix}$$

such that

$$\alpha_i'\alpha_i = 1 \quad \text{and} \quad \alpha_i'\alpha_j = 0$$

for $i \neq j = 1, ..., p$. Then the successive principal components are

$P_{1t} = \alpha_{11} X_{1t} + ... + \alpha_{1p} X_{pt}$

...

$P_{pt} = \alpha_{p1} X_{1t} + ... + \alpha_{pp} X_{pt}$

with var $P_{it} = \lambda_i$ for i=1, ..., p.

We define he index as a weighted average of successive principal components as

$$I_t = \frac{\lambda_1 P_{1t} + \ldots + \lambda_p P_{pt}}{\lambda_1 + \ldots + \lambda_p};$$

maximum weight ($\lambda_1 / \Sigma\lambda_i$) has been assigned to the first principal component as it describes the largest proportion of total variation in all x's. The second principal component has the second highest weight ($\lambda_2 / \Sigma\lambda_i$), and so on.

The advantage of including **all** p principal components is that
(a) they account for total variation in all x's and
(b) we can express

$(\Sigma\lambda_i)\, I_t = \lambda_1 (\alpha_{11} X_{it} + ... + \alpha_{1p}X_{pt} +$

...

$\lambda_p (\alpha_{p1} X_{1t} + ... + \alpha_{pp}X_{pt})$

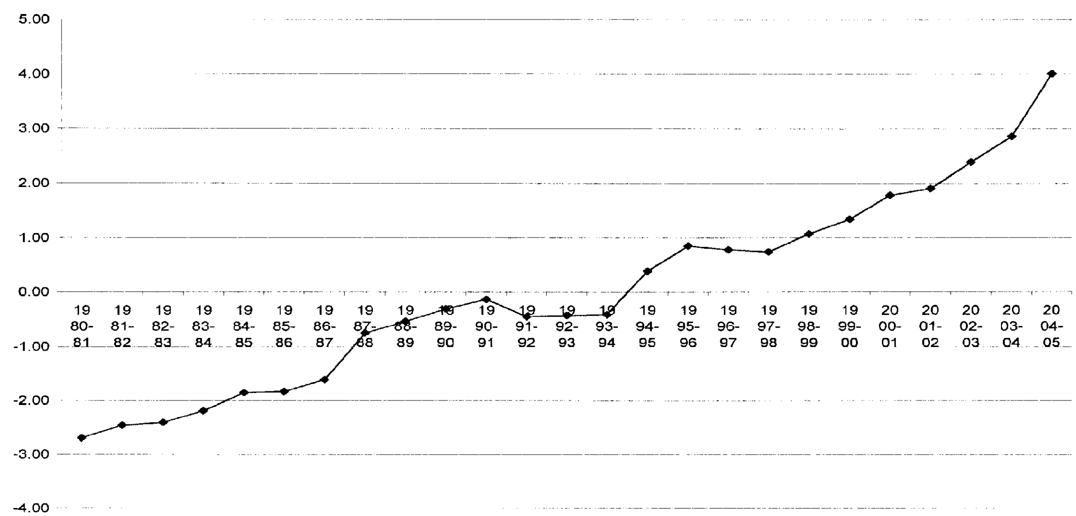
or,

$$I_t = \frac{\sum \lambda_i \alpha_{i1}}{\sum \lambda_i} X_{1t} + \ldots + \frac{\sum \lambda_i \alpha_{ip}}{\sum \lambda_i} X_{pt}$$

where summation over i is from 1, ..., p, and X_{it} is standardised value.

YEAR	PI
1980-81	-2.69
1981-82	-2.46
1982-83	-2.41
1983-84	-2.19
1984-85	-1.85
1985-86	-1.83
1986-87	-1.61
1987-88	-0.75
1988-89	-0.54
1989-90	-0.31
1990-91	-0.14
1991-92	-0.46
1992-93	-0.43
1993-94	-0.42
1994-95	0.38
1995-96	0.85
1996-97	0.78
1997-98	0.74
1998-99	1.07
1999-00	1.34
2000-01	1.78
2001-02	1.90
2002-03	2.39
2003-04	2.86
2004-05	4.01

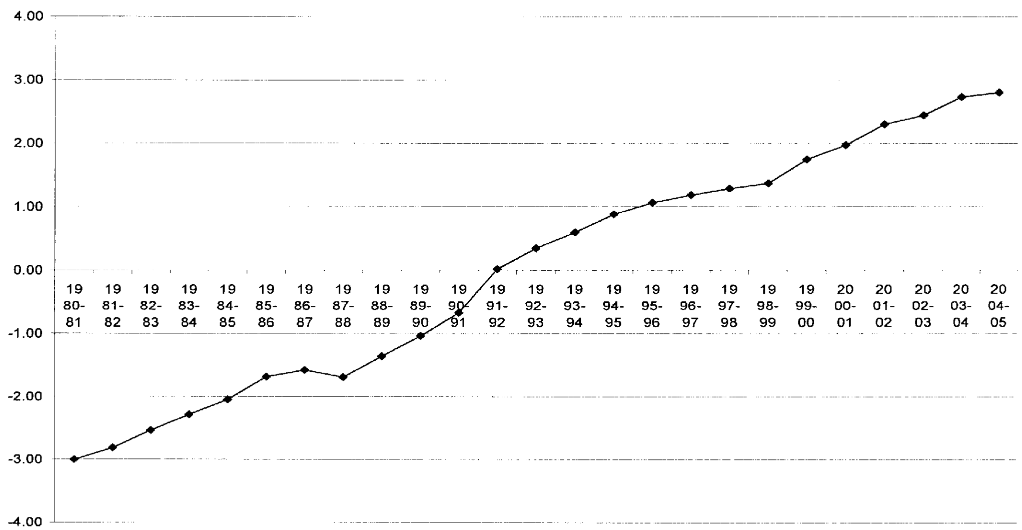
Figure 1
Showing Values of PI



$$\underset{(17.24)}{PI = 0.35\,SRD} + \underset{(18.23)}{0.37\,RLT} + \underset{(11.82)}{0.24\,FLMS} + \underset{(17.24)}{0.35\,ECI} + \underset{(8.37)}{0.17\,INTU} + \underset{(11.33)}{0.23\,ATF} + \underset{(15.76)}{0.32\,PTT}$$

Year	SI
1980-81	-3.00
1981-82	-2.81
1982-83	-2.54
1983-84	-2.29
1984-85	-2.05
1985-86	-1.69
1986-87	-1.58
1987-88	-1.69
1988-89	-1.36
1989-90	-1.04
1990-91	-0.68
1991-92	0.02
1992-93	0.35
1993-94	0.60
1994-95	0.88
1995-96	1.06
1996-97	1.18
1997-98	1.29
1998-99	1.37
1999-00	1.75
2000-01	1.97
2001-02	2.30
2002-03	2.44
2003-04	2.73
2004-05	2.80

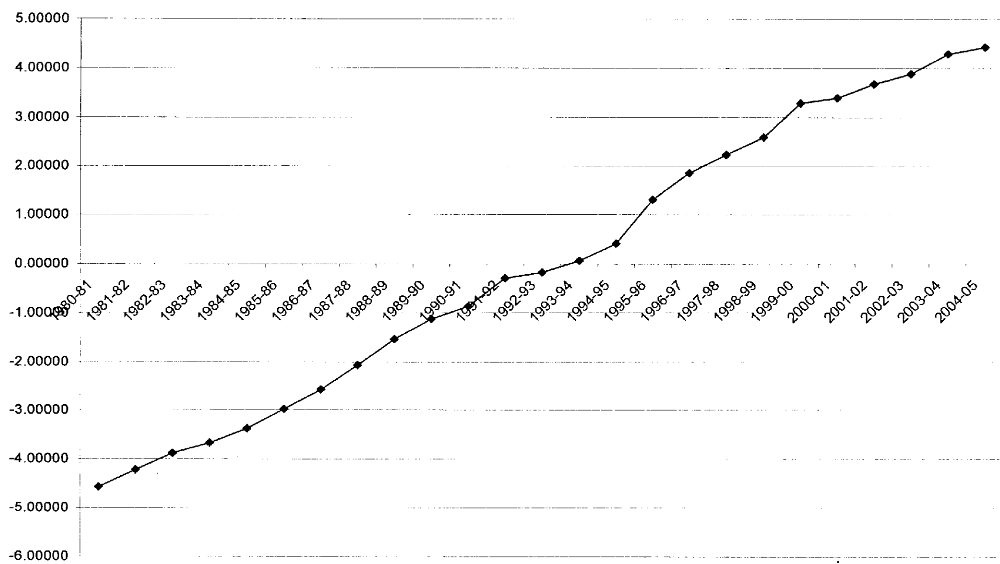
Figure 2
Showing Values of SI



$$\underset{(16.34)}{\mathbf{SI = 0.33\,GER}} + \underset{(18.32)}{\mathbf{0.37\,NOS}} + \underset{(2.48)}{\mathbf{0.05NOB}} + \underset{(16.83)}{\mathbf{0.34\,NOD}} + \underset{(16.83)}{\mathbf{0.34\,NON}} + \underset{(12.87)}{\mathbf{0.26\,IMMDPT}} + \underset{(16.34)}{\mathbf{0.33\,ACCDW}}$$

Year	API
1980-81	-4.57
1981-82	-4.22
1982-83	-3.89
1983-84	-3.68
1984-85	-3.38
1985-86	-2.98
1986-87	-2.57
1987-88	-2.07
1988-89	-1.54
1989-90	-1.13
1990-91	-0.87
1991-92	-0.29
1992-93	-0.17
1993-94	0.06
1994-95	0.41
1995-96	1.30
1996-97	1.85
1997-98	2.23
1998-99	2.59
1999-00	3.29
2000-01	3.40
2001-02	3.68
2002-03	3.89
2003-04	4.29
2004-05	4.43

Figure 3
Showing Values of API



API= -0.24 EPH + 0.25 STEEL + 0.18 COPMTL + 0.24 ALMNM + 0.25 CEMENTS + 0.22 PRP + 0.25 SACS + 0.26 SUG +0.26 PAPER+ 0.25 COAL
(-8.92) (9.29) (6.69) (8.92) (9.29) (8.18) (9.29) (9.67) (9.67) (9.29)
+ 0.26 FER + 0.26 URBPOP + 0.25 NOV
(9.67) (9.67) (9.29)

DATA APPENDIX

Variables used in the construction of Physical Infrastructure (PI)

1. **SRD:** Surfaced roads density (kms per 1000 sq km of geographical area). The data have been obtained from **Economic Intelligence Service- CMIE-Infrastructure- May 2006.** (The figure of the year 1996-97 is the arithmetic mean of those of 1995-96 and 1997-98 and figures of the year 2002-03 and onwards are repeated considering the value of 2001-02.)
2. **RLT:** Railway route length (kms per 1000 sq km). The data on RLT have been obtained from **Economic Intelligence Service- CMIE-Infrastructure- May 2006.** (The values from 1980 to 1985-86 are repeated considering the value of 1986-87)
3. **FLMS:** Fixed line and mobile telephone subscribers (per 1000 people). The data have been obtained from **WDI CD-ROM 2006.**
4. **ECI:** Electricity capacity installed (thousand kw). The data on ECI have been obtained from various issues of **Statistical Abstract, CSO.**
5. **INTU:** Internet users (per 1000 people). The data have been obtained from **WDI CD-ROM 2006.**
6. **ATF: Air** transport, freight (million tons per km). The data have been obtained from **WDI CD-ROM 2006.**
7. **PTT:** Port traffic (thousand tons). The data have been obtained from **Economic Intelligence Service-CMIE-Infrastructure- May 2006.**

Variables used in the construction of Social Infrastructure (SI)

1. **GER-** is the combined gross enrolment ratio (%) for primary, secondary and tertiary schools. The data on GER have been obtained from the **Health Information of India, Ministry of Health and Family Welfare, Govt. of India.** (The figure of the 2004-05 is obtained by linear extrapolation.)
2. **NOS-** is the total number of schools (obtained by adding the number of schools under the category of nursery, primary and secondary until 1987-88 and under the category pre-primary, primary, middle sr. basic and higher secondary for the years 1988-89 to 1997-98. The data have been obtained from various issues of **Statistical Abstract, CSO.** (The figures of the years 1998-99 to 2001-02 are obtained by linear interpolation. The figure of 2004-05 has been obtained by polynomial extrapolation.)
3. **NOB-** is number of beds per 1000 people, obtained as the ratio of 'total number of hospital beds available' to 'the size of yearly population'. The data on the total number of hospital beds available have been obtained from various issues of **Statistical Abstract, CSO** and on the size of yearly population have been obtained from **WDI CD-Rom-2006.** (The figures of the years 2003-04 and 2004-05 are repeated considering the value of the year 2002-03).
4. **NOD-** is the number of doctors per 1000 people obtained as the ratio of 'total number of nurses' to 'the size of yearly population' multiplied by 1000. The data on total number of doctors have been obtained from various issues of **Statistical Abstract, CSO** and on the size of yearly population have been obtained from **WDI CD-Rom-2006.**
5. **NON-** is the number of nurses per 1000 people, obtained as the ratio of 'total number of nurses' to the 'the size of yearly population' multiplied by 1000. The data on the total number of nurses have been obtained from various issues of **Statistical Abstract, CSO** and on the size of yearly population have been obtained from **WDI CD-Rom-2006.** (The figure of the year 2004-05 has been repeated as the value of the previous year).
6. **IMMDPT-immunisation DPT (% of children ages 12-23 months who** received vaccinations before 12 months or at any time before the survey). A child is considered adequately immunised against diphtheria, pertussis (or whooping cough), and tetanus (DPT) after receiving three doses of vaccine. The data have been obtained from **WDI CDROM 2006.** (The figure of the year 1990-91 is the arithmetic mean of those of 1989-90 and 1991-92)
7. **ACCDW**-percent of population with access to safe drinking water. The data on ACCDW are given as 38.19 for 1981-82, 62.30 for 1991-92 and 77.9 for 2001-02 from **Statistical Abstract, CSO.** (The figure of the year 1980-81 has been taken as the same as that of 1981-82. The intervening figures are obtained by linear interpolation. The figures of following years from 2002-03 are repeated considering the figure of the year 2001-02.)

Variables used in the construction of Air Pollution Index (API)

1. **EPH** - is the electricity production from hydroelectric sources (% of total). The data have been obtained from the **WDI, CD-ROM 2006.** (The figure of the year 2004-05 has been assumed as 12 considering the figure 11.9 of the year 2003-04).
2. **STEEL-** is finished steel production (1000 tonnes). The data have been obtained from **Handbook of Statistics on Indian Economy, RBI.**
3. **COPMTL-** is the copper metal (cathode) production (1000 tonnes). The data have been obtained from **Handbook of Statistics on Indian Economy, RBI.**
4. **ALMNM** - is the alluminium ingots production (1000 tonnes). The data have been obtained from **Handbook of Statistics on Indian Economy, RBI.**
5. **CEMENTS** - is the cements all kind production (1000 tonnes). The data have been obtained from **Handbook of Statistics on Indian Economy, RBI.**

6. **PRP** - is the petroleum refinery goods production (1000 tonnes). The data have been obtained from **Handbook of Statistics on Indian Economy, RBI.**
7. **SACS -** is the soda ash and caustic soda production together (1000 tonnes). The data have been obtained from the various issues of **Economic Survey.**
8. **SUG -** is the sugar production (1000 tonnes). The data have been obtained **from Handbook of Statistics on Indian Economy, RBI.**
9. **PAPER -** is the paper and paperboard production (1000 tonnes). The data have been obtained from **Handbook of Statistics on Indian Economy, RBI.**
10. **COAL-** is the coal production (million tones). The data have been obtained from **Handbook of Statistics on Indian Economy, RBI.**
11. **FER-** is the fertiliser (nitrogenous and phosphatic) production (1000 tonnes). The data have been obtained from **Handbook of Statistics on Indian Economy, RBI**
12. **URBPOP -**is the total urban population. The data has been obtained from **WDI CDROM 2006.**
13. **NOV -** is the number of vehicles per thousand people, obtained as the ratio of 'total number of motor vehicle registered' to 'the size of yearly population' multiplied by 1000.The data on the number of motor vehicle registered have been collected from the various issues of **Statistical Abstract, CSO** and the population figure are taken from **WDI, CD-ROM 2006.** (The figure of the year 2004-05 has been obtained from polynomial extrapolation.)

Endogenous Variables

1. **GDPPC-** is the gross domestic product per capita at constant 1993-94 prices. Yearly gross domestic product at constant 1993-94 prices has been divided by the yearly population. The data on gross domestic product have been obtained from the CSO website (http://mospi.nic.in/) and the data on yearly population have been obtained from **WDI CD-ROM 2006.**
2. **LE -** is the life expectancy at birth. The data on life expectancy at birth have been taken from various issues of **Health Information of India. Ministry of Health and Family Welfare, Govt. of India**
3. **NOCRD** - is the number of cases of respiratory diseases per 1000 people. The data on NOCRD have been obtained from the various issues of **Health Information of India. Ministry of Health and Family Welfare, Govt. of India**
4. **PM10 -** is the fine suspended particulates less than 10 microns in diameter that are capable of penetrating deep into the respiratory tract and causing significant health damage. The data on PM10 (micrograms per cubic meter) from the year 1990 to 2004 have been obtained from the **WDI CD-ROM.** For the rest of the years the data have been obtained from the polynomial extrapolation.

VOTERS' RESPONSE TO ECONOMIC AND GOVERNANCE OUTCOMES AND ELECTORAL TRADE-OFF BETWEEN INFLATION AND GROWTH: EVIDENCE FROM 2009 LOK SABHA ELECTION*

Vikas Chitre

We examine the voting pattern in 2009 Lok Sabha election in India to assess voter response to various economic and governance outcomes. We find evidence that vote shares for the Indian National Congress (INC) and the Bharatiya Janata Party in the states were influenced by macroeconomic outcome variables such as consumer price inflation, growth rate of per capita net state domestic product, as well as specific indicators of infrastructure development like the density of rural and urban roads, and implementation of welfare schemes and safety nets such as the employment and income supplement provided under the National Rural Employment Guarantee (NREG) Act and subsidised food grains provided through Public Distribution System (PDS) in the states. The evidence was weak for electoral response to the other macroeconomic outcome variables such as employment rate, employment growth and inequality of personal consumption levels, to public services such as provision of drinking water, and to the law and order situation in the states as reflected in the crime rates in the states. In the process, we identify the electoral trade-off between consumer price inflation rate and the growth rate of per capita nsdp and the other factors causing shifts in this trade off relationship. Briefly, for every one percentage point increase in the average nsdp growth rate over the previous five years, the voters would have been willing to accept an increase of CPI inflation rate of 0.24 per cent to keep the vote share of INC unchanged at the level obtained in 2004 Lok Sabha election. Thus, the voters' trade-off between inflation and growth in India is strongly adverse to growth. Further, the voters would have been willing to accept a somewhat higher rate of CPI inflation and kept INC vote share constant if NREG wages per head or PDS subsidy share of expenditure on subsidised food commodities or increase in rural road density was higher. In states in which the percentage of SC and ST in population was higher, voters would require a lower CPI inflation rate to keep the INC vote share unchanged.

Introduction

1. There have been some studies conducted by political scientists analysing the factors governing voting choices of Indian electorate in a number of Lok Sabha (Lower House of India's Parliament) and Vidhan Sabha (Lower House of India's State Legislature) elections, based on voter perceptions as revealed through opinion polls, for example, Sanjay Kumar et. al. [2008] and K.C. Suri [2009]. Our present study, on the other hand, analyses the actual voting data of the 2009 Lok Sabha election. Of late, there has also been some debate in the press as well as in academic circles about whether economic performance of the Union and state governments in India influences voters' response, for example, Suri [2009], Gupta and Panagariya [2011] and Subramanian and Tantri [2013]. While Suri considers the effect of the survey respondents' perception of economic performance of the political party on their reported voting for the political party coalitions United Progressive Alliance (UPA) and National Democratic Alliance (NDA) in 2009 Lok Sabha election, the latter two consider growth rate of state domestic product as the only indicator of economic outcome influencing the success of

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* This is a revised version of the paper presented at the Dandekar memorial seminar on "Political Response to Economic Restructuring in India", organised on 2-3 August, 2013, at the Indian School of Political Economy. I am grateful to Professors Lalit Deshpande, V. N. Pandit, Nilakantha Rath, Sanjay Kumar and K.C. Suri for their valuable comments and discussion on the earlier drafts of the paper. However, I alone am responsible for any errors and shortcomings which still remain in the paper.

the concerned candidate in the election. Focusing exclusively on the growth rate of state domestic product leads to neglecting the effect on voting of other equally crucial macroeconomic indicators of economic performance such as consumer price inflation, employment rate and the growth of employment, inequality of personal consumption (and income) levels, as well as specific indicators of infrastructure development like the density of rural and urban roads, public services such as provision of drinking water, implementation of welfare schemes and safety nets such as the employment and income supplement provided under the National Rural Employment Guarantee Act (NREGA) and subsidised food grains provided through Public Distribution System (PDS) in the states, and the law and order situation in the states as reflected, for example, in the crime rates in the states. On the other hand, studying the effect of voter perceptions about "economic performance" does not tell us much about how these various outcomes of policy initiatives affect voter perceptions in the first place.

In the process, we are able to exhibit the voters' trade-off between inflation and growth, a finding which will be of considerable interest and importance to macro-economists, policy makers and politicians.

Most important, our examination of the voters' response to the above mentioned wide array of variables related to economic and governance outcomes, infrastructure development, welfare schemes and safety nets provides some evidence to show that the democratic system must, at some stage, begin to reckon with the broad social and economic requirements of the populace even in a still enormously poor and largely illiterate, rural and caste-ridden country such as India.

2. In this paper, we examine electoral response to a number of these important economic and governance outcomes through a number of statistical exercises (see Annexure Tables 1 and 2) based on vote shares polled by the Indian National Congress (INC) and the Bharatiya Janata Party (BJP) in different states in the 2009 Lok Sabha election. We use the data published by the Election Commission of India, reproduced in *Journal of Indian School of Political Economy*, Vols. 1-2, January-June 2008 and data on economic and governance outcomes published in or compiled on the basis of information available in various official publications. We have not endeavoured to analyse the more important but also much more complex question of how the vote share, in turn, translates into the number of seats won by the parties. No doubt our ultimate interest would be in knowing what influences the number of seats won by the parties, but focusing only on seats won hides the primary voter response to the economic and governance outcomes.

Specification

3. We study the variables influencing the change in the vote share in 2009 Lok Sabha election compared to that in 2004 Lok Sabha election for INC and BJP in separate sets of multi-variate regression equations. The basic regression equation seeks to explain the change in the vote share of INC or BJP between the two elections. Empirically, the variables explaining the change in vote share of the two parties could be divided into two groups. For some variables, the effect of the change in state level value of the variable on the change in INC (or BJP) vote share in the state was found not to depend upon whether INC and its Allies (or the BJP or its Allies) happened to be in power in the state; for some variables the effect depended on whether INC and its Allies or BJP and its Allies were in power in the state. The variables from the first group are:

(i) Vote share for the party in 2004 Lok Sabha election (which represents the party loyalty of voters in the state as a group).

We regress the change in vote share of the party concerned between the current and the previous Lok Sabha election on the party's vote share in the state in the previous Lok Sabha election (along with the other relevant variables) to assess how far the change in the party's vote share is influenced by voters' loyalty to the party.

The vote share in 2004 election represents the percentage of voters who favoured the party concerned at the time of that election. Voters' loyalty to particular parties is likely to create a certain degree of inertia in the voting behaviour. Further, depending on the strength of their loyalty to the party concerned, they are likely to spread favourable opinion about the party's ideology, policies, programmes and candidates in their interactions with other voters, whether keeping in mind any forthcoming elections or not. When the voter turnout in the state increases between the two elections considered, the vote share in the later election would go down even if all the party loyalists voted in favour of the same party, unless the party loyalists (or others) are able to persuade a larger percentage of the new turnouts to vote in favour of their party. Therefore, normally, the coefficient of vote share in the previous election in an equation regressing increase in vote share of any party on its vote share in the previous election would be negative. Also, since normally the party loyalists from the previous election would not *all* desert the party in the succeeding election, the above mentioned coefficient normally would not be algebraically smaller than (-) 1. That is, the said coefficient would be normally expected to be negative but smaller than unity in absolute value. Since the average all-India change in turnout in 2009 Lok Sabha election was 2.5 percentage points higher than that in 2004 Lok Sabha election, this is what we would expect to find in the present exercise as well. Further, the party which has a stronger voter loyalty would show the said coefficient in its regression equation to be smaller in absolute value.

In rare instances of extremely enthusiastic and active group loyalty to the party, this could lead to an *increase* in the vote share of the party. If this was the situation, it would show up in the above mentioned coefficient being positive. At the other extreme, also in rare situations, if their own assessment of the party's performance as a ruling or an opposition party during the period after the last election itself has been extremely adverse, the voters who earlier supported the party could all become adversarial to the party concerned, leading to a *decrease* in the party's vote share. This would show up in the said coefficient to be *negative and algebraically smaller than (-)1.* However, we do not expect such outcomes in the present exercise.

(ii) Change in Voter Turnout.

Political scientists often emphasise the role of changes in voter turnout in explaining swings in vote shares of in individual parties. The swings, of course, would depend upon the composition of voters predominantly responsible for the changes in turnout. Depending upon whether the change in voter turnout is caused predominantly by voter groups favourable or unfavourable to the party concerned, the coefficient of the variable could be positive or negative.

(iii) Structural - social and demographic -variables. We consider here the following sets of variables although some more variables in this group could also be considered.

(a) The percentage of SC population in the state in rural area or rural plus urban areas; and
(b) The degree of urbanisation of the state in March 2009 or the change in urbanisation between March 2004 and March 2009.

If groups of voters belonging to specific sections of the society such as the SCs or the urbanised population happen to vote in favour of or against particular parties, this would show up in statistically significant coefficients of the these variables with corresponding signs in the relevant regression equation.

(iv) Income supplement provided through NREG wage employment during 2008-09, or alternatively the proportion of person days of NREG employment provided to the SC population during 2008-09 (see discussion in paragraph 10 below), NREG being the most important welfare scheme introduced by the UPA Government after its coming to power in 2004.

The direct beneficiaries of each such scheme are likely to vote in favour of the political party which they perceive was responsible in effectively implementing that scheme. Other voters who consider such schemes and transfers to be socially highly desirable may also vote for the party concerned.

(v) Infrastructure development variables such as density (or changes in density) of rural or urban roads.

While road development is a state subject, with important road development schemes such as National Highway Development, Golden quadrilateral, Jawaharlal Nehru Urban Renewal Mission, Prime Minister's Gram Sadak Yojana (PMGSY) which are projected as centrally funded and centrally sponsored schemes, whether the voters credit the party in power at the centre or in the state for progress in respect of roads is likely to be an empirical question. We examine it here by means of the tests of significance of the density (or changes in it) of rural or urban roads in the regression equations for changes in vote shares of the two main parties.

(vi) Consumer price inflation

(vii) Rate of growth of per capita net state domestic product.

(viii) When the variables do not show statistical significance without being placed in the context of the party in power in the state, we had to further check whether the credit or the blame for the performance may be assumed to go to the party in power in the state. Major variables for which this was required to be done in our empirical exercise are the following:

(a) Additional macroeconomic variables such as rate of growth of per capita nsdp (in some equations) or the rate or the rate of growth of total or regular employment in the state;
(b) Indicators of efficacy of safety nets such as PDS subsidy share in the total consumer expenditure on the subsidised commodities in the state;
(c) Indicators of provision of public services such as the percentage of population in the state with safe drinking water or drinking water in the vicinity in the state;
(d) Indicators of law and order situation such as the percentage change in the crime rate in the state.

To check the statistical significance of the variables in explaining vote shares for INC or BJP in states in which the respective party or its Allies happened to be in power in March 2009, each of these state-specific performance variables is multiplied by a dummy variable representing the party in power (explained in greater detail in the immediately following sub-paragraph) and then used in the regression equation for INC or that for BJP. Since each of these variables is multiplied by the same multiplicative dummy in the equation for INC or BJP, the resultant variables are highly correlated with one another; hence only one such variable from this group, that is from (viii)(a) - (viii)(d), can be used at a time in the regression equation along with the variables listed in (i) -(vii) above.

In order to test whether the credit or the blame for the performance in respect of any particular variable x may be assumed to go to the party in power in the state, we use a multiplicative dummy variable, taking the values +1 if INC or its Allies were in power in the state and -1 otherwise, That is, a positive coefficient for the variable x multiplied by this dummy variable would imply that a better achievement in respect of x has a positive effect on the increase in vote share of the party in power in the state in March 2009 and a better performance in a non-INC or Allies (or non-BJP and Allies) ruled state (as the case may be) leads to a negative effect on the increase in vote share of INC (or BJP, as the case may be). In fact, in order further to explicitly take note of the specific competing political parties for INC and BJP within each state on the basis of the vote shares of the political parties in 2004 Lok Sabha election, we further modified the above mentioned multiplicative dummy for political party in power (see Annexure Table 3) by setting it to be zero for the states in which INC (or the BJP) did not figure in the first three political parties by their vote share in the 2004 Lok Sabha election. This amounts to ignoring the effect of the variable x for these states in the corresponding equations. On this criterion, we set the value for the modified multiplicative Dummy variable to be zero for Pondicherry and Mizoram in the equation for INC and that for Nagaland, Sikkim, Mizoram and Lakshadweep in the equation for BJP. In Bihar, INC was a distant fourth in the vote share in 2004 Lok Sabha election and in Tamil Nadu BJP was a distant fourth. However, these states were not dropped in the re-construction of the above mentioned multiplicative dummy as the vote shares of these parties in the concerned states in the 2004 Lok Sabha election were still quite significant at 5.1 and 4.5 per cent, respectively. It may be noted that the effect of the variable x under consideration in no major state gets removed in this adjustment. Further, the modified multiplicative Dummy was assigned the value (+) 1 for the centrally administered UTs in the equation for INC as they did not have state governments and the credit for a better performance in respect of any variable x was assumed to be flowing to the party in power at the centre, i.e., INC. An exception was made in respect of Lakshadweep and Dadra & Nagar Haveli in which INC had ranked second in vote share in 2004 Lok Sabha election and the Dummy variable was assigned a value (-) 1 for these UTs for equations with the increase in vote share of INC. For equations for the increase in vote share for BJP, the Dummy variable was assigned a value (-) 1 for all UTs, except Lakshadweep as stated above. The modified multiplicative Dummy variables to be used with any variable x of interest are denoted in Annexure Table 3 as Party_in_Power_INC and Party_in_Power_BJP, according as the variable was to be used in the equation for INC or that for BJP and the variable x after multiplication by the modified Dummy variable was denoted by x_INC and x_BJP.

Formal Presentation:

The typical estimated regression equations may be represented as follows:
For change in vote share for INC:

$$
\begin{aligned}
&(\text{INC\_VOTE\_2009} - \text{INC\_VOTE\_2004}) = \\
&\quad \text{CONST} + a_1\ \text{INC\_VOTE\_2004} \\
&+ a_2\ \text{CHANGE\_TURNOUT} \\
&+ a_3\ \text{NREG\_WAGES\_PER\_HEAD} \\
&\quad (\text{or, SC\_PERSONDAYS\_PER\_HEAD}) \\
&+ a_4\ \text{RUR\_ROAD\_SQKM\_INCREASE} \\
&+ a_5\ \text{CPI\_INFL} + a_6\ \text{GR\_NSDP\_PER\_CAPITA} \\
&+ a_7\ \text{X\_INC} + a_8\ \text{CHANGE\_URBANISATION} \\
&\quad (\text{or URBANISATION\_2009}) + a_9\ \text{PER\_CENT\_SC\_TOTAL} \\
&+ a_{10}\ \text{PER\_CENT\_ST\_TOTAL} + u \qquad (1)
\end{aligned}
$$

And, for change in vote share for BJP:

$$
\begin{aligned}
&(\text{BJP\_VOTE\_2009} - \text{BJP\_VOTE\_2004}) = \\
&\quad \text{CONST} + b_1\ \text{BJP\_VOTE\_2004} \\
&+ b_2\ \text{CHANGE\_TURNOUT} + b_3\ \text{NREG\_WAGES\_PER\_HEAD} \\
&\quad (\text{or, SC\_PERSONDAYS\_PER\_HEAD}) \\
&+ b_4\ \text{PMGSY\_ROADS\_PERSQKM} \\
&+ b_5\ \text{CPI\_INFL} + b_6\text{GR\_NSDP\_PER\_CAPITA} \\
&+ b_7\ \text{X\_BJP} + b_8\ \text{CHANGE\_URBANISATION} \\
&+ b_9\ \text{URBAN\_ROADS\_PER\_SQKM} + v \qquad (2)
\end{aligned}
$$

where X_INC and X_BJP stand for any one state-specific performance variables multiplied by a dummy variable representing the party in power (INC and ALLIES or BJP and ALLIES) from (viii)(a) - (viii)(d) above, whose statistical significance is to be assessed in addition to the other variables in the equation. u and v are the stochastic error terms in the equations.

Selected estimated regression equations for increase in vote share in 2009 Lok Sabha election for INC and BJP are presented in Annexure Tables 1 and 2, respectively. While the meaning of the variables in the above equations should be clear from the nomenclatures used, we have explained the precise definitions of the variables and the data sources in the sections below in which we discuss the empirical results relating to the corresponding variables. Data are presented in Annexure in Data Sets 1- 6. In most equations in Annexure Tables 1 and 2, statistically insignificant variables are dropped.

Party Loyalty of Voters

4. The coefficients a_1 and b_1 of the party's vote share in 2004 election in equations (1) and (2), respectively, turn out to be negative but much smaller than unity in absolute value and statistically significant in most of the estimated equations, as expected. As the dependent variable in the estimated equation is the change in vote share of the party under consideration, if we re-write the estimated equation algebraically, to show the vote share of the party under consideration in 2009 election as the dependent variable, the coefficient of vote share of the party in the 2004 election would be positive but smaller than unity. Since the coefficients $(1+a_1)$ and $(1+b_1)$ in the *transformed* equations are positive, it means that, after taking out the effects of other variables, the vote shares of both the parties continued to be higher in 2009 in the states and UTs in which their respective shares were higher in 2004. However, since the coefficients of vote share in 2004 in the transformed equations are smaller than unity, it means that the *increases* in vote shares were smaller in those states in which the vote share of the party was higher in 2004. That is, both parties did benefit from voter loyalty considering state voters as a group, but the strength of loyalty to protect the party's vote shares in 2009 election diminished as we consider states and UTs with larger vote shares in 2004 election.

Since the coefficient for the vote share of the party in 2004 election is smaller in absolute value in the equation for the increase in vote share for BJP than that in the equation for INC in most estimated equations (compare for example, eq. (2.8) in Annexure Table 2 with eq. (1.8) in Annexure Table 1), it suggests that the voter loyalty for BJP was perhaps stronger than that for INC; however, we are not able to test the statistical significance of the difference. So, we cannot make any such statement with confidence.

NREG Wage per Head

5. NREG wage income per head of rural population, which variable takes into account the effect of wage income per head of persons working on NREG schemes as well as the percentage of *rural* population covered by such schemes in the state, was the most important variable which increased the vote share of INC. In states in which NREG wage per head was high, INC secured a higher vote share; INC even pulled votes away from BJP as well as from other parties. For, the coefficient of this variable in the equation for the change in BJP vote share was negative and statistically significant.

Increase in Rural Road Density

6. Increase of road density per sq. km. in the state (used here instead of the preferred variable, namely, the percentage of villages in the state connected by all-weather roads, because of the lack of ready availability of the data on it) resulted in increased vote share for the INC. However, increase of road density under Pradhan Mantri Gram Sadak Yojana (PMGSY) benefited the BJP rather than the INC. It may be that the voters still give credit of the PMGSY to the BJP, under which party's earlier regime the scheme was initiated.

Urbanisation

7. Growing urbanisation favoured INC (see eqns. (1.4) and (1.5) in Annexure Table 1) instead of BJP, contrary to the general presumption that urban areas are the strongholds of the BJP. Possibly, urbanisation offered opportunities for better earning to rural migrants as well as the original urban residents, both of whom rewarded the ruling party at the Centre for the new opportunities. Suri [2009] also brings out that while urban voters did not have a particularly strong perception of satisfaction with the performance of the UPA government (showing a positive but statistically not significant coefficient in the equation for satisfaction with UPA), they voted positively in favour of it (showed a positive and statistically significant coefficient in the equation for voting for the UPA).

While it appears that the voters gave credit to INC rather than BJP for higher urban road density, when we correctly take into account the party in power in the state, it clearly emerges that voters in the states with the BJP in power in 2009 duly gave it credit for higher urban road density per sq. km. achieved in the state. (See eq. (2.8)).

Drinking Water

8. Percentage of households with safe drinking water, i.e., with treated tap water and from covered wells, and drinking water in the vicinity, i.e., drinking water in the premises and near the premises, even when used with the multiplicative dummy for the political party in power in the state in March 2009, used alternatively in different equations, yielded statistically insignificant, though positive coefficients for INC as well as for BJP. This may not be as surprising as it seems at first. Access to tap and well water, with scanty water in the source, may not be expected to yield a favourable electoral response. (These equations have not been reported here).

NREG and Party in Power in the State

9. It may be argued that the NREG Scheme was implemented better in the states in which INC and its Allies were in power in 2009 and the PMGSY in the states in which BJP and its Allies were in power and the increases in vote shares for the two parties in 2009 Lok Sabha elections simply reflected the fact that the voters in these states favoured the parties in power anyway and not because of the implementation of these schemes. However, it can be checked that the implementation of NREG was not uniformly better in all states ruled by INC and its Allies and uniformly poor in other states. Further, it can also be seen that voters in all these states did not uniformly increase the vote shares of the parties in power. These observations are elaborated below.

Average NREG wage income per head was higher in INC ruled states compared to that in BJP ruled states: at Rs. 442 against Rs. 354. (See Annexure Table 3.) But these averages are unduly influenced by extreme observations. Therefore, if we look at the medians instead, median NREG wage income per head was lower in INC ruled states compared to that in BJP ruled states, being Rs. 212 against Rs. 234.

To be sure, NREG wage per head was quite high in a number of states which were ruled by INC and its Allies in March 2009 such as Andhra Pradesh, Himachal Pradesh, Rajasthan, Jharkhand, Assam, Meghalaya, Mizoram and Manipur, and very low in some states ruled by BJP and its Allies, namely, Gujarat, Goa and Punjab, and in some states ruled by other parties, such as Bihar, Orissa and West Bengal. But there were a number of states among those ruled by INC and its Allies in which NREG wage per head was very low, for example, Karnataka, Kerala, Pondicherry, Maharashtra, Haryana and Uttarakhand whereas it was very high in some states ruled by BJP and its Allies, namely, Madhya Pradesh, Chhattisgarh and Nagaland and high in some states ruled by other parties, namely, Sikkim and Tripura.

On the whole, out of 17 states in which INC and Allies were in power, NREG wage per head was higher than the national median in nine states and lower than the national median in seven states, and one state, namely, Delhi, did not have NREG scheme. Out of six states ruled by BJP and Allies, NREG wage was higher than the national median in three and lower than the national median in three states. Out of the seven states in which neither the INC nor the BJP nor their Allies were in power, NREG wage income was higher than national median in three and lower than it in four states.

Only in eight states and UTs in INC and Allies ruled states was the increase in INC vote share higher than the national median and in the remaining eight states and UTs, it was lower than the national median. Similarly, only in three out of six states ruled by BJP and Allies was the increase in BJP vote share higher than the national median.

Did voters in INC and Allies ruled states give credit or blame to the incumbent party in power in the state depending on the level of NREG wages per head, as we would expect? The answer, we find, is that there is some weak evidence of this, but there is stronger evidence that INC gets the credit or blame of the performance of NREG in all states regardless of the incumbent party in the state, a result which is also confirmed by our multi-variate analysis, as reported above.

In seven out of the 16 states in which INC and Allies were in power in March 2009 and NREG Act was implemented, voter response was based on giving the party in power credit or blame for the performance of NREG. Among INC and Allies ruled states with high NREG wage income per head, the increase in vote share was also high in Rajasthan, Arunachal Pradesh, Mizoram and Manipur and among INC and Allies ruled states with low NREG wage income per head, the increase in vote share of INC was also low in Maharashtra, Jammu and Kashmir, and Haryana.

Was voter response in BJP and Allies ruled states or non-INC, non BJP and Allies ruled states favourable to INC where NREG wage per head was low and unfavourable to INC where it was high, as we would expect? Two out of six states in which BJP and Allies parties were in power, show such voter response for INC. These were Punjab with low NREG wage income per head and a high increase in INC vote share and Chhattisgarh with high NREG wage income per head and a low increase in INC vote share. In seven states ruled by non_INC non_BJP and Allies, voter response to NREG implementation was in line with our expectation in three states, namely, Uttar Pradesh and Bihar, with a low NREG wage income per head and a high increase in INC vote share and Tamil Nadu with high NREG wage income per head, and a low increase in INC vote share. Orissa and West Bengal both with low NREG wage per head in the states still show a low increase in INC vote share, and Sikkim and Tripura with high NREG wage income per head yet show high increase in INC vote share, contrary to our expectation.

Altogether, voters in 14 out of 35 states and UTs credited or penalised the party in power for the implementation of NREG while voting for INC. On the other hand, in 17 states and UTs, voters gave credit or blame to INC, depending on whether the NREG wages per head were higher or lower than the national median, regardless of whether INC and Allies were in power in the state or not. (See Annexure Table 3).

We now do a similar check with respect to the relationship between NREG wages per head in the states and the increase in vote share of BJP. Among the INC and Allies ruled states with low NREG wage income per head, the increase in BJP vote share was high in Karnataka and Kerala, while with high NREG wage income per head, the increase in BJP vote share was low in Andhra Pradesh, Rajasthan, Jharkhand, Assam, Arunachal Pradesh, and Manipur. Thus, out of 14 INC and Allies ruled states for which it is possible to check the relationship between NREG wage per head and the increase in BJP vote share, eight states show a negative relationship between the two, as expected.

Among BJP and Allies ruled states with low NREG wage income per head, the increase in BJP vote share was high in Gujarat, Goa and Punjab and with high NREG wage income per head, the increase in BJP vote share was low in Madhya Pradesh; the increase in BJP vote share was not available in Nagaland. This goes against the hypothesis of a positive relationship between NREG wage per head and the increase in BJP vote share. Thus, on the whole, we observe a negative relationship between the two as far as the increase in BJP vote share is concerned. The sole case supporting a positive relationship between wage income per head and the increase in vote share of BJP among BJP and Allies ruled states is that of Chhattisgarh, wherein both were high.

Among the states ruled by other parties, Bihar, Orissa and West Bengal had low NREG wage income per head and a high increase (low decrease) in BJP vote share and Tripura a high NREG wage income per head and a low increase in BJP vote share, in line with the expected negative relationship.

On the whole, there were 14 cases showing a positive relationship between the level of NREG wage income and the increase in vote share of BJP; 13 cases showing a negative relationship. For 8 cases, data on either of the two variables was not available. By comparison, in 20 cases, the increase in BJP vote share moved in opposite direction of the level of NREG wage income per head, regardless of which party was in power in the state. (See Annexure Table 3).

Needless to emphasise that voter response is not exclusively governed by a single factor such as which party ruled the state or the implementation of NREG. These effects certainly get mitigated or strengthened by other factors such as development of rural roads (not merely through PMGSY), urban roads and changes in urbanisation. In our multi-variate exercises, Dummy variables reflecting whether INC and its Allies or BJP and its Allies were in power in the state in 2009 invariably turned out to be statistically insignificant and the variables indicating the performance of NREG scheme and PMSGY remained significant and with the same signs as discussed above. So, the argument stated at the beginning of this section, namely that the NREG Scheme was implemented better in the states in which INC and its Allies were in power in 2009 and the PMGSY in the states in which BJP and its Allies were in power and the increases in vote shares for the two parties in 2009 Lok Sabha elections simply reflected the fact that the voters in these states favoured the parties in power anyway and not because of the implementation of these schemes does not seem to be supported. What emerges is that INC got the credit or the blame for the implementation of NREG, regardless of which party was in power in the state.

Percentage of SC Population in the State

10. It may also be argued that NREG wage income per head may be highly correlated with the percentage of Scheduled Caste population in rural areas and as such NREG wage income per head in the above equations may simply be a spurious reflection of the SC vote in favour of INC. We, therefore, compiled the percentage of

SC population in rural population in all states and UTs in March 2009, from the state wise total and SC populations in 2001 and 2011 Census data. Using this variable in the equations for increase in the vote share of INC and BJP, it turns out that while this variable comes out to be statistically not significant in the equation for the change in vote share of INC in 2009 compared to that in 2004, NREG wage income per head continues to be statistically significant. The percentage of total SC population in the state is only a slightly better variable in this equation than that in rural areas, though again statistically not significant, but NREG wage income per head continues to be statistically significant variable even in this case. Introduction of the percentage of SC population in the state, whether in rural areas or in total, in fact, improves the statistical significance of NREG wage income per head; it reduces the statistical significance of other variables such as the increase in rural road density in the state and the CPI inflation. Indeed, the percentage of SC in rural or total population of the state is not at all significantly correlated with NREG wage income per head. In other words, the implementation of NREG across the states is not necessarily better if the percentage of SC in the state is higher. The variable which is highly correlated with NREG wage income per head is the person-days of NREG employment provided to SC persons relative to the state's SC rural population, which tells us about the extent to which the rural SC population in the state benefits from NREG employment. The correlation of this variable with NREG wage income per head is 0.95. Using this variable in place of NREG wage income per head produces similar, if only marginally weaker, results. In this equation, the coefficient of the percentage of SC population in the state does come out to be statistically significant but negative. While the negative and statistically significant sign of percentage of SC population in the state may appear to be somewhat surprising, even Suri [2009] also found that in the 2009 Lok Sabha election the respondents from "Hindu lower strata" did not vote in favour of the UPA. And, like NREG wage income per head, the person-days of SC employment per head of SC population of the state is also uncorrelated with the percentage of SC population in the state, so the result is not due to multicollinearity. The conclusion which may be drawn from this is that INC may have benefitted from the SC vote in 2009 only to the extent that the SC population derived the benefit of employment and income from NREGA. We should also note that it is the person-days of NREG employment to SC persons relative to SC population which is the variable which turns out to be statistically significant in our equations and not the person-days of NREG employment to SC persons relative to households provided NREG employment. That is, the increase in INC vote share depended on wider spread of NREG coverage among SC and other population and not on whether NREG was directed particularly towards SC population.

As regards the equation for the change in BJP vote share, the variables for the percentage of SC population are statistically not significant in that equation, as one would expect. Furthermore, the coefficient of the variable SC person-days of NREG employment relative to SC population of the state comes out to be statistically significant and negative just as in the case of NREG wage income per head in the equation for the change in BJP vote share.

NREG and Party in Power in the State: Further Tests

11. In the above discussion, NREG wage income per head is seen to have a positive effect on change in INC vote share and a negative effect on change in BJP vote share *regardless of the party in power in the state.* That is, a high NREG wage income per head in states in which BJP and its Allies were in power also led to an increase in the vote share of INC rather than that of BJP. In other words, INC which introduced the NREG Act got the credit for the NREG schemes. How does the variable NREG wage income per head perform in the INC and BJP vote share equations if we take account of the party in power in the state? We examine this question here using multivariate analysis.

As one may expect from the above discussion, replacing NREG wages per head in the equation (1.1) shown in Annexure Table 1 by NREG_INC (the altered equation not shown) greatly lowers the R-squared to 0.54, although NREG_INC comes out to be statistically significant at 10 per cent level. However, as the correlation between SC_PERSONDAYS_PER_HEAD and NREG_INC is as low as -0.022, it is possible to add SC_PERSONDAYS_PER_HEAD in the equation with NREG_INC (which is not possible in the equation with NREG wages per head); this produces an excellent equation, with an R-square of 0.79 and NREG_INC statistically significant at 1 per cent and SC_PERSONDAYS_PER_HEAD statistically significant at just over 5 per cent (see equation 1.5 reported in the Annexure Table 1). In the equation for increase in BJP vote share (Annexure Table 2, equation (2.1)), NREG wages per head has a statistically significant and *negative* coefficient, implying as stated earlier, that high NREG wage income per head in any state benefits INC in vote share. Replacing NREG wage income per head by NREG_BJP in that equation lowers the R-square from 0.67 to 0.64, but NREG_BJP variable is statistically significant at 1 per cent level and is *positive* (see eq. (2.2) in Annexure Table 2). It may be observed that NREG_BJP has very high *negative* correlations of (-) 0.77 with NREG wages per head and of (-) 0.68 with SC_PERSONDAYS_PER_HEAD. Because of this, it is not possible in this case to use NREG_BJP and SC_PERSONDAYS_PER_HEAD in the same equation for BJP as it was possible to use them in the equation for INC.

The two hypotheses appear to perform very close to each other. However, considering the results of multivariate regressions and the successful test counts shown in the last four columns of Annexure Table 3 and mentioned above in paragraph 9, the hypothesis that INC seems to have got something like a brand name for the introduction of NREG and therefore secured an increase in vote share in all states where NREG was implemented successfully appears to have a slight edge over the other hypothesis that the party in power got the advantage of successfully implementing the NREG Scheme.

Efficacy of Public Distribution System in the State Estimating PDS Subsidy per Head

12. An equally relevant variable influencing voters' choices could be how effectively the public distribution system in the state is implemented and how large the implicit subsidy income as consumers is received through subsidised food and (other commodities) by citizens and by specific population groups such as farmers through procurement at high prices. We concentrate on the former here as it is likely to be more wide spread while the latter relates to a relatively smaller section of population, namely surplus farmers, in a few states. We calculated from NSS data for 2009-10, the state-wise implicit subsidy income of consumers and also the same as proportion of the total expenditure in the state on rice, wheat and sugar, the three *food* commodities (hence ignoring kerosene) which are supplied at subsidised prices through fair price shops. Unfortunately for our purpose, the collection of data for this NSS round was spread over a year *after* the 2009 Lok Sabha election. However, the thin NSS round in 2007-08 does not provide the quantities and values of purchases of rice, wheat and sugar separately for purchases from PDS and other sources, and whatever data is provided is not for all states and UTs, as the 2009-10 round does, and the 2004-05 round is a little too far back in the past. We computed the annual PDS income subsidy for food per capita for each state for 2009-10 by evaluating the quantities supplied per capita of rice, wheat and sugar through PDS source at the prices of the same from other sources, (i.e., the open market prices) and deducting from it the value of the purchases of these commodities from the PDS source.

State-wise Estimates of Implicit PDS Food Subsidy Per Head

It may be of interest in itself to compare the state-wise estimates of implicit PDS food subsidy per head with those for NREG wage incomes per head. In order to do this, we computed the latter also for 2009-10. (See Data Set 3). NREG Wage income per head for India as a whole was Rs. 313 per year compared to the annual PDS income subsidy for food per head of Rs. 295 for rural population for 2009-10. (The annual PDS income subsidy for food for urban population for India as a whole in 2009-10 was Rs. 252, making the annual PDS income subsidy for food per capita in 2009-10 for rural plus urban population in India as a whole to be Rs. 282.)

While at all India level NREG wage income per head was similar to PDS food subsidy per head for rural population in 2009-10, there are marked differences between the two at the level of individual states. Among the states in which INC or its Allies were in power in March 2009, NREG wage incomes were considerably lower than the implicit food subsidy from PDS per head for rural population for Andhra Pradesh, Karnataka, Kerala, Pondicherry, Maharashtra, Jammu & Kashmir, Himachal Pradesh, Haryana, Uttarakhand and Arunachal Pradesh, and the opposite was true for Rajasthan, Jharkhand, Assam, Meghalaya, Manipur and Mizoram. Among the states in which the BJP or its Allies were in power in March 2009, the NREG wage incomes per head were lower than the implicit PDS food subsidy per head in Gujarat, Goa, Punjab and Chhattisgarh and the opposite was true in Madhya Pradesh and Nagaland. Among the other states, NREG wage incomes per head were much lower than the implicit PDS food subsidy in Tamil Nadu and Orissa and in all UTs while NREG wage income was higher in Bihar, West Bengal, Sikkim and Tripura.

The implicit annual PDS food subsidy per head for rural plus urban population was notably high in Lakshadweep (Rs. 1316), Tamil Nadu (Rs. 1243), Andaman and Nicobar Islands (Rs. 874), Chhattisgarh (Rs. 816), Jammu & Kashmir (Rs. 744), Andhra Pradesh (Rs. 726), Himachal Pradesh (Rs. 714), Sikkim (Rs. 646), Mizoram (Rs. 637) and Pondicherry (Rs. 581). The states and UTs with low PDS food subsidy per head for rural plus urban population were Chandigarh (Rs. 40), Manipur (Rs. 48), Bihar (Rs. 56), Delhi (Rs. 57), Rajasthan (Rs. 76), Haryana (Rs. 98), Punjab (Rs. 99), Uttar Pradesh (Rs. 123), West Bengal (Rs. 134), Gujarat (Rs. 137) and Daman & Diu (Rs. 157).

Voter Response to State Level PDS Efficacy

As the implicit PDS food subsidy per head computed above is likely to have an upward bias on account of food price inflation, including the possible inflationary impact of PDS on open market prices of the commodities supplied through PDS, and correspondingly a negative effect on the increase in vote share of the party in power in the state, we use the share of it in the total expenditure (including that on PDS and open market purchases) on rice, wheat and sugar in the state as an explanatory variable in our regression equations. This does not fully remove the bias due to the above mentioned inflationary impact but dampens it somewhat because the total expenditure on these commodities also increases with an increase in their open market prices. PDS food subsidy share in the expenditure on these commodities is the highest in Tamil Nadu at 74 per cent, followed by Lakshadweep (68 percent), Chhattisgarh (42 per cent), Andaman & Nicobar

Island (39 per cent), Himachal Pradesh (36 per cent), Tripura (36 per cent), Karnataka (33 per cent), Andhra Pradesh (32 per cent) and Jammu & Kashmir (32 per cent), which showed a reasonably good coverage of PDS. On the other hand, Delhi, Manipur, Haryana, Rajasthan, Assam, Jharkhand and Uttarakhand showed very low values of the PDS food subsidy share in the expenditure on these commodities, of 10 per cent or less, Maharashtra with 11 per cent being just above them.

For assessing the influence of PDS food subsidy on increase in vote share of INC in 2009 Lok Sabha election, we use the PDS food subsidy share multiplied by the above mentioned dummy variable. This variable has the expected positive sign in all the equations considered. PDS food subsidy share in urban areas performs better than that in rural areas or in rural plus urban areas. In the equations with NREG wage income, increase in rural roads per square km., CPI inflation and the percentage of SCs in rural (or total) population, PDS food subsidy share in urban area showed a statistical significance of 3 per cent (see eq. (1.2) in Annexure Table 1). That in urban plus rural area showed a statistical significance of 4 per cent and each of the other variables statistically significant on replacing NREG wage income by the SC person-days of NREG employment per head of rural SC population of the state (eq. (1.3)). Replacing NREG wage income by the SC person-days of NREG employment per head of SC population of the state and the CPI inflation by urbanisation of the state in 2009, yields a set of variables explaining 79 per cent of the variance of the increase in vote share for INC, with PDS food subsidy share in urban area with a positive coefficient which is statistically significant at 1 per cent (eq. (1.4)). In this equation, PDS food subsidy share in rural area or that in rural plus urban area, used alternatively, also show statistical significance at 5 per cent. Thus, while NREG wage income per head or the SC person-days of NREG employment per head of rural SC population of the state was a more important variable explaining the increase in vote share for INC in 2009 Lok Sabha election, the PDS food subsidy share also contributed to it. However, the PDS food subsidy share corrected by the multiplicative dummy for the political party in power in the state was not statistically significant in the equations for increase in the vote share of the BJP.

The effect of NREG wage income is likely to have been stronger than that of PDS subsidy income because while the former involves an explicit payment, the latter is only an implicit and notional benefit.[2] Furthermore, as mentioned above, increases in the latter would often reflect the impact of food price inflation which would dampen the favourable electoral effect of PDS food subsidy. NREG wage income, on the other hand, has been more or less fully protected against loss in real value from inflation through annual adjustment in NREG wage. Because of both these reasons, it is understandable that NREG wage income shows a more certain and favourable effect on voting for INC.

Crime Rate in the State

13. There appears to have been considerable resentment and public outcry currently against growing number of crimes in the country and about inadequate state action against criminals. Will this anger and anguish find its reflection in the voting behaviour of the electorate? Did this happen in the Lok Sabha election in 2009? Maintenance of law and order and controlling crime is a primary function of the state. When the state sought to withdraw from many spheres of activities after initiating economic reforms in the country, maintenance of law and order was one function which was emphasised to be continued

2. By this reasoning, the direct cash subsidy may be expected to produce more favourable voter response.

to be focused upon as a primary and priority function of the state, from which the state would not withdraw. Given that law and order is a state level rather than a Union subject according to our Constitution, do we find any evidence if an increase in the crime rate in a state led to a decline in the vote share for the political party which was in power in the state in March 2009 and to an increase in the vote share of the competing political parties not in power in the state? We used the data on the rates of crime under Indian Penal Code (IPC) published by the National Crime Records Bureau of the Ministry of Home Affairs of the Government of India to see if there is any evidence about whether the changes in the crime rates in the states from 2003 to 2008 influenced voting in 2009 Lok Sabha election, whether as reflecting the public's assessment of the performance of the government of the political party in power in the state in maintaining general law and order situation in the state or because of public abhorrence of crime as such?

Crimes under Indian Penal Code include crimes against body, crimes against property, crimes against public order, economic crimes, crimes against women, crimes against children and other IPC crimes. Of these, we consider cognisable crimes because in such crimes the Police have the direct responsibility to take up immediate action on the receipt of a complaint or credible information about the possible occurrence of the crime and to investigate the facts, apprehend the offender and arraign him/her before the court of law. There are cognisable offences under Special and Local Laws as well, the principal ones among which include those under Narcotic Drugs & Psychotropic Substances Prevention Act, Explosives and Explosive Substances Act, Immoral Traffic Act, Terrorist Disruptive Activities Act, SC/ST (Prevention of Atrocities) Act, Forest Act, etc. We should have considered the data on these as well. However, the published data on these before 2005 are not comparable with that after 2005, because of an error in classification of cognisable crimes before 2005, which was corrected in 2005. We use the state-wise percentage rate of change in the crime rate (i.e incidence as percentage of mid-year population of the year) of cognisable crimes under IPC between 2003 and 2008 for our analysis.

From 2003 to 2008, the crime rate for cognisable IPC crimes increased in all states and UTs in India, except in Jammu & Kashmir (-16.68 per cent), Delhi (-10.51 per cent), Rajasthan (-5.22 per cent), Mizoram (-46 per cent), Madhya Pradesh (-1.69 per cent), and Daman & Diu (-18.05 per cent). For the country as a whole, it showed an average increase of 12.94 per cent and a median increase at the rate of 11.57 per cent. Among the states in which INC or allied political parties were in power in March 2009, five states, namely, Maharashtra, Haryana, Assam, Meghalaya and Manipur showed higher increase in the crime rate than the All India median, and four of them, except Manipur, showed a decline in the vote share of INC. Of the remaining 12 states (and UTs), which showed a change in the crime rate lower than the All India median, seven, namely, Karnataka, Kerala, Delhi, Rajasthan, Uttarakhand, Arunachal Pradesh and Mizoram, increased the vote share of INC. Among the six states ruled by BJP and Allies, crime rate increased by a higher percentage than the national median in three, namely, Punjab, Chhattisgarh and Nagaland; of these two, namely, Punjab and Nagaland increased their vote share for INC; crime rate had changed by less than the national median for three states, namely, Gujarat, Goa and Madhya Pradesh, for all of which the change in the vote share for INC was also less than the national median. Among the seven states in which non-INC non-BJP (and Allies) parties were in power in the state in March 2009, crime rate had increased by a higher percentage than the national median rate in five, namely, Uttar Pradesh, Bihar, Orissa, Sikkim and Tripura. Of these, three, namely, Uttar Pradesh, Sikkim and Tripura, saw an increase in the INC vote share at a rate higher than the national median. In Tamil Nadu, wherein the crime rate had changed by a smaller percentage than the national median, the vote share for INC also changed by a percentage smaller than the national median. Among the centrally administered UTs, crime rate increased by a higher percentage than the national median in Lakshadweep, Andaman & Nicobar and Chandigarh. Of these, only in Lakshadweep, the INC vote share increased by a higher percentage than the national median. Out of Diu & Daman and Dadra & Nagar Haveli, in which centrally administered UTs crime rate had increased at a rate less than the national median, the vote share for INC was less than the national median only for Diu & Daman. Thus, we find that in 22 out of 35 states and UTs, the voters rewarded (or penalised) INC in voting depending on whether the percentage increase in crime rate over 2003-2008 was lower (higher) than the national median rate in states and UTs with INC or Allies in power in March 2009 or in centrally administered UTs and higher (lower) than the national median rate in states with other political parties in power. Using national average rather than median, as a cut off for considering better or worse outcomes in crime rate change and increase in INC vote share, shows only 17 states and UTs conforming to the hypothesis. In the multi-variate regression equations too while the crime rate change variable corrected by the modified multiplicative dummy for the political party in power comes out to be statistically not significant, it does have the hypothesised negative sign. The quality of data on crime rates, particularly the varying degrees of under-reporting of crimes across states and, to some extent, over the five year period preceding the 2009 Lok Sabha election, could be one possible reason for the weak statistical significance of the percentage increase in the crime rate in the regression equations.

The voters' behaviour on the above lines, for which we have seen some very weak evidence, has to strengthen substantially in future, for democracy in this country to have greater hope.

Macroeconomic Outcomes:
CPI Inflation Rate and Growth Rate of Per Capita NSDP

14. Do macro outcomes matter directly for the voters? At least as far as the 2009 Lok Sabha elections are concerned, while growth rate of per capita Net State Domestic Product (nsdp) of the state (at constant (2004) prices) during 2004-2009 showed a positive effect on the vote share of INC, the coefficient was statistically not significant. (However, see below, paragraph 16 in particular). CPI (IW) inflation (March 2009 over March 2006, in CPI (IW) with base year 2001) showed negative effect on the vote share of INC as well as on the vote share of BJP, but while in the former case it was statistically significant often at a some what higher level, in the latter case it was statistically not significant. As regards the statistical significance of the inflation variable, it is conceivable that the low inflation rates which prevailed during the years preceding the 2009 elections as well as the mitigation of the effects of inflation through dearness allowances and linking of NREG wage to inflation made the voters less sensitive to inflation than what one might have expected. The statistical significance of CPI inflation as well as our ability to experiment with additional variables has also been severely constrained by the lack of ready availability of suitable data on consumer price inflation for a number of states and Union Territories (UTs), namely, Arunachal Pradesh, Andaman & Nicobar Islands, Daman & Diu, Dadra & Nagar Haveli, Meghalaya, Mizoram, Manipur, Nagaland, Sikkim, which correspondingly reduces the number of observations, making inference difficult. We have used the CPI (IW) inflation rates for neighbouring states for these states and UTs, as a variable denoted by CPI_INFL_ADJ in Annexure Tables 1 and 2, which, however, some what worsened the statistical significance of all coefficients.

The effect of per capita nsdp growth rate on voting improves when we qualify it by considering the party in power in the state. Using the per capita nsdp growth rate with the modified multiplicative dummy for the political party in power in the state greatly improves the statistical significance of per capita nsdp growth rate in the equation for INC vote share (eq. (1.7) in Annexure Table 1). Thus, higher per capita nsdp growth rate in a state raises the vote share of INC if INC or an allied political party happened to be in power in March 2009 and lowers it if a political party allied to BJP or any other political party was in power in the state. However, per capita nsdp growth rate used with the multiplicative dummy for BJP and political parties allied to it did not come out to be statistically significant in the equation for increase in BJP vote share (eq. (2.7) in Annexure Table 2). This means that the BJP did not seem to be able to increase its vote share by cutting into the vote share of non-INC non-BJP parties if the states governed by them failed to improve their per capita nsdp growth rate; INC got the benefit from this.

As regards the effect of a higher CPI inflation rate was concerned, interestingly this effect did not depend upon which political party (or parties) ruled the concerned state, unlike the effect of per capita nsdp growth rate mentioned above. A higher CPI inflation rate adversely affected the vote shares of both INC and BJP, though in the case of BJP this effect was not statistically significant. Thus, voters seem to attribute success in raising per capita nsdp growth rate to the political party in power in the state, but not so as far as success in preventing an increase in the CPI inflation rate in the state was concerned. However, this apparent asymmetry in voter response to inflation and growth and the apparent support for a corresponding incorrect perception are removed once we use the specification necessary to bring out the electoral trade-off between inflation and growth, as seen in equation (1.8) in Annexure Table 1. (See paragraphs 15 and 16 below).

Consumption Gini Coefficients

State level consumption Gini coefficients for both urban and rural areas also turned out to be statistically not significant in all the equations in which these variables were attempted. Indian voters may be accepting inequalities in consumption (and income) stoically; voters in states with greater consumption inequalities seem to take that these may not be changed by changing the party in power at the Centre.

Employment:
Employment Scene during Years Preceding Election

Perhaps the most important macroeconomic variable likely to affect voter behaviour may be employment. We examined the effect of worker population ratio, employment rate, employment growth, as well as regular wage employee population ratio, regular wage employment rate and growth rate of regular wage employment, at rural, urban and total levels, all adjusted by the modified multiplicative dummy for political party in power in the state, referred to above. The data for these variables were drawn and computed from N.S.S. Reports on Employment and Unemployment for 2009-10 (66^{th} Round) and 2004-05 (61^{st} Round).

Before assessing the effect of these variables on voters' behaviour, it may be worthwhile to note a few important facts brought out by them, which may be of considerable interest in themselves. The worker population ratios for 1000 population for rural, urban and rural plus urban areas for all India in 2009-10 were 408, 350 and 392 respectively, whereas the regular employee population ratios per 1000 population were as low as 30, 145 and 62, respectively. The worker population ratio for rural plus urban areas was relatively high for

Himachal Pradesh, Andhra Pradesh, Karnataka, Mizoram, Meghalaya, Tamil Nadu, Maharashtra and Gujarat, whereas, that for regular employees was on the higher side only for Chandigarh, Goa and Andaman & Nicobar Islands and was very low for Bihar, Uttar Pradesh, Jharkhand, Chhattisgarh, Orissa, Madhya Pradesh, Assam, Rajasthan, Manipur and West Bengal.

Regular employees ratio for urban areas was high for Andaman & Nicobar Islands, Dadra & Nagar Haveli, Goa, Chandigarh and Sikkim and low for Bihar, Manipur and Uttar Pradesh. For the rural areas this ratio was relatively high for Goa and Chandigarh only while it was low for most of the states and UTs such as Bihar, Uttar Pradesh, Jharkhand, Chhattisgarh, Rajasthan, Orissa, West Bengal, Gujarat, Karnataka, Maharashtra, Assam, Andhra Pradesh, Tripura, Dadra & Nagar Haveli, Manipur, listed in an increasing order of the ratio; Manipur, Mizoram, Punjab and Tamil Nadu were just above the median.

All-India employment rates (giving the percentage of employed persons to the number in the labour force) for rural, urban and rural plus urban areas were 98.55, 96.69 and 98.00, respectively. Employment rate for rural plus urban areas was extremely low for Tripura, Nagaland, Andaman & Nicobar Islands, Lakshadweep and Kerala. (For Kerala, it was 92.40 per cent). Regular wage employment rate, giving the percentage of regular wage or salaried employees in the labour force, for India was 7.2 per cent for rural areas, 40 per cent for urban areas and 18.6 per cent for rural plus urban areas. Regular employment rate for rural areas was low for Bihar (3.1 per cent), Uttar Pradesh, Chhattisgarh, Madhya Pradesh, Rajasthan, Jharkhand, Orissa, Karnataka, Gujarat, Andhra Pradesh, Maharashtra, Uttarakhand, West Bengal, Mizoram, Tripura, Assam, Meghalaya and Tamil Nadu (9.74 per cent), which was the state with median rate for all states. It was very high for Goa, Delhi, Chandigarh, being above 50 per cent. For urban areas, Jammu & Kashmir was the median state with regular wage employment rate of 40.44 per cent. The other major states below the median were Uttar Pradesh, Kerala, Madhya Pradesh, Rajasthan, Orissa, Uttarakhand, West Bengal, Jharkhand and Chhattisgarh.

Among all these ratios, regular employees ratio for the rural areas showed the largest coefficient of variation of 84 per cent; while regular employees ratio for urban areas showed a much lower coefficient of variation of 31 per cent. Worker population ratios showed very low coefficients of variation of 16 per cent and lower. Employment rates exhibited the lowest variability across states with the coefficients of variation less than 5 per cent. Regular employment rate for rural areas showed a high coefficient of variation of 94.5 per cent, while that for urban areas was only 27.2 per cent.

Employment growth between 2004-05 and 2009-10 could have been adversely affected by the fact that 2009-10 was a drought year, with poor agricultural performance. For the country as a whole, employment in rural areas declined by 1.2 per cent, and increased in urban areas by 12.14 per cent, yielding the overall employment growth for rural plus urban areas for the country during the period to be 2.44 per cent.

Employment growth rates were markedly variable across the states. For rural areas, employment growth was the lowest at (-) 47.14 per cent for Dadra & Nagar Haveli followed by (-) 42.46 per cent for Chandigarh, (-) 37.14 per cent for Bihar, (-) 25.53 per cent for Goa, (-) 22.67 per cent for Tamil Nadu, (-) 16.74 per cent for Andaman & Nicobar Islands, (-) 14.06 for Nagaland, (-) 12.79 per cent for Jharkhand, (-) 8.05 per cent for Chhattisgarh, (-) 6.49 per cent for Uttar Pradesh, (-) 6.17 per cent for Manipur, (-) 6.04 per cent for Arunachal Pradesh, (-) 5.30 for Maharashtra, (-) 4.24 per cent for Uttarakhand, (-) 3.81 per cent for Orissa, (-) 2.94 per cent for Punjab and (-) 2.15 per cent for Assam, which was the median state for rural employment growth for the period. Gujarat (- 1.70 per cent) and Meghalaya (-1.26 per cent), though above the median, also showed declines in rural employment. Among major states, Himachal Pradesh, West Bengal, Andhra Pradesh, Rajasthan, Haryana, Madhya Pradesh, Jammu & Kashmir and Kerala, saw positive employment growth in rural areas. Employment growth for urban areas was comparatively much more substantial, being 12.14 per cent and a median level of 14.63 per cent for the country as a whole. A large number of major states such as Tamil Nadu, Jammu & Kashmir, Maharashtra, Karnataka, Haryana, Punjab, Kerala, Gujarat, Orissa, Jharkhand, Uttarakhand, West Bengal and Andhra Pradesh achieved double digit employment growth in urban areas. Among the major states which performed very poorly on this front were Himachal Pradesh, Chhattisgarh, Rajasthan and Bihar.

However, the large growth of employment in urban areas during 2004-05 to 2009-10 was mainly due to the growth of self-employment and casual employment as regular employment in rural as well as urban areas collapsed at the steep rate of around (-) 55 per cent for the country as a whole, with median rates of decline being more than 50 per cent in rural and urban areas. The decline in regular wage employment was uniform across all the states, with little variability among them. Apart from the *sole exception* of the urban region in Tripura, which showed an increase in regular wage employment at the rate of a little over 38 per cent, *all* the states and UTs experienced massive declines in regular employment in rural, urban and rural plus urban areas.

Voter Response to Employment

Against this bleak picture of rural employment growth and rural and urban regular wage employment growth, it is natural to expect that the worker population ratio, employment rate or employment growth in the state may have exercised a strong effect on the voting behaviour of the electorate. Did the voters in the states in which the employment scenario was comparatively better reward the party ruling in the state? Did the voters in the states in which the employment scenario was comparatively poor penalise the party ruling the state by voting for other parties? Did the voters respond to the worker population ratios or employment rates across the states or did the growth and declines in employment in their state over time influence their voting behaviour? We have already noted that NREG wage income per head or the person-days of employment provided to SC population in the state under NREGA did certainly and favourably influence the voters' response. The drought situation in 2009-10 and the resultant wide spread steep declines in rural employment clearly necessitated providing relief through NREG and voters seem to have responded favourably to this safety net. Drought also caused food inflation and voters responded favourably to political parties ruling in the states in which PDS subsidy share in expenditure on rice, wheat and sugar was high. As noted earlier, because the multiplicative dummy for the political party in power in the state is common to all variables for which such a restriction needs to be considered, variables used with the multiplicative dummy are all highly correlated with each other and we have to use them one at a time. We are also constrained by the limited number of observations. Therefore, replacing PDS subsidy share one by one by employment related variables considered above, we find that regular employment ratio in rural area with the above mentioned modified multiplicative dummy for the states in which INC or its Allies were in power comes out to be statistically significant (at nearly 7 per cent level) (see eq. (1.6) in Annexure Table 1) in explaining the increase in vote share of INC, when used along with the above mentioned other key variables, namely, INC vote share in 2004 Lok Sabha election, SC person-days of NREG employment as proportion to the SC rural population in the state, the percentage of SCs in the state's population, increase in rural road density and the rate of urbanisation in the state in 2009, all the variables explaining about 72 per cent of the variation in the increase in vote share of INC. Regular wage employees' ratio for urban area is significant at a little over 14 per cent level and that for rural plus urban areas at less than 12 per cent (equations not reported here). The other employment variable which seems to matter and is statistically significant (at nearly 11 per cent level only) is the worker population ratio for rural plus urban areas, used with the modified multiplicative dummy, replacing the regular employment ratio in rural area. None of the other employment related variables showed statistical significance at a reasonably acceptable level in any regression equation.

The statistical significance of regular wage employees ratio for the rural area is somewhat surprising as this ratio averages to a very low level of only 3 per cent (with a median of 4.4 per cent only) for the country as a whole, compared to 14.5 per cent (with a median of 15.1 per cent) for the urban areas. For the INC or Allies ruled states such as Andhra Pradesh, Karnataka, Maharashtra, Assam, and Jharkhand, which were lower than median for the regular wage employees ratio for rural areas and Meghalaya, which was just above the median, the vote share increase for INC was also low. For the INC or Allies ruled states and centrally ruled UTs, such as Kerala, Pondicherry, Arunachal Pradesh, Delhi, Lakshadweep and Mizoram, which were higher than median for the regular wage employees ratio for rural areas, the vote share increase for INC was high. For the states with non-INC and Allies in power in the state such as Tamil Nadu, Goa, Madhya Pradesh, Uttar Pradesh, Bihar, Tripura, Nagaland, which were higher (lower) than median for the regular wage employees ratio for rural areas, the vote share increase for INC was low (high). These 19 states or UTs seem to show the effect of regular wage employees' ratio in rural areas in the state as per above stated statistical result. Other 16 states or UTs are contrary to the statistical result obtained. Perhaps it shows the natural aspiration of the rural voters for regular wage and salaried employment, in the face of steeply declining rural employment and regular wage and salaried employment in rural (as well as urban) areas. In the equations explaining increase in vote share of BJP, regular employees' ratio for urban and rural plus urban areas show statistical significance at nearly 14 per cent level (see eq. (2.4) in Annexure Table 2) and employment rate in urban areas and employment rate for rural plus urban areas at 15 per cent (eq. (2.3) in Annexure Table 2) and 16 per cent (equation not presented) at best, respectively.

Most surprising, however, is the lack of statistical significance of growth of employment (particularly in rural areas), very low elasticity of INC vote share in 2009 with respect to total employment growth of 0.045, and regular wage and salaried employment in explaining increase in vote share of either INC or BJP and any indication of the electoral anger in the 2009 Lok Sabha election against the backdrop of dismal employment growth outcome in rural areas and regular employment growth everywhere.

Change in Voter Turnout

15. We have not been able to analyse the composition of the new voters in the 2009 Lok Sabha election to be able to surmise on that basis on the likely effect of the change in voter turnout in that election. However, the moderately high and positive correlation of 0.44 between Change_Turnout and NREG Wage per Head and of 0.43 between Change_Turnout and SC_Persondays_per_Head suggests that a considerable proportion of the beneficiaries of the NREG programme came out and exercised their right to vote and probably voted in favour of INC. Thus, we find that adding the variable Change (in Voter) Turnout to each of equations (1.1)-(1.7) shown in Annexure Table 1 (except eq.1.2) throws up a statistically insignificant coefficient for Change_Turnout variable while continuing to show a significant coefficient for NREG Wage per Head or SC Person-days per Head. It is only when we drop the NREG related variables while keeping all other variables unchanged that the Change_Turnout variable comes out to be statistically significant, though in all these equations (not reported here) both the R-square and adjusted R-square decline compared to the equations shown in Annexure Table 1. Replacing NREG Wages per Head by Change_Turnout in eq. (1.2) shows Change_Turnout to be significant but with a much lower R-square and adjusted R-square. Adding the variable Change_Turnout and NREG Wages per Head as in eq. (1.2) (in Annexure Table 1) raises both R-square and adjusted R-square and shows both NREG Wages per Head and Change_Turnout to be statistically significant. Thus, the NREG-related variables perform better than the Change_Turnout variable.

Further, adding the variable Growth Rate of NSDP Per Capita to the resulting equation yields an equation in which all the variables (including Growth Rate of NSDP Per Capita and Consumer Price Inflation), except as observed above, Percentage of SC Population in Rural areas, are statistically significant and has a much higher R-square and adjusted R-square. Serial autocorrelation in the residuals of this equation is ruled out with a probability of one by the Breusch-Godfrey Serial Correlation LM test so that the standard errors are not biased and the Jarque-Bera test (which is really a large sample test) suggests that these residuals are likely to be normally distributed with a probability of 0.64, which would justify our using the t-test for testing the statistical significance of the coefficients even when our sample size is not very large. Replacing Percent_SC_Rural by Percent_SC_Total and Percent_ST_Total further raises R-square to 0.86 and adjusted R-square and shows the voting behaviour of SC and ST population separately, though these variables are not statistically significant. This equation is shown as eq. (1.8) in Annexure Table 1. It is especially noteworthy that in this equation the variable Growth Rate of NSDP Per Capita does not need to be constrained by reference to the party in power in the state by using the modified multiplicative dummy as in eq. (1.7).

In the equations for Change in Vote Share for BJP, the Change_Turnout variable always comes out to be statistically insignificant and negative, as we may expect.

Electoral Trade-Off between Inflation and Growth

16. A most interesting relationship is observed in eq. (1.8). It shows the political (electoral) trade-off between Growth Rate of NSDP per Capita and consumer price inflation rate. This trade off is explicitly shown below after considering the change in INC vote share to be zero and taking CPI Inflation Rate on the left hand side, as equation (3).

CPI INFL RATE=2.65
+ 0.24 NSDP PER CAPITA GROWTH RATE
+ 0.0027NREG WAGE PER HEAD
+ 2.95 PDS_URB_SH_R_INC
+ 40.25 RUR_ROAD_SQKM_INCREASE
- 0.04 PERCENT_SC_TOTAL
- 0.01PERCENT_ST_TOTAL
- 0.06INC_VOTE_2004+ 0.07 CHANGE_TURNOUT (3)

The above equation quantifies the electorate's inflation growth trade-off as reveled through the state-wise voting pattern in 2009 Lok Sabha election. It gives the relationship among the principal variables of concern to the voters required for keeping the INC vote share unchanged at the level obtained in 2004 Lok Sabha election. Briefly, for every one percentage point increase in the average nsdp per capita growth rate over the previous five years, the voters would be willing to accept an increase of CPI inflation rate of 0.24 per cent. Thus, the voters' trade-off between inflation and growth in India is strongly adverse to growth. Further, the voters would have been willing to accept a some what higher rate of CPI inflation and kept INC vote share constant if NREG wages per head or PDS subsidy share of expenditure on subsidised food commodities or increase in rural road density was higher. In states in which the percentage of SC and ST in population was higher, voters would require a lower CPI inflation rate to keep the INC vote share unchanged.

Economists are familiar with the trade-off between inflation and growth encountered in the discussions on macroeconomic policy. Where in the context of this trade-off relationship the policy makers should choose to move to is often considered to be indicated by the preferences of the society or polity. Our estimation may provide probably a first illustration of the political or electoral trade-off between inflation and growth as indicated by the voting behaviour reflected in the 2009 Lok Sabha election in India.

A similar trade-off between the CPI inflation rate and the growth rate of per capita nsdp to keep the BJP vote share constant could also have been defined from an equation such as (2.8) in Annexure Table 2. However, the coefficients for both the CPI inflation rate and the growth rate of per capita nsdp happen to be statistically not significant in that equation. Hence, we refrain from alluding to that trade-off.

Comparing the Voter Response to Different Variables

17. As the dimensions of the various explanatory variables used to explain the increase in vote shares of INC and BJP in the 2009 Lok Sabha election are different from each other, it is not possible to compare the size of the effects of these variables on the increase in vote share of INC or BJP by simply looking at the coefficients of the explanatory variables. We, therefore, computed the elasticities (at the sample means) of the increase in the vote share of INC and BJP with respect to each of the explanatory variables appearing in our best equations, i.e., equation (1.8) for INC and equation (2.8) for BJP shown in the Annexure Tables 1 and 2, respectively. For INC, it shows that the strongest effect (on average) on the increase in vote share of INC is that due to CPI inflation (with an elasticity measure of -6.67, meaning that one per cent increase in the rate of CPI inflation led to a 6.67 per cent decrease in the change in vote share of INC), followed by INC vote share in 2004 (-3.81), then the growth rate of nsdp per capita (3.32), then NREG wages per head (2.20), then the increase in the density of rural roads per square km.(1.73), followed by the proportion of SC population in the state's population (-0.97), and the proportion of ST population in the state's population (-0.53) and finally the urban PDS subsidy share in consumer expenditure on rice, wheat and sugar first in non-INC and Allies ruled states (-0.78) and then in INC and Allies ruled states (0.37).

Since the average increase in vote share for INC happened to be positive, we could compute the elasticities of the increase in vote share of INC with respect to its explanatory variables. Elasticity is not defined where the dependent variable takes negative values. For this reason, elasticities of the increase in the vote share of BJP at the sample means cannot be computed as the average increase in vote share for BJP in 2009 election happened to be negative. Similarly, even for INC, the elasticities of increase in vote share for INC cannot be computed for some individual states, such as Maharashtra, which had a negative increase in vote share of INC in the 2009 Lok Sabha election. Therefore, we compute the elasticities of the vote shares of INC and BJP instead, by deriving the equations for them from those for their increases in vote shares by adding the vote shares in 2004 to both sides of the above referred estimated equations for increase in the vote shares of INC and BJP reported in the Annexure. These will naturally be much smaller than those for the increases in vote shares.

Again the order of the elasticities of 2009 vote share of INC with respect to its explanatory variables is the same as that reported above, except that INC vote share in 2004 shows the largest effect (with corresponding elasticity being 0.64). The elasticity with respect to CPI inflation is -0.50, with respect to the growth rate of nsdp per capita is 0.25, with respect to NREG wages per head is 0.17, with respect to the increase in the density of rural roads per square km. is 0.13, with respect to the proportion of SC population in the state's population is -0.07, with respect to the proportion of ST population in the state's population is -0.04, with respect to PDS subsidy share in urban consumer expenditure on rice, wheat and sugar first in non-INC and Allies ruled states is (-) 0.10 and with respect to PDS subsidy share in urban consumer expenditure on rice, wheat and sugar in INC and Allies ruled states is 0.03, and finally that with respect to the change in voter turnout is 0.03.

The highest elasticity for BJP vote share in 2009 Lok Sabha election (computed from equation (2.8) in Annexure Table 2) is with respect to the BJP vote share in 2004 Lok Sabha election (1.07), but it is noteworthy that it is followed by that with respect to roads under PMGSY (0.28), then that with respect to the density of urban roads in the non-BJP and Allies ruled states (-0.21) and in the BJP and Allies ruled states and UTs (0.08), then that with respect to CPI inflation (-0.16), then by that with respect to change in urbanisation (0.08) and finally that with respect to the growth rate of nsdp per capita (0.05) (though the coefficients of CPI inflation, growth rate of nsdp per capita and change in urbanisation are statistically not significant in this equation).

Elasticities need to be computed to rank the variables by their relative size of effects on vote share. To assess the size of the effect of an increase in rural road density on INC vote share as an example, a little computation shows that by constructing a little over 8200 kms. of additional rural roads, INC could swing the vote share by one percentage point in its favour at all-India level, compared to the actual INC vote share increase of 2.03 per cent in 2009 election compared to that in 2004 election. Comparatively, the favourable effect of rural road construction under PMGSY for BJP vote share is considerably smaller but not negligible. Similar computation shows that rural road construction under PMGSY of nearly 32000 kms (compared to total rural road construction under PMGSY of 214214 kms. during 2009) would have been required to swing the vote share in favour of BJP by one percentage point at the national level (compared to all-India decline of vote share of 3.40 per cent for BJP between the Lok Sabha elections for 2004 and 2009).

The lessons from the voters' choices reflected in 2009 Lok Sabha election are clear. Rath [2012] has sought to trace the origin of regional and caste politics to long term neglect by the mainstream political parties of provision of basic public services to large sections of population. We have found the much felt need for the provision of public services being expressed through voting by the electorate.

Seat Equivalents of the Changes in Vote Shares: Weighted Regression

18. In the above analysis, we have considered changes in vote shares of INC and BJP state-wise, without taking into account the number of Lok Sabha seats in each state. In fact, we wanted to include all states and UTs in our analysis but our hands are tied because of lack of availability of data and much to our regret, in fact, the regressions in the above exercise are often based on 24 major states, leaving out 11 smaller states and UTs, though the included states are all given equal weights. Considering changes in vote shares in each state weighted by the number of Lok Sabha seats in the state, thus considering the seat equivalents of the changes in vote shares of each party as a dependent variable would mean that the political parties consider opportunistically providing safety nets and provision of public services in each state corresponding to the number of Lok Sabha seats in the state only. Fortunately for Indian polity, none of the above variables turn out statistically significant in explaining the seat equivalents of increase in vote shares of the parties. Neglecting the need for having representatives of national parties or regional Allies supporting them from small states or UTs with only one or two Lok Sabha seats such as Arunachal Pradesh, Meghalaya, Tripura, Mizoram, Manipur, Nagaland, Sikkim, Chandigarh, Goa, Daman & Diu, Dadra & Nagar Haveli, Pondicherry, Lakshadweep and A. & N. Islands (accounting for altogether 16 Lok Sabha seats) would have amounted to compromising on the vital questions of territorial integrity and unity of the country, would have been politically highly unwise and what is most important, ethically wrong.

Limitations

19. In the above discussion, we have not considered reservation of constituencies for SC/ST candidates. However, as long as there is competition for votes among candidates of different political parties contesting for the reserved seats, above analysis remains applicable. The other thing which the above analysis ignores is the much too common use of money and muscle power by individual candidates to secure votes. In this context, if the use of money and muscle power is random in relation to different political parties, that is, if candidates of no one party resort to money and muscle power in a disproportionate manner, the above results will continue to be more or less valid. Otherwise, they are likely to be vitiated by the use of such illegal means, as their impact cannot be separated from that of other variables. Finally, we have not taken into account the possibility of episodic factors at national (for example, the post-Emergency wave in favour of the Janata Party in the 1977 Lok Sabha election or the post Indira Gandhi assassination sympathy wave in favour of INC in the 1984 Lok Sabha election) or at the state levels (for example, in the aftermath of the re-organisation of the states in India preceding the Lok Sabha and Vidhan Sabha elections in 1957). There were no such major political developments in the backdrop of the 2009 Lok Sabha election. The relative calm on the political front provides a reasonably good setting for analysing voters' response to economic factors.

Conclusion: Issues Arising from the Study

20. A number of issues relating to voter response to economic and governance outcomes may be raised, some based on the exercises reported above,[3] some not examined.

(i) Different macroeconomic and governance outcomes mattered to varying extent in 2009 Lok Sabha election. In particular, it was possible to discern political or electoral trade-off between the CPI and the growth rate of per capita nsdp of the states. Voters' preference was greatly tilted in favour of lower inflation, voters accepting 0.24 percentage point increase in the consumer price inflation for every 1 percentage point increase in the growth rate of per capita nsdp to keep the INC vote share unchanged. It is worth noting that this was the case when the inflation and growth outcomes were more or less satisfactory, as during 2004-2009, preceding Lok Sabha election of 2009 with the all India average (and median) CPI rate across states being around 3.3 per cent and the average (and median) growth rate of per capita nsdp being around 6.6 per cent. Would the inflation and growth outcomes not matter even more critically in an election when the outcomes may not have been satisfactory, as in the recent few years? How would the electoral trade-off between inflation and growth be altered in the current situation when the inflation rate(s) have been so much higher and the growth rate(s) so much lower?

(ii) Voters are concerned about and possibly respond favourably to both better implementation of welfare schemes and safety nets (such as NREG schemes and an effective PDS) and even more favourably to infrastructure development and the spread and quality of delivery of public services (such as rural and urban roads and supply of drinking water), even in national elections. This is likely to be even more pronounced in state level and local elections. Do the political parties as well as civil society and think-tanks provide enough attention to educating public opinion regarding these?

(iii) Do political parties and politicians look upon schemes of infrastructure development and delivery of public services only as instruments of accumulating private funds to be deployed in the unscrupulous use of money and muscle power for winning elections rather than as being vital for improving living conditions of people in their constituencies?

(iv) If so, what reforms may be necessary in public funding of political parties and elections to achieve more serious and free response of the voters to such schemes?

(v) Have political parties and civil society been rather impervious to the macro outcomes such as the reach and quality of growth reflected in personal inequalities in income, wealth and asset holdings, regional inequalities, lack of employment growth, and raising adequate noise about these issues?

3. In the exercise reported here, we were greatly constrained by the small number of observations in drawing strong inferences. We have, therefore, compromised by some times accepting a higher level of significance of 10 per cent for the coefficients of the explanatory variables and also a less stringent 1 per cent level of significance of the Durbin Watson statistic than the usual 5 per cent level for detecting serial auto-correlation, although we have used the more general Breusch-Godfrey Serial Correlation LM Test also in the reported equations. We also could not simultaneously use more than one explanatory variable corrected by multiplicative dummy for the political party in power because of high mutual correlation among them. These problems can be overcome by using indices for groups of variables reflecting macroeconomic conditions, welfare schemes, public services, social groups and demographic factors, based on their principal components, suggested by Nagar et. al. [2012]. The approach may possibly be also fruitfully utilised for exploring structural inter-relationships among welfare schemes, public services, macroeconomic variables such as growth and inflation and voters' choices. However, this has not been attempted here as the focus of the present paper was on exploring the impact of individual economic and governance outcome variables on voters' choices.

(vi) Is voter response greatly variable from election to election or from state to state, making each election a unique event, in turn raising doubts about predictive power of statistical exercises (such as the present ones) relating to voter response in specific elections? Are voter responses durable or ephemeral?

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Annexure Table 1. Equations for Change in INC Vote Share in Lok Sabha Elections 2004-2009
Dependent Variable: CHANGE_INC_VOTE

Eq. No.		INC_ VOTE_ 2004	CHANGE _TURN- OUT	NREG_ WAGES _PER_ HEAD_R	NREG_ INC	SC_ PERSON DAYS_ PER_ HEAD	PDS_ URB_ SH_R_ INC	PDS_ TOT_ SH_R_ INC	RUR_ ROAD_ SQKM_ INCREA- SE	CPI_ INFL_ ADJ_R	GR_ NSDP_ PER_ CAPITA	GR_ NSDP_ HEAD_ INC	REG_ EMPL_ RATIO_ R_INC	PER CENT _SC_ RURAL	PER CENT _SC_ TOTAL	PER CENT _ST_ TOTAL	URBANI- SATION_ 2009	CHANGE _URBANI- SATION	C
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
1.1	Coeff.	-0.18		0.01				-	140.75	-4.98			-	-	0.08		-	0.37	16.74
	t-value	-1.95		3.41					1.79	-1.80					0.48			1.27	1.58
	Prob.	0.07		0.00					0.09	0.09					0.64			0.22	0.13
1.2	Coeff.	-0.28	0.44	0.01			12.64		176.21	-5.63				0.07					20.19
	t-value	-3.15	2.35	2.82			2.37		2.50	-2.28				0.57					2.17
	Prob.	0.01	0.03	0.01			0.03		0.02	0.04				0.57					0.04
1.3	Coeff.	-0.16		-		0.76	-	10.26	345.45	-				-	-0.39		0.30		-6.88
	t-value	-1.83				3.15		2.24	4.24						-2.36		2.91		-1.34
	Prob.	0.08				0.01		0.04	0.00						0.03		0.01		0.20
1.4	Coeff.	-0.23	0.28	-		0.79	15.90	-	311.81	-4.46			-	-	-0.18		0.23		8.80
	t-value	-2.58	1.40			2.97	2.77		3.84	-1.78					-1.05		2.14		0.83
	Prob.	0.02	0.18			0.01	0.01		0.00	0.10					0.42		0.05		0.74
1.5	Coeff.	-0.21	0.27		0.01	0.44			288.79	-3.16					-0.15			0.69	7.52
	t-value	-2.72	1.64		3.37	2.10			4.03	-1.38					-0.99			2.69	0.84
	Prob.	0.02	0.12		0.00	0.05			0.00	0.19					0.34			0.02	0.41
1.6	Coeff.	-0.15		-		0.61	-	-	356.42	-			0.05	-	-0.40		0.26		-5.96
	t-value	-1.70				2.64			4.19				1.94		-2.36		2.56		-1.13
	Prob.	0.11				0.02			0.00				0.07		0.03		0.02		0.27
1.7	Coeff.	-0.20				0.47			336.06			0.37		-0.24				0.58	0.38
	t-value	-2.16				1.94			3.92			2.12		-1.68				2.02	0.09
	Prob.	0.05				0.07			0.00			0.05		0.11				0.06	0.93
1.8	Coeff.	-0.31	0.38	0.01			15.34		209.31	-5.20	1.25				-0.18	-0.05			13.78
	t-value	-3.89	1.98	3.92			2.76		2.07	-2.47	2.66				-1.21	-0.77			1.53
	Prob.	0.00	0.07	0.00			0.02		0.06	0.03	0.02				0.25	0.45			0.15

(Contd.)

Annexure Table 1. *(Concld.)*

Eq. No.	No. of Observations	R-squared/Adjusted R-squared	F-statistic/ Prob. (F-Statistic)	Durbin-Watson stat/Significance	Breusch-Godfrey Serial Correlation LMTest	Jarque-Bera statistic
(1)	(21)	(22)	(23)	(24)	(25)	(26)
1.1	25	0.67	5.97	2.03	rules out autocorrelation at 5 per cent.	residuals are normally distributed
		0.55	0.00	0.05		
1.2	25	0.75	7.38	1.86	rules out autocorrelation at 5 per cent.	residuals are normally distributed
		0.65	0.00	inconclusive for positive autocorrelation		
1.3	24	0.74	7.87	1.97	does not rule out second order auto-correlation at 5 per cent	residuals are normally distributed
		0.64	0.00	0.01		
1.4	24	0.79	7.17	1.78	rules out auto- correlation at 5 per cent.	residuals are normally distributed
		0.68	0.00	inconclusive for positive autocorrelation		
1.5	24	0.82	8.49	1.93	rules out autocorrelation at 5 per cent.	residuals are normally distributed
		0.72	0.00	inconclusive for positive autocorrelation		
1.6	24	0.72	7.27	2.20	does not rule out higher order auto-correlation at 1 per cent	residuals are normally distributed
		0.62	0.00	0.01		
1.7	24	0.70	6.67	1.89	rules out autocorrelation at 5 per cent.	residuals are normally distributed
		0.60	0.00	0.01		
1.8	23	0.86	8.64	1.92	rules out autocorrelation at 5 per cent.	residuals are normally distributed
		0.76	0.00	inconclusive for positive autocorrelation		

Annexure Table 2. Equations for Change in BJP Vote Share in Lok Sabha Elections 2004-2009 Dependent Variable: CHANGE_BJP_VOTE

Eq. No.		BJP_ VOTE_ 2004	NREG_ WAGES_ PER_ HEAD_R	NREG_ BJP	SC_ PERSON DAYS_ PER_ HEAD	PDS_ URB_ SH_R_ BJP	PMGSY_ ROADS_ PERSQKM	URBAN_ ROADS_ PER_ SQKM	URB_ ROAD_ SQKM_ BJP	CPI_ INFL_ ADJ_R	GR_ NSDP_ PER_ CAPITA	GR_ NSDP_ HEAD_ BJP	EMPL_ RATE_ URBAN_ BJP	REG_ EMPL_ RATIO_ T_BJP	CHANGE_ URBANI-SATION	C
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
2.1	Coeff.	-0.11	-0.01				106.21	-13.61		-0.52					0.43	-2.39
	t-value	-1.68	-3.37				3.06	-4.22		-0.21					1.38	-0.25
	Prob.	0.11	0.00				0.01	0.00		0.83					0.19	0.80
2.2	Coeff.	-0.17		0.01			78.14	-12.74		-1.25					0.37	1.83
	t-value	-2.25		2.89			2.27	-3.78		-0.47					1.12	0.18
	Prob.	0.04		0.01			0.04	0.00		0.64					0.28	0.86
2.3	Coeff.	-0.18	-0.01		-	-	87.31	-12.92		-1.68			0.02	-		6.79
	t-value	-2.58	-3.10				2.67	-3.99		-0.68			1.51			0.72
	Prob.	0.02	0.01				0.02	0.00		0.51			0.15			0.48
2.4	Coeff.	-0.18	-0.01		-	-	81.93	-11.74		-2.12				0.02		7.72
	t-value	-2.56	-2.98				2.48	-3.42		-0.84				1.55		0.80
	Prob.	0.02	0.01				0.02	0.00		0.41				0.14		0.43
2.5	Coeff.	-0.17			-0.75	-	104.91	-13.28		-0.89			-	-		1.80
	t-value	-2.35			-2.81		2.83	-3.84		-0.33						0.18
	Prob.	0.03			0.01		0.01	0.00		0.75						0.86
2.6	Coeff.	-0.14	-0.01		-	0.29	90.65	-13.76		-0.92			-	-		2.04
	t-value	-1.83	-2.98			0.05	2.48	-4.06		-0.36						0.21
	Prob.	0.08	0.01			0.96	0.02	0.00		0.73						0.84
2.7	Coeff.	-0.18	-0.01				87.40	-12.94		-1.38		0.25				5.51
	t-value	-2.43	-3.21				2.61	-3.89		-0.55		1.22				0.58
	Prob.	0.03	0.00				0.02	0.00		0.59		0.24				0.57
2.8	Coeff.	-0.13	-0.01				103.94		13.16	-1.07	0.17				0.33	-1.61
	t-value	-1.95	-3.02				2.98		4.30	-0.44	0.38				1.06	-0.16
	Prob.	0.07	0.01				0.01		0.00	0.67	0.71				0.30	0.88

(Contd.)

Annexure Table 2. (Concld.)

Eq. No.	No. of Observations	R-squared/Adjusted R-squared	F-statistic/ Prob. (F-Statistic)	Durbin-Watson stat/ Significance	Breusch-Godfrey Serial Correlation LMTest	Jarque-Bera statistic
(1)	(18)	(19)	(20)	(21)	(22)	(23)
2.1	25	0.67	6.18	2.12	rules out serial autocorrelation of residuals with a probability of 0.98.	residuals are normally distributed.
		0.56	0.00	0.01		
2.2	25	0.64	5.25	1.98	rules out serial autocorrelation of residuals with a probability of 0.60.	residuals are normally distributed.
		0.52	0.00	0.01		
2.3	25	0.68	6.36	1.94	rules out serial autocorrelation of residuals with a probability of 99 per cent	residuals may be normally distributed with a probability of 10 per cent.
		0.57	0.00	0.01		
2.4	25	0.68	6.42	2.06	rules out serial autocorrelation of residuals with a probability of 1.	residuals may be normally distributed at 10 per cent level
		0.58	0.00	0.01		
2.5	24	0.63	6.14	1.93	rules out serial autocorrelation of residuals with a probability of 1.	residuals may be normally distributed at 10 per cent level.
		0.53	0.00	0.05		
2.6	25	0.64	5.31	1.71	rules out serial autocorrelation with a probability of 1.	the residuals are normally distributed
		0.52	0.00	inconclusive for positive autocorrelation at 1% level.		
2.7		0.67	5.99	1.86	rules out serial autocorrelation with a probability of 1.	the residuals are normally distributed with probability of 0.21.
		0.56	0.00	0.01		
2.8	25	0.69	5.42	2.16	rules out serial autocorrelation with a probability of 1.	the residuals are normally distributed with probability of 0.22.
		0.56	0.00	0.05		

N.B.: CHANGE_TURNOUT was not statistically significant in any equation for CHANGE_BJP_VOTE.

Annexure Table 3. Effect of NREG Wages Per Rural Person, Taking Account of Party in Power in the State

Serial Number	Zones/State Name	INC_Allies/ BJP_Allies/ Others	PARTY_ IN_ POWER_ INC	PARTY_ IN_ POWER_ BJP	CHANGE_ INC_ VOTE	CHANGE_ INC_ VOTE (H=1/L=0) Compared to National Median	CHANGE_ BJP_ VOTE	CHANGE_ BJP_ VOTE (H=1/L=0) Compared to National Median	NREGA WAGES PER_ HEAD_ R (2008-09) (Rs.)	NREGA WAGES PER_ HEAD_ R (2008-09) (Rs.) (H=1/L=0) Compared to National Median	Expected NREG_ WAGES Effect on INC (Y=1/N=0)	Expected NREG_ WAGES Effect on BJP (Y=1/N=0)	Positive NREG_ WAGES Effect on INC Every where (Y=1/N=0)	Negative NREG_ WAGES Effect on BJP Every where (Y=1/N=0)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1	Andhra Pradesh	INC_Allies	1	-1	-2.6	0	-4.6	0	401.98	1	0	1	0	1
2	Karnataka	INC_Allies	1	-1	0.9	1	6.9	1	63.10	0	0	1	0	1
3	Kerala	INC_Allies	1	-1	8	1	-4.1	1	100.26	0	0	1	0	1
4	Pondicherry	INC_Allies	0	-1	NA	NA	-33.5	0	34.31	0	0	0	0	0
5	Maharashtra	INC_Allies	1	-1	-4.2	0	-4.4	0	52.04	0	1	0	1	0
6	Jammu & Kash-mir	INC_Allies	1	-1	-3.1	0	-4.4	0	60.72	0	1	0	1	0
7	Himachal Pra-desh	INC_Allies	1	-1	-6.3	0	5.4	1	337.72	1	0	0	0	0
8	Haryana	INC_Allies	1	-1	-0.3	0	-5.1	0	51.08	0	1	0	1	0
9	Delhi	INC_Allies	1	-1	2.3	1	-5.5	0	NA	NA	NA	NA	NA	NA
10	Rajasthan	INC_Allies	1	-1	5.8	1	-12.4	0	859.98	1	1	1	1	1
11	Uttarakhand	INC_Allies	1	-1	4.8	1	-7.2	0	128.39	0	0	0	0	0
12	Jharkhand	INC_Allies	1	-1	-6.4	0	-5.5	0	281.50	1	0	1	0	1
13	Assam	INC_Allies	1	-1	-0.2	0	-6.7	0	222.89	1	0	1	0	1
14	Arunachal Pra-desh	INC_Allies	1	-1	41.1	1	-16.7	0	201.60	1	1	1	1	1
15	Meghalaya	INC_Allies	1	-1	-0.8	0	NA	NA	269.31	1	0	NA	0	1
16	Mizoram	INC_Allies	0	0	65.6	1	NA	NA	2701.31	1	1	NA	1	1
17	Manipur	INC_Allies	1	-1	28.1	1	-11.2	0	1307.84	1	1	1	1	1
	Average				7.81		-6.41		416.12					
	Median				0.35	H=8, L=8	-5.5	H=3, L=12	212.25	H=9, L=7	Y=7, N=9	Y=8, N=6	Y=7,N=9	Y=10, N=6
1	Gujarat	BJP_Allies	-1	1	-0.5	0	-0.9	1	42.39	0	0	0	1	1
2	Goa	BJP_Allies	-1	1	-7.2	0	-2	1	16.95	0	0	0	1	1
3	Punjab	BJP_Allies	-1	1	11	1	-0.4	1	25.84	0	1	0	0	1
4	Madhya Pradesh	BJP_Allies	-1	1	6	1	-4.6	0	425.50	1	0	0	1	1
5	Chattishgarh	BJP_Allies	-1	1	-2.9	0	-2.8	1	480.80	1	1	1	0	0
6	Nagaland	BJP_Allies	-1	0	3.6	1	NA	NA	1129.47	1	0	NA	1	NA
	Average				1.67		-1.78		353.49					
	Median				1.55	H=3, L=3	-2.00	H=4, L=1	233.94	H=3, L=3	Y=2, N=4	Y=1, N=4	Y=4,N=2	Y=4, N=1

(Contd.)

Annexure Table 3. ***(Concld.)***

Serial Number	Zones/State Name	INC_Allies/ BJP_Allies/ Others	PARTY_ IN_ POWER_ INC	PARTY_ IN_ POWER_ BJP	CHANGE_ INC_ VOTE	CHANGE_ INC_ VOTE (H=1/L=0) Compared to National Median	CHANGE_ BJP_ VOTE	CHANGE_ BJP_ VOTE (H=1/L=0) Compared to National Median	NREGA WAGES PER_ HEAD_ R (2008-09) (Rs.)	NREGA WAGES PER_ HEAD_ R (2008-09) (Rs.) (H=1/L=0) Compared to National Median	Expected NREG_ WAGES Effect on INC (Y=1/N=0)	Expected NREG_ WAGES Effect on BJP (Y=1/N=0)	Positive NREG_ WAGES Effect on INC Every where (Y=1/N=0)	Negative NREG_ WAGES Effect on BJP Every where (Y=1/N=0)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1	Tamil Nadu	Others	-1	0	0.6	0	-2.8	1	261.00	1	1	0	0	0
2	Uttar Pradesh	Others	-1	-1	6.3	1	-4.7	0	150.42	0	1	0	0	0
3	Bihar	Others	-1	-1	5.8	1	-0.7	1	95.87	0	1	1	0	1
4	Orissa	Others	-1	-1	-7.6	0	-2.4	1	116.54	0	0	1	1	1
5	West Bengal	Others	-1	-1	-1.1	0	-2	1	100.47	0	0	1	1	1
6	Sikkim	Others	-1	0	2.2	1	NA	NA	523.11	1	0	NA	1	NA
7	Tripura	Others	-1	-1	16.5	1	-4.4	0	1113.02	1	0	1	1	1
	Average				3.24		-2.43		337.20					
	Median				2.2	H=3, L=3	-2.6	H=4, L=2	150.42	H=3, L=4	Y=3, N=4	Y=4, N=2	Y=4,N=3	Y=4, N=2
1	Lakshawdeep	Centrally ruled UT	-1	0	3.1	1	NA	NA	911.96	1	0	NA	1	NA
2	A. & N. Island	Centrally ruled UT	1	-1	-13.3	0	8.2	1	52.14	0	1	1	1	1
3	Daman & Diu	Centrally ruled UT	1	-1	-20.5	0	17.1	1	NA	NA	NA	NA	NA	NA
4	Dadra & Nagar Haveli	Centrally ruled UT	-1	-1	20.2	1	30.8	1	0.29	0	1	1	0	1
5	Chandigarh	Centrally ruled UT	1	-1	-5.2	0	-5.5	0	NA	NA	NA	NA	NA	NA
	Average				-3.14		10.12		192.88					
	Median				-5.2	H=2, L=3	12.65	H=3, L=1	52.14	H=1, L=2	Y=2, N=1	Y=1, N=1	Y=2, N=1	Y=2, N=0
All-India	Average				4.28		-2.46		357.71					
	Median				0.75	H=16, L=16	-4.40	H=14, L=16	176.01	H=16, L=16, NA=3	Y=14,N=18 , NA=3	Y=14,N=13 , NA=8	Y=17, N=15, NA=3	Y=20, N=9, NA=6

Data Set 1. Voting in Lok Sabha Election 2009

SERIAL NUMBER	STATES/UTs	INC_ALLIES/ BJP_ALLIES/ OTHERS	INC_VOTE_ 2004	INC_VOTE_ 2009	CHANGE_ INC_VOTE	BJP_VOTE_ 2004	BJP_VOTE_ 2009	CHANGE_ BJP_VOTE	CHANGE_ TURNOUT	PARTY_IN_ POWER_INC	PARTY_IN_ POWER_BJP
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	Andhra Pradesh	INC_Allies	41.6	39	-2.6	8.4	3.8	-4.6	2.7	1	-1
2	Karnataka	INC_Allies	36.8	37.7	0.9	34.8	41.7	6.9	-6.1	1	-1
3	Kerala	INC_Allies	32.1	40.1	8	10.4	6.3	-4.1	1.9	1	-1
4	Pondicherry	INC_Allies	NA	49.4	49.4	35.7	2.2	-33.5	3.6	0	-1
5	Maharashtra	INC_Allies	23.8	19.6	-4.2	22.6	18.2	-4.4	-3.7	1	-1
6	Jammu & Kashmir	INC_Allies	27.8	24.7	-3.1	23	18.6	-4.4	4.5	1	-1
7	Himachal Pradesh	INC_Allies	51.9	45.6	-6.3	44.2	49.6	5.4	-1.3	1	-1
8	Haryana	INC_Allies	42.1	41.8	-0.3	17.2	12.1	-5.1	1.7	1	-1
9	Delhi	INC_Allies	54.8	57.1	2.3	40.7	35.2	-5.5	4.7	1	-1
10	Rajasthan	INC_Allies	41.4	47.2	5.8	49	36.6	-12.4	-1.6	1	-1
11	Uttarakhand	INC_Allies	38.3	43.1	4.8	41	33.8	-7.2	5.2	1	-1
12	Jharkhand	INC_Allies	21.4	15	-6.4	33	27.5	-5.5	-4.5	1	-1
13	Assam	INC_Allies	35.1	34.9	-0.2	22.9	16.2	-6.7	0.4	1	-1
14	Arunachal Pradesh	INC_Allies	10	51.1	41.1	53.9	37.2	-16.7	11.6	1	-1
15	Meghalaya	INC_Allies	45.6	44.8	-0.8	8.6	NA	NA	11.7	1	-1
16	Mizoram	INC_Allies	NA	65.6	65.6	NA	NA	NA	-11.8	0	0
17	Manipur	INC_Allies	14.9	43	28.1	20.7	9.5	-11.2	9.8	1	-1
	Average		30.45	41.16	10.71	27.42	20.50	-6.41	1.69		
	Median		36.8	43	0.9	28	18.6	-5.5	1.9		
1	Gujarat	BJP_Allies	43.9	43.4	-0.5	47.4	46.5	-0.9	2.7	-1	1
2	Goa	BJP_Allies	29.8	22.6	-7.2	46.8	44.8	-2	-3.5	-1	1
3	Punjab	BJP_Allies	34.2	45.2	11	10.5	10.1	-0.4	8.2	-1	1
4	Madhya Pradesh	BJP_Allies	34.1	40.1	6	48.1	43.5	-4.6	3.1	-1	1
5	Chattishgarh	BJP_Allies	40.2	37.3	-2.9	47.8	45	-2.8	3.2	-1	1
6	Nagaland	BJP_Allies	25.8	29.4	3.6	NA	NA	NA	-1.8	-1	0
	Average		34.67	36.33	1.67	33.43	31.65	-1.78	1.98		
	Median		34.15	38.7	1.55	47.4	44.8	-2	2.9		

(Contd.)

Data Set 1. ***(Concld.)***

SERIAL NUMBER	STATES/UTs	INC_ALLIES/ BJP_ALLIES/ OTHERS	INC_VOTE_ 2004	INC_VOTE_ 2009	CHANGE_ INC_VOTE	BJP_VOTE_ 2004	BJP_VOTE_ 2009	CHANGE_ BJP_VOTE	CHANGE_ TURNOUT	PARTY_IN_ POWER_INC	PARTY_IN_ POWER_BJP
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	Tamil Nadu	Others	14.4	15	0.6	5.1	2.3	-2.8	12.2	-1	-1
2	Uttar Pradesh	Others	12	18.3	6.3	22.2	17.5	-4.7	-0.5	-1	-1
3	Bihar	Others	4.5	10.3	5.8	14.6	13.9	-0.7	-13.5	-1	-1
4	Orissa	Others	40.4	32.8	-7.6	19.3	16.9	-2.4	-0.8	-1	-1
5	West Bengal	Others	14.6	13.5	-1.1	8.1	6.1	-2	3.4	-1	-1
6	Sikkim	Others	27.4	29.6	2.2	NA	1.8	NA	5.8	-1	0
7	Tripura	Others	14.3	30.8	16.5	7.8	3.4	-4.4	17.4	-1	-1
	Average		18.23	21.47	3.24	11.01	8.84	-2.43	3.43		
	Median		14.4	18.3	2.2	11.35	6.1	-2.6	3.4		
1	Lakshawdeep	Centrally ruled UT	48.8	51.9	3.1	NA	0.6	NA	4.4	-1	0
2	A. & N. Island	Centrally ruled UT	55.8	42.5	-13.3	36	44.2	8.2	0.5	1	-1
3	Daman & Diu	Centrally ruled UT	49.5	29	-20.5	48.4	65.5	17.1	1.1	1	-1
4	Dadra & Nagar Haveli	Centrally ruled UT	25.7	45.9	20.2	15.6	46.4	30.8	2.6	-1	-1
5	Chandigarh	Centrally ruled UT	52.1	46.9	-5.2	35.2	29.7	-5.5	14.4	1	-1
	Average		46.38	43.24	-3.14	27.04	37.28	10.12	4.60		
	Median		49.5	45.9	-5.2	35.6	44.2	12.65	2.6		
All-India	Average		31.00	36.69	5.69	25.11	22.48	-2.46	2.51		
	Median		34.2	40.1	0.9	23	18.4	-4.4	2.7		

Data Set 2. Macroeconomic and Demographic Variables

SERIAL NUMBER	STATES/UTs	INC_ ALLIES/ BJP_ ALLIES/ OTHERS	NSDP_ PER_ CAPITA	GR_ NSDP_ PER_ CAPITA	CPI_IW_ INFL	CPI_ INFL_ ADJ_R	CONSUMPTION_ GINI_ URBAN	URBANISATION_ 2004	URBANISATION_ 2009	CHANGE_ URBANISATION	POPULATION MID 2009-10			PER CENT_ SC_ RURAL	PER CENT_ SC_ TOTAL	PER CENT_ ST_ TOTAL
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1	Andhra Pradesh	INC_Allies	35272	8.64	3.99	3.99	0.35	28.04	32.90	4.86	12110909	8849709	3254488	19.08	16.36	6.9
2	Karnataka	INC_Allies	37687	8.81	3.24	3.24	0.38	34.55	38.15	3.60	6734020	6060357	672769	19.64	16.92	6.86
3	Kerala	INC_Allies	42433	7.42	2.80	2.80	0.40	28.10	45.26	17.16	27175427	17143355	10008653	10.47	9.24	1.37
4	Pondicherry	INC_Allies	69760	9.63	4.09	4.09	0.38	66.79	68.16	1.37	9808825	6917401	2876082	27.76	15.85	NA
5	Maharashtra	INC_Allies	51053	9.19	2.71	2.71	0.38	42.78	44.98	2.20	66418899	50068912	16334164	11.88	11.40	9.23
6	Jammu & Kashmir	INC_Allies	25641	4.22	3.93	3.93	0.31	25.11	26.99	1.88	1980284	1438972	518601	8.27	7.43	11.65
7	Himachal Pradesh	INC_Allies	41666	5.73	2.83	2.83	0.35	9.83	10.02	0.19	2500414	1712821	781269	25.92	25.08	5.21
8	Haryana	INC_Allies	49806	7.02	3.10	3.26	0.36	29.62	34.24	4.62	2847188	2278078	568781	22.26	19.97	NA
9	Delhi	INC_Allies	91845	9.50	2.49	2.49	0.35	93.73	97.11	3.38	30423020	26196406	4221080	19.65	16.79	NA
10	Rajasthan	INC_Allies	23356	5.91	3.18	2.93	0.32	23.58	24.76	1.18	89420875	61472201	27846394	18.37	17.66	13.25
11	Uttarakhand	INC_Allies	38625	11.80	3.39	3.39	0.40	26.26	30.09	3.83	70473697	51141606	19321415	20.95	18.55	2.92
12	Jharkhand	INC_Allies	19867	1.78	3.47	3.47	0.34	22.47	23.89	1.42	224936	64233	136559	12.53	12.02	26.23
13	Assam	INC_Allies	18922	3.05	2.97	2.97	0.33	13.05	13.97	0.92	59694834	37057491	22554742	6.78	7.08	12.44
14	Arunachal Pradesh	INC_Allies	31971	4.70	NA	2.97	0.30	20.99	22.50	1.51	1440799	567428	861087	NA	NA	67.6
15	Meghalaya	INC_Allies	30963	6.48	NA	2.97	0.24	19.64	20.04	0.40	63869	15474	44475	0.46	0.55	86.08
16	Mizoram	INC_Allies	31933	6.67	NA	2.97	0.23	49.87	51.34	1.47	70493233	36864234	33552529	0.03	0.06	94.45
17	Manipur	INC_Allies	21169	3.23	NA	2.97	0.19	27.03	29.88	2.85	1197256	382923	814089	2.19	3.48	34.9
	Average		38939	6.69	2.48	3.17	0.33	33.03	36.13	3.11	26647558	18131271	8492187	13.31	11.67	22.30
	Median		35272	6.67	3.18	2.97	0.35	27.03	30.09	1.88	9808825	6917401	2876082	15.45	13.94	12.05
1	Gujarat	BJP_Allies	43685	8.07	2.83	2.83	0.31	38.00	42.10	4.10	193917070	151222140	42644120	6.64	6.82	14.76
2	Goa	BJP_Allies	90386	4.10	3.93	3.93	0.25	51.22	60.98	9.76	100263446	89081425	11161884	1.69	1.75	0.01
3	Punjab	BJP_Allies	41003	5.50	3.63	3.63	0.36	34.37	37.17	2.80	1059707	512033	547271	36.41	31.18	NA
4	Madhya Pradesh	BJP_Allies	19442	5.93	2.63	2.63	0.37	26.61	27.53	0.92	31911934	24337243	7563521	15.69	15.51	20.89
5	Chattishgarh	BJP_Allies	23926	6.56	4.09	4.09	0.31	20.47	22.95	2.48	41108930	34361180	6730864	12.45	12.50	30.89
6	Nagaland	BJP_Allies	39041	6.42	NA	2.97	0.22	18.44	27.69	9.25	376678	237520	138584	NA	NA	87.0
	Average		42914	6.10	2.85	3.35	0.30	31.52	36.40	4.89	61439628	49958590	11464374	12.15	11.29	25.59
	Median		40022	6.17	3.63	3.30	0.31	30.49	32.43	3.45	36510432	29349212	7147192	12.45	12.50	20.89

(Contd.)

Data Set 2. ***(Concld.)***

SERIAL NUM-BER	STATES/UTs	INC_ ALLIES/ BJP_ ALLIES/ OTHERS	NSDP_ PER_ CAPITA	GR_ NSDP_ PER_ CAPITA	CPI_IW_ INFL	CPI_ INFL_ ADJ_R	CONSUMPTION_ GINI_ URBAN	URBANISATION_ 2004	URBANISATION_ 2009	CHANGE_ URBANISATION	POPULATION MID 2009-10			PER CENT_ SC_ RURAL	PER CENT_ SC_ TOTAL	PER CENT_ ST_ TOTAL
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1	Tamil Nadu	Others	42939	9.32	3.46	3.46	0.33	44.59	48.05	3.46	1028831	32267	986335	25.08	19.77	1.09
2	Uttar Pradesh	Others	15713	4.95	3.78	3.78	0.32	20.97	22.15	1.18	24704593	19096583	5584688	23.08	20.80	0.16
3	Bihar	Others	10994	8.57	3.43	3.43	0.32	10.57	11.22	0.65	58733928	34216552	24418701	16.56	15.87	1.17
4	Orissa	Others	22963	6.80	3.31	3.31	0.38	15.20	16.53	1.33	316896	181021	120023	17.65	16.98	22.68
5	West Bengal	Others	27914	5.36	3.43	3.32	0.38	28.45	31.53	3.08	109733756	60608944	49074276	27.36	23.40	5.73
6	Sikkim	Others	35398	7.31	NA	3.32	0.19	12.31	23.27	10.96	83205385	56218305	26780651	4.54	4.71	29.44
7	Tripura	Others	31711	6.78	3.25	3.25	0.29	18.04	25.22	7.18	33162121	18174111	13962604	16.35	17.72	31.59
	Average		26805	7.01	2.95	3.41	0.31	21.45	25.42	3.98	44412216	26932540	17275326	18.66	17.04	13.12
	Median		27914	6.80	3.43	3.32	0.32	18.04	23.27	3.08	33162121	19096583	13962604	17.65	17.72	5.73
1	Lakshawdeep	Centrally ruled UT	NA	NA	NA	2.80	0.28	47.84	74.35	26.51	24614312	16269804	8283882	NA	NA	94.74
2	A. & N. Island	Centrally ruled UT	56304	8.30	NA	NA	0.32	33.01	35.40	2.39	16268785	456774	15733620	NA	NA	7.65
3	Daman & Diu	Centrally ruled UT	NA	NA	NA	2.83	0.26	39.86	70.55	30.69	598962	460449	123810	3.48	2.65	6.88
4	Dadra & Nagar Haveli	Centrally ruled UT	NA	NA	NA	2.83	0.22	25.11	43.83	18.72	1331573	1031268	299594	0.80	1.82	54.59
5	Chandigarh	Centrally ruled UT	88284	4.45	2.51	2.51	0.37	90.71	96.58	5.87	3593936	2703539	861750	17.08	18.53	NA
	Average		28918	2.55	0.50	2.19	0.29	47.31	64.14	16.84	9281514	4184367	5060531	4.27	4.60	32.77
	Median		72294	6.38	2.51	2.82	0.28	39.86	70.55	18.72	3593936	1031268	861750	3.48	2.65	31.12
All-India	Average		35762	6.06	2.36	3.11	0.32	32.49	38.04	5.55	33683981	23355222	10268096	12.89	11.67	22.52
	Median		35335	6.61	3.31	3.11	0.32	27.03	31.53	2.85	16268785	8849709	4221080	16.35	15.85	12.84

Data Set 3. Welfare Schemes

Sr. No.	STATES/UTs	INC_ALLIES/ BJP_ALLIES/ OTHERS	NREG_WAGES_ PER_HEAD_R 2008-09	SC-PERSON DAYS NREG EMPLOYMENT PER SC RURAL POPULATION 2008-09	NREG_WAGE_ INCOME_PER_ HEAD_ 2009-10	PDS_SUBS_ RURAL_09 2009-10	PDS_SUBS_ URBAN_09 2009-10	PDS_SUBS_ TOTAL_09 2009-10	PDS_RURAL_ SHARE 2009-10	PDS_URBAN_ SHARE 2009-10	PDS_TOTAL_ SHARE 2009-10
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	Andhra Pradesh	INC_Allies	401.98	6.67	660.84	798.89	572.61	725.5	0.39	0.22	0.32
2	Karnataka	INC_Allies	63.10	1.1	464.96	615.71	314.57	501.51	0.53	0.16	0.33
3	Kerala	INC_Allies	100.26	1.55	225.34	455.92	360.79	412.93	0.24	0.19	0.2
4	Pondicherry	INC_Allies	34.31	0.77	42.66	851.1	453.93	580.96	0.42	0.18	0.22
5	Maharashtra	INC_Allies	52.04	0.97	54.75	316.26	90.68	215.27	0.21	0.05	0.11
6	Jammu & Kashmir	INC_Allies	60.72	0.92	243.30	636.43	1036.31	744.11	0.3	0.46	0.32
7	Himachal Pradesh	INC_Allies	337.72	4.41	113.09	740.31	479.09	714.18	0.4	0.22	0.36
8	Haryana	INC_Allies	51.08	1.02	1388.35	112.67	69.37	97.99	0.06	0.03	0.04
9	Delhi	INC_Allies	NA	NA	587.23	339.44	48.5	56.67	0.21	0.03	0.01
10	Rajasthan	INC_Allies	859.98	15.26	299.53	84.92	47.72	75.76	0.05	0.02	0.04
11	Uttarakhand	INC_Allies	128.39	1.97	55.59	272.25	104.79	222.89	0.15	0.04	0.1
12	Jharkhand	INC_Allies	281.50	4.50	448.61	235.04	93.31	201.4	0.12	0.04	0.09
13	Assam	INC_Allies	222.89	4.43	243.30	207.51	100.42	192.63	0.08	0.04	0.07
14	Arunachal Pradesh	INC_Allies	201.60	0.00	464.09	350.84	521.7	389.37	0.14	0.23	0.15
15	Meghalaya	INC_Allies	269.31	3.81	234.17	352.22	147.65	311.33	0.18	0.07	0.15
16	Mizoram	INC_Allies	2701.31	0.00	170.75	679.27	597.66	637.09	0.32	0.27	0.26
17	Manipur	INC_Allies	1307.84	12.61	228.06	38.47	69.51	48.25	0.01	0.02	0.01
	Average		416.12	3.53	348.51	416.90	300.51	360.46	0.22	0.13	0.16
	Median		212.25	1.76	243.30	350.84	147.65	311.33	0.21	0.07	0.15
1	Gujarat	BJP_Allies	42.39	1.19	NA	186.82	66.49	136.59	0.15	0.03	0.08
2	Goa	BJP_Allies	16.95	NA	785.01	264.58	249.35	255.35	0.11	0.12	0.11
3	Punjab	BJP_Allies	25.84	0.48	514.56	114.9	71.05	98.72	0.06	0.03	0.04
4	Madhya Pradesh	BJP_Allies	425.50	6.60	429.44	263.4	145.7	231.11	0.16	0.08	0.12
5	Chattishgarh	BJP_Allies	480.80	8.65	152.70	816.36	557.53	757.61	0.51	0.24	0.42
6	Nagaland	BJP_Allies	1129.47	0.00	896.82	NA	NA	NA	NA	NA	NA
	Average		353.49	2.82	463.09	274.34	181.69	246.56	0.17	0.08	0.13
	Median		233.95	1.19	514.56	263.40	145.70	231.11	0.15	0.08	0.11

(Contd.)

Data Set 3. (Concld.)

Sr. No.	STATES/UTs	INC_ALLIES/ BJP_ALLIES/ OTHERS	NREG_WAGES_ PER_HEAD_R 2008-09	SC-PERSON DAYS NREG EMPLOYMENT PER SC RURAL POPULATION 2008-09	NREG_WAGE_ INCOME_PER_ HEAD_ 2009-10	PDS_SUBS_ RURAL_09 2009-10	PDS_SUBS_ URBAN_09 2009-10	PDS_SUBS_ TOTAL_09 2009-10	PDS_RURAL_ SHARE 2009-10	PDS_URBAN_ SHARE 2009-10	PDS_TOTAL_ SHARE 2009-10
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	Tamil Nadu	Others	261.00	7.87	180.14	1280	1202.5	1243.03	0.99	0.65	0.74
2	Uttar Pradesh	Others	150.42	3.52	30.87	137.65	71.76	123.14	0.07	0.04	0.06
3	Bihar	Others	95.87	3.41	429.44	58.94	28.87	55.59	0.03	0.01	0.03
4	Orissa	Others	116.54	1.45	2031.26	453.53	235.44	417.73	0.24	0.11	0.22
5	West Bengal	Others	100.47	1.76	524.75	162.29	71.58	133.94	0.08	0.03	0.06
6	Sikkim	Others	523.11	7.16	291.07	645.96	24.16	502.16	0.39	0.01	0.26
7	Tripura	Others	1113.02	18.66	124.46	542.45	1727.95	836.16	0.26	0.69	0.36
	Average		337.20	6.26	516.00	468.69	480.32	473.11	0.29	0.22	0.25
	Median		150.42	3.52	291.07	453.53	71.76	417.73	0.24	0.04	0.22
1	Lakshadweep	Centrally ruled UT	911.96	0.00	135.66	1389.37	1292.87	1316.25	0.84	0.83	0.68
2	A. & N. Island	Centrally ruled UT	52.14	0.00	515.05	857.11	902.06	873.71	0.45	0.44	0.39
3	Daman & Diu	Centrally ruled UT	0.29	0.00	338.18	479	92.11	313.12	0.27	0.04	0.15
4	Dadra & Nagar Haveli	Centrally ruled UT	NA	NA	260.88	365.4	72.56	156.18	0.19	0.04	0.08
5	Chandigarh	Centrally ruled UT	NA	NA	3472.93	NA	41.07	39.78	NA	0.02	0.01
	Average		192.88	0.00	944.54	618.18	480.13	539.81	0.35	0.27	0.26
	Median		52.14	0.00	338.18	668.06	92.11	313.12	0.36	0.04	0.15
All-India	Average		357.71	3.45	486.80	431.57	341.76	389.09	0.25	0.16	0.19
	Median		176.01	1.76	295.30	352.22	125.25	283.34	0.21	0.06	0.14

Data Set 4. Public Services

Sr. No.	STATES/ UTs	INC_ ALLIES/ BJP_ ALLIES/ OTHERS	PMGSY_ ROADS_ PERSQKM	RURAL_ ROAD_ PER_ SQKM	RUR_ ROAD_ SQKM_ INCREASE	URBAN_ ROADS_ PER_ SQKM	URBAN_ ROAD_ INCR_ SQ	DRIN- KING_ WATER_ SAFE	DRIN- KING_ WATER_ TAP_ WELL	DRIN- KING_ WATER_ VICINITY	RURAL_ ROAD_ PER_ SQKM	URBAN_ ROAD_ PER_ SQKM	RUR_ ROAD_ SQKM_ INCREASE	URBAN_ ROAD_ INCR_SQ	CRIME_ RATE_ IPC	CRIME_ RATE_ PER- CENT_ CH
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1	Andhra Pradesh	INC_Allies	0.05	0.51	7.68	0.05	0.00	49.50	76.30	80.50	0.51	0.05	0.0112	0.00003270	7.89	-35.12
2	Karnataka	INC_Allies	0.05	0.80	47.95	0.13	0.00	42.20	75.10	81.80	0.80	0.13	0.0157	0.00004170	7.11	-8.56
3	Kerala	INC_Allies	0.02	3.98	3.75	0.34	0.00	38.00	91.30	91.80	3.98	0.34	0.0068	0.00010300	6.3	71.41
4	Pondi-cherry	INC_Allies	0.00	2.55	0.00	1.57	0.03	97.70	92.00	98.90	2.55	1.57	0.0000	0.02922800	2.76	-1.85
5	Maha-rashtra	INC_Allies	0.04	0.37	59.82	0.07	0.00	58.50	82.30	87.00	0.37	0.07	0.0101	0.00010700	17.28	-10.01
6	Jammu & Kashmir	INC_Allies	0.00	0.02	10.93	0.01	0.00	36.60	70.40	76.90	0.02	0.01	0.0030	0.00000000	-16.68	-20.12
7	Himachal Pradesh	INC_Allies	0.13	0.14	4.46	0.04	0.00	85.50	92.40	90.50	0.14	0.04	0.0271	0.00073600	10.67	4.43
8	Haryana	INC_Allies	0.07	0.07	15.40	0.18	0.01	56.60	71.80	87.90	0.07	0.18	0.0178	0.01284700	32.25	9.01
9	Delhi	INC_Allies	0.00	NA	NA	19.61	0.00	75.30	81.40	93.80	NA	19.61	NA	0.00067400	-10.51	-30.42
10	Rajasthan	INC_Allies	0.12	0.25	5.08	0.04	0.00	33.20	51.40	74.00	0.25	0.04	0.0127	0.00000000	-5.22	-2.55
11	Uttara-khand	INC_Allies	0.04	0.04	5.95	0.08	0.00	54.60	69.30	84.90	0.04	0.08	0.0143	0.00200100	3.34	164.99
12	Jharkhand	INC_Allies	0.04	0.04	5.45	0.01	0.00	11.90	49.40	68.10	0.04	0.01	0.0192	0.00000000	11.57	13.6
13	Assam	INC_Allies	0.08	2.35	9.42	0.08	0.00	10.90	29.40	81.50	2.35	0.08	0.0267	0.00130000	28.66	28.77
14	Arunachal Pradesh	INC_Allies	0.02	0.05	3.66	0.00	0.00	27.80	71.20	78.50	0.05	0.00	0.0088	0.00000000	8.11	8.66
15	Meghalaya	INC_Allies	0.03	0.06	0.36	0.01	0.00	34.70	64.70	67.30	0.06	0.01	0.0043	0.00000000	30.37	13.57
16	Mizoram	INC_Allies	0.07	0.07	0.08	0.02	0.00	41.40	63.40	77.90	0.07	0.02	0.0096	0.00000000	-46.02	-43.66
17	Manipur	INC_Allies	0.05	0.22	0.74	0.01	0.00	28.40	46.10	62.30	0.22	0.01	0.0394	0.00000000	24.02	32.22
	Average		0.05	0.68	10.63	1.31	0.00	46.05	69.29	81.39	0.68	1.31	0.0133	0.00276885	6.58	11.43
	Median		0.04	0.18	5.26	0.05	0.00	41.40	71.20	81.50	0.18	0.05	0.0120	0.00004170	7.89	4.43
1	Gujarat	BJP_Allies	0.03	0.25	35.64	0.11	0.00	42.20	76.10	87.50	0.25	0.11	0.0077	0.00248400	10.91	13.85
2	Goa	BJP_Allies	0.04	1.20	9.95	0.13	0.00	86.10	96.50	95.20	1.20	0.13	0.0448	0.00027000	5.9	-16.45
3	Punjab	BJP_Allies	0.06	1.07	142.25	0.16	0.00	41.30	56.00	95.90	1.07	0.16	0.0731	0.00000000	15.55	-4.41
4	Madhya Pradesh	BJP_Allies	0.09	0.24	24.48	0.05	0.00	17.60	43.40	69.50	0.24	0.05	0.0337	0.00000000	-1.69	0.47
5	Chattish-garh	BJP_Allies	0.09	0.23	8.38	0.05	0.00	13.10	32.10	73.50	0.23	0.05	0.0297	0.00339500	22.26	17.71
6	Nagaland	BJP_Allies	0.14	1.31	0.24	0.01	0.00	12.70	72.90	71.70	1.31	0.01	0.0165	0.00000000	16.38	14.71
	Average		0.07	0.72	36.82	0.08	0.00	35.50	62.83	82.22	0.72	0.08	0.0343	0.00102483	11.55	4.31
	Median		0.07	0.66	17.22	0.08	0.00	29.45	64.45	80.50	0.66	0.08	0.0317	0.00013500	13.23	7.16

(Contd.)

Data Set 4. ***(Concld.)***

Sr. No.	STATES/ UTs	INC_ ALLIES/ BJP_ ALLIES/ OTHERS	PMGSY_ ROADS_ PERSQKM	RURAL_ ROAD_ PER_ SQKM	RUR_ ROAD_ SQKM_ INCREASE	URBAN_ ROADS_ PER_ SQKM	URBAN_ ROAD_ INCR_ SQ	DRIN-KING_ WATER_ SAFE	DRIN-KING_ WATER_ TAP_ WELL	DRIN-KING_ WATER_ VICINITY	RURAL_ ROAD_ PER_ SQKM	URBAN_ ROAD_ PER_ SQKM	RUR_ ROAD_ SQKM_ INCREASE	URBAN_ ROAD_ INCR_SQ	CRIME_ RATE_ IPC	CRIME_ RATE_ PER-CENT_ CH
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1	Tamil Nadu	Others	0.04	0.78	7.43	0.14	0.00	57.00	84.90	93.00	0.78	0.14	0.0149	0.00003840	7.44	-13
2	Uttar Pra-desh	Others	0.11	0.31	63.41	0.21	0.11	20.80	31.30	87.90	0.31	0.21	0.0395	0.11207500	61.47	127.7
3	Bihar	Others	0.07	1.02	29.71	0.11	0.00	3.80	8.70	88.00	1.02	0.11	0.0302	0.00020200	22.39	21.71
4	Orissa	Others	0.07	1.10	32.95	0.12	0.00	12.20	33.30	64.60	1.10	0.12	0.0247	0.00001930	13.44	8.9
5	West Ben-gal	Others	0.09	1.90	14.46	1.00	0.00	21.70	31.40	73.30	1.90	1.00	0.0164	-0.00330100	61.71	-90.58
6	Sikkim	Others	0.30	0.30	0.19	0.01	0.00	29.70	85.90	82.30	0.30	0.01	0.0140	0.00366400	55.06	23.52
7	Tripura	Others	0.10	1.47	0.47	0.02	0.00	23.20	60.60	67.60	1.47	0.02	0.0496	0.00486400	41.89	45.23
	Average		0.11	0.98	21.23	0.23	0.02	24.06	48.01	79.53	0.98	0.23	0.0270	0.01679453	37.63	17.64
	Median		0.09	1.02	14.46	0.12	0.00	21.70	33.30	82.30	1.02	0.12	0.0247	0.00020200	41.89	21.71
1	Laksha-dweep	Centrally ruled UT	0.00	NA	NA	0.03	0.00	16.00	97.20	98.00	NA	0.03	NA	0.00000000	179.88	191.03
2	A. & N. Island	Centrally ruled UT	0.00	NA	NA	0.01	0.00	69.60	92.30	87.60	NA	0.01	NA	0.00000000	23.05	-21.82
3	Daman & Diu	Centrally ruled UT	0.00	0.99	0.00	0.31	0.00	55.10	75.90	98.50	0.99	0.31	0.0000	0.00000000	-18.05	-14.72
4	Dadra & Nagar Haveli	Centrally ruled UT	0.00	NA	NA	NA	NA	27.50	53.70	89.00	NA	NA	NA	NA	4.27	2.41
5	Chandigarh	Centrally ruled UT	0.00	NA	NA	14.15	0.00	93.80	96.80	97.90	NA	14.15	NA	0.00000000	24.91	2.89
	Average		0.00	0.20	0.00	2.90	0.00	52.40	83.18	94.20	0.20	2.90	0.0000	0.00000000	42.81	31.96
	Median		0.00	0.99	0.00	0.17	0.00	55.10	92.30	97.90	0.99	0.17	0.0000	0.00000000	23.05	2.41
All-India	Average		0.06	0.68	15.72	1.11	0.00	40.75	65.91	82.99	0.68	1.11	0.0178	0.00487946	18.82	14.39
	Median		0.05	0.34	7.56	0.07	0.00	36.60	71.20	84.90	0.34	0.07	0.0161	0.00003555	11.57	4.43

Data Set 5. Employment

SERIAL NUMBER	STATES/UTs	INC_ALLIES/ BJP_ALLIES/ OTHERS	WPR_RURAL	WPR_URBAN	WPR_TOTAL	EMPL_RATE_ RURAL	EMPL_RATE_ URBAN	EMPL_RATE_ TOTAL	EMPL_GR_ RURAL	EMPL_GR_ URBAN	EMPL_GR_ TOTAL
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	Andhra Pradesh	INC_Allies	521	364	476	98.86	97.07	98.55	5.43	11.03	5.84
2	Karnataka	INC_Allies	497	382	456	99.60	97.20	98.92	-14.8	36.61	-10.44
3	Kerala	INC_Allies	383	363	377	92.51	92.84	92.40	0.19	21.81	5.51
4	Pondicherry	INC_Allies	481	381	414	96.98	96.95	96.96	3.71	24.76	1.9
5	Maharashtra	INC_Allies	488	380	443	99.39	96.94	98.44	-5.3	42.86	-3.43
6	Jammu & Kashmir	INC_Allies	431	347	411	97.51	94.04	96.93	1.04	116.89	8.89
7	Himachal Pradesh	INC_Allies	512	359	499	98.46	95.23	98.23	8.93	-6.31	8.35
8	Haryana	INC_Allies	396	361	385	98.26	97.57	97.96	2.11	22.73	4.8
9	Delhi	INC_Allies	301	333	331	98.37	97.37	97.35	1.62	24.01	14.86
10	Rajasthan	INC_Allies	436	323	409	99.77	97.88	99.27	4.06	5.07	5.28
11	Uttarakhand	INC_Allies	431	336	407	98.40	97.11	98.07	-4.24	13.72	6.78
12	Jharkhand	INC_Allies	333	294	326	96.24	93.93	95.88	-12.79	14.63	-7.88
13	Assam	INC_Allies	368	322	363	96.08	94.99	96.03	-2.15	8.9	4.62
14	Arunachal Pradesh	INC_Allies	404	302	383	98.78	96.49	98.46	-6.04	2.29	-8.07
15	Meghalaya	INC_Allies	480	333	454	99.59	94.87	98.91	-1.26	2.44	-2.13
16	Mizoram	INC_Allies	506	403	460	98.83	97.11	98.08	0.92	21.8	2.47
17	Manipur	INC_Allies	361	315	349	96.27	95.17	96.14	-6.17	8.62	-4.62
	Average		431	347	408	97.88	96.04	97.45	-1.46	21.87	1.93
	Median		431	347	409	98.40	96.94	98.07	0.19	14.63	4.62
1	Gujarat	BJP_Allies	459	370	424	99.35	98.14	98.83	-1.7	13.22	-1.99
2	Goa	BJP_Allies	311	332	337	95.22	95.95	95.47	-25.53	4.39	3.35
3	Punjab	BJP_Allies	391	365	382	97.51	95.30	96.71	-2.94	22.72	0.66
4	Madhya Pradesh	BJP_Allies	426	426	326	99.30	97.31	99.02	1.17	8.75	12.38
5	Chattishgarh	BJP_Allies	442	313	419	99.33	97.20	99.05	-8.05	4.57	-2.15
6	Nagaland	BJP_Allies	411	293	380	89.35	90.71	89.62	-14.06	-5.59	-13.37
	Average		407	350	378	96.68	95.77	96.45	-8.52	8.01	-0.19
	Median		419	349	381	98.40	96.58	97.77	-5.50	6.66	-0.67

(Contd.)

Data Set 5. ***(Concld.)***

SERIAL NUMBER	STATES/UTs	INC_ALLIES/ BJP_ALLIES/ OTHERS	WPR_RURAL	WPR_URBAN	WPR_TOTAL	EMPL_RATE_ RURAL	EMPL_RATE_ URBAN	EMPL_RATE_ TOTAL	EMPL_GR_ RURAL	EMPL_GR_ URBAN	EMPL_GR_ TOTAL
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	Tamil Nadu	Others	501	383	448	98.43	96.96	97.82	-22.67	146.42	24.38
2	Uttar Pradesh	Others	344	300	335	98.85	97.09	98.53	-6.49	7.96	-1.52
3	Bihar	Others	283	252	280	97.92	92.65	97.56	-37.19	5.85	11.23
4	Orissa	Others	410	350	402	96.93	95.89	96.87	-3.81	19.66	-0.64
5	West Bengal	Others	392	370	386	98.25	95.85	97.47	7.31	12.52	9.53
6	Sikkim	Others	442	398	437	95.67	99.75	96.04	4.50	28.72	16.06
7	Tripura	Others	390	327	379	90.91	82.99	89.60	25.46	194.39	57.4
	Average		395	340	381	96.71	94.46	96.27	-4.70	59.36	16.63
	Median		392	350	386	97.92	95.89	97.47	-3.81	19.66	11.23
1	Lakshawdeep	Centrally ruled UT	456	378	415	90.30	94.03	91.81	33.69	61.10	54.41
2	A. & N. Island	Centrally ruled UT	404	392	399	92.03	91.59	91.72	-16.74	22.96	2.03
3	Daman & Diu	Centrally ruled UT	416	344	384	96.07	97.45	96.73	6.94	-5.30	1.72
4	Dadra & Nagar Haveli	Centrally ruled UT	311	339	318	95.11	94.69	94.93	-47.14	16.89	-33.90
5	Chandigarh	Centrally ruled UT	301	352	342	75.44	96.44	92.18	-42.46	55.45	-1.47
	Average		378	361	372	89.79	94.84	93.47	-13.14	30.22	4.56
	Median		404	352	384	92.03	94.69	92.18	-16.74	22.96	1.72
All-India	Average		412	348	392	96.28	95.51	96.47	-4.98	28.19	4.88
	Median		411	350	386	97.92	96.44	97.35	-2.15	14.63	2.47
	Average*		408	350	392	98.55	98.00	98.00	-1.20	12.14	2.44

N.B.* Starred average uses all-India values. In all Tables, non-starred averages are averages of state values.

Data Set 6. Regular Employment

Sr. No.	STATES/UTs	INC_ALLIES/ BJP_ALLIES/ OTHERS	REG_EMPL_ RATIO_R	REG_EMPL_ RATIO_U	REG_EMPL_ RATIO_T	EMPL_ RATE_ REG_R	EMPL_ RATE_ REG_U	EMPL_ RATE_ REG_T	EMPL_GR_ REG_RURAL	EMPL_GR_ REG_URBAN	EMPL_GR_ REG_TOTAL
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	Andhra Pradesh	INC_Allies	36	163	72	6.82	43.49	14.99	-45.04	-50.26	-46.94
2	Karnataka	INC_Allies	32	151	74	6.37	38.30	16.08	-40.89	-46.18	-40.40
3	Kerala	INC_Allies	74	124	89	17.95	31.75	21.88	-52.59	-58.34	-55.99
4	Pondicherry	INC_Allies	75	209	165	15.13	53.13	38.56	-61.55	-31.63	-30.49
5	Maharashtra	INC_Allies	34	207	106	6.86	52.83	23.54	-56.91	-22.14	-18.43
6	Jammu & Kashmir	INC_Allies	63	149	83	14.24	40.44	19.69	-50.91	-6.74	-43.63
7	Himachal Pradesh	INC_Allies	73	175	82	14.08	46.37	16.11	-30.63	-54.38	-40.13
8	Haryana	INC_Allies	65	185	102	16.02	50.05	26.07	-48.49	-37.04	-37.01
9	Delhi	INC_Allies	179	183	183	58.63	53.46	53.71	-65.50	-31.92	-58.13
10	Rajasthan	INC_Allies	25	117	47	5.79	35.43	11.45	-48.70	-61.96	-60.75
11	Uttarakhand	INC_Allies	36	122	58	8.17	35.35	13.89	-47.68	-58.60	-66.16
12	Jharkhand	INC_Allies	17	114	34	4.91	36.35	10.10	-54.78	-55.64	-60.62
13	Assam	INC_Allies	35	141	46	9.03	41.60	12.21	-60.48	-52.30	-72.01
14	Arunachal Pradesh	INC_Allies	62	156	82	15.21	49.98	20.98	-38.64	-47.01	-32.50
15	Meghalaya	INC_Allies	45	181	69	9.26	51.61	14.99	-3.58	-44.27	-19.21
16	Mizoram	INC_Allies	44	129	82	8.60	30.98	17.44	-31.73	-61.14	-44.96
17	Manipur	INC_Allies	42	86	53	11.07	25.98	14.63	-50.02	-70.35	-57.35
	Average		55	152	84	13.42	42.18	20.37	-46.36	-46.46	-46.16
	Median		44	151	82	9.26	41.60	16.11	-48.70	-50.26	-44.96
1	Gujarat	BJP_Allies	31	153	79	6.66	40.53	18.36	-52.41	-53.24	-39.11
2	Goa	BJP_Allies	213	223	216	59.90	64.48	61.20	-58.07	-29.85	-34.04
3	Punjab	BJP_Allies	46	156	84	11.51	40.69	21.30	-60.94	-47.60	-47.22
4	Madhya Pradesh	BJP_Allies	20	112	41	4.67	33.57	10.14	-58.03	-62.48	-76.83
5	Chattishgarh	BJP_Allies	20	123	39	4.57	38.10	9.12	-44.80	-59.01	-66.50
6	Nagaland	BJP_Allies	58	139	79	12.51	42.91	18.59	-42.36	-55.35	-47.46
	Average		65	151	90	16.63	43.38	23.00	-52.77	-51.26	-51.86
	Median		39	146	79	9.08	40.61	18.47	-55.22	-54.30	-47.34

(Contd.)

Data Set 6. ***(Concld.)***

Sr. No.	STATES/UTs	INC_ALLIES/ BJP_ALLIES/ OTHERS	REG_EMPL_ RATIO_R	REG_EMPL_ RATIO_U	REG_EMPL_ RATIO_T	EMPL_ RATE_ REG_R	EMPL_ RATE_ REG_U	EMPL_ RATE_ REG_T	EMPL_GR_ REG_RURAL	EMPL_GR_ REG_URBAN	EMPL_GR_ REG_TOTAL
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	Tamil Nadu	Others	50	153	96	9.74	38.69	20.95	-61.13	-1.68	-54.66
2	Uttar Pradesh	Others	16	91	31	4.55	29.32	9.15	-70.45	-67.40	-75.65
3	Bihar	Others	9	55	13	3.13	20.10	4.69	-76.48	-77.03	-94.36
4	Orissa	Others	26	127	39	6.11	34.71	9.46	-51.09	-56.68	-57.51
5	West Bengal	Others	33	137	61	8.25	35.47	15.48	-54.45	-58.37	-64.06
6	Sikkim	Others	118	221	129	25.45	55.36	28.42	-51.13	-28.56	-52.16
7	Tripura	Others	39	153	59	9.00	38.92	13.86	-60.67	38.07	-50.84
	Average		42	134	61	9.46	36.08	14.57	-60.77	-35.95	-64.18
	Median		33	137	59	8.25	35.47	13.86	-60.67	-56.68	-57.51
1	Lakshawdeep	Centrally ruled UT	135	149	142	26.64	37.07	31.44	-30.15	-36.53	-35.78
2	A. & N. Island	Centrally ruled UT	148	300	212	33.77	70.16	48.64	-36.60	-5.81	-27.55
3	Daman & Diu	Centrally ruled UT	148	134	142	34.20	37.91	35.71	-38.53	-63.16	-52.76
4	Dadra & Nagar Haveli	Centrally ruled UT	41	247	93	12.65	69.13	27.73	-87.74	-14.67	-72.97
5	Chandigarh	Centrally ruled UT	211	220	218	52.81	60.27	58.81	-54.96	-2.84	-34.62
	Average		137	210	161	32.01	54.90	40.46	-49.60	-24.60	-44.74
	Median		148	220	142	33.77	60.27	35.71	-38.53	-14.67	-35.78
All-India	Average		66	157	91	15.84	42.98	22.55	-50.80	-42.06	-50.54
	Median		44	151	82	9.74	40.44	18.36	-51.13	-50.26	-50.84
	Average*		30	145	62	7.19	40.03	15.39	-55.41	-53.57	-56.79

N.B.* Starred average uses all-India values. In all Tables, non-starred averages are averages of state values.

YOUTH EMPLOYMENT AND UNEMPLOYMENT IN INDIA: TRENDS AND DIMENSIONS

Sankar Kumar Bhaumik*

This paper seeks to understand the trends and dimensions of youth employment and unemployment in India and her 15 major states over a period spanning over past 25 years or so (1983 to 2009-10). Such an understanding is necessary to appreciate the difficulties faced by the youth in the labour market today as also to highlight the necessity of devising more effective policies to improve their labour market outcomes than those hitherto been followed. Beginning with a discussion on age group-wise distribution of population, employed/workers and unemployed in all-India and 15 major states, we move on to examine the trends and patterns of employment for the youth and non-youth groups in terms of indicators like labour force participation rate, workforce participation rate, growth of employment, sectoral composition of employment and modes of employment. We also look into the unemployment scenarios for the youth and non-youth groups and changes therein in all-India and 15 major states. Finally, we carry out an econometric exercise to identify some important determinants of the youth in India being employed (as against remaining unemployed).

I. INTRODUCTION

The problems of youth unemployment and underemployment are global phenomena. Many of the developed and developing countries are plagued by these problems though with varying degrees and forms. In many countries, the young people are found in disadvantageous position in the labour market as they lack marketable education and skills, work experience, job search abilities and financial resources which are important to obtain employment [Mitra and Verick, 2013]. At the global level, the number of unemployed youth has been rising in recent years of financial crisis. As reported by the International Labour Organisation [2012, p. 43], 74.6 million youth were unemployed around the world in 2012, which was higher by 4.3 million compared to the number of unemployed youth in 2007. In 2012, the youth unemployment rate at the global level stood at 12.7, which is 2.7 times greater than the non-youth unemployment rate. What is worrying is that neither the global unemployment rate for the youth revealed any declining trend during the decade of 2000s nor the medium-term projection predicted improvement of situation in near future.

It is thus natural that the issue of youth employment and unemployment has drawn considerable research attention in recent years, and the governments in many countries are rather compelled to formulate specific polices to improve the plight of the unemployed youth. This is more so because high incidence of youth unemployment has been responsible for generating many problems: unhappiness, inclination towards crime, drugs-trafficking, drugs-addiction, social unrest, political instability, and so on [World Bank, 2012, Pp. 132-33; Matsumoto, Hengge and Islam, 2012, p. 2]. There are also economic costs associated with high levels of youth unemployment. It has been observed that high and persistent youth unemployment imposes significant costs on national

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This paper forms a part of the work being done by the author for the ICSSR-sponsored research project titled "Globalisation, Economic Growth and Employment in India: An Analysis of Possible Linkages". An earlier version of this paper was presented at the *International Seminar on Youth Unemployment in India: Dimensions, Challenges and Strategies* organised jointly by the Department of Economics, Patna University, ISLE, New Delhi, and IHD Eastern Regional Centre, Ranchi, during 18-19 May 2013. The author is thankful to the participants of the seminar, especially to Dr. Rizwanul Islam, for useful comments and encouragements. The comments obtained from an anonymous referee of this Journal were also helpful. Ankita De Sarker provided excellent research assistance. However, usual disclaimers apply.

budgets due to loss of output and tax revenues engendered by underutilisation of human resources [Ibid., p. 1]. It may also lead to increased income inequality as there exists a positive correlation between poor youth employment outcomes and inequality.[1] Moreover, continuance of unemployment among the youth leads to perpetuation of 'generational poverty'.[2] In any case, the shackles of generational poverty could not be broken unless the youth are equipped with required skills and provided employment.

In the context of India, the issue of youth employment and unemployment assumes greater significance as it is one of the countries often credited for enjoying the advantage of 'demographic dividend' which may be channelised to hasten the pace of economic growth in future. The fact of the matter is that a significantly high proportion of India's population belongs to the prime working age-group of 15-59 years, and this proportion has been rising steadily for some time while the share of the dependent population (children and old-aged) has been declining.[3] However, to what extent India has been successful in productively utilising its 'demographic dividend', especially the 'youth' component of it (aged 15-29 years), becomes an important issue for discussion. In this respect, several past studies highlighted persistence of adverse labour market outcomes for the youth in India *vis-à-vis* the non-youth. Not only the youth are reported to suffer from high unemployment rates but are also often compelled to accept subsidiary and low-paid employments (especially the young females).[4] Thus, in recognition of the necessity of expansion of decent employment for the youth, Manmohan Singh, the Prime Minister of India, while addressing the 44th Indian Labour Conference, rightly stated: "We need to provide opportunities for gainful employment to the large number of young people who enter the work force every year. Youth employment is a high-priority agenda item for our government. This can happen only if we equip our young people with skills that are required to meet the demands of our growing economy".

Against this backdrop, this paper seeks to understand the trends and dimensions of youth employment and unemployment in India and her 15 major states over a period spanning over 25 years or so (1983 to 2009-10). Such an understanding is necessary to appreciate the difficulties faced by the youth in the labour market today as also to highlight the necessity of devising more effective policies to improve their labour market outcomes than those hitherto been followed. Our discussion is organised through seven sections. In Section II, we spell out the source of data and clarify a few methodological matters. Section III looks into age group-wise distribution of population, employed/workers and unemployed in all-India and 15 major states during the period 1983 to 2009-10. Section IV discusses trends and patterns of employment for the youth and non-youth groups in terms of indicators like labour force participation rate, workforce participation rate, growth of employment, sectoral composition of employment and modes of employment for these categories. The unemployment rates for the youth and non-youth in all-India and 15 major states are examined in Section V. In Section VI, we undertake an econometric exercise to identify some important determinants of the youth being employed (as against remaining unemployed). The final section VII provides a summary of main findings.

II. DATA BASE AND METHODOLOGY

This study is based on data available from the NSSO reports on employment/unemployment for three survey rounds: 38th (for the year 1983), 50th (1993-94) and 66th (2009-10).[5] We have also used the unit-level data for 2009-10 to understand sectoral composition of employment and modes of employment for the youth and non-youth groups and also to carry out our econometric exercise. The NSSO data have been used for the simple reason that it followed, by and large, a common conceptual framework for estimation of number of employed/unemployed in all its surveys. Moreover, unlike the Census data, the NSSO estimates of employed or workers are comprehensive and include most workers who contribute to the production of goods and services in the country and hence the question of underestimation of any section of workers does not arise much in the context of NSSO data.

As is well-known, the NSSO follows three different approaches to measure the employed/unemployed in any survey year (National Sample Survey Organisation, 2001, Section 4). These are known as the employed based on concepts of usual activity status (US), current weekly status (CWS) and current daily status (CDS). The usual activity status refers to the activity status of a person during the reference period of 365 days preceding the date of survey. The activity status on which a person spent relatively longer time, (i.e., 'major time criterion') during the 365 days is considered as the usual principal activity status (US-PS) of the person. To decide this, the persons are first categorised, on the basis of the 'major time criterion', as those in the labour force and those not in the labour force during the 365 days. Persons adjudged as not belonging to the labour force are assigned the broad activity status 'neither working nor available for work', (i.e., not in the labour force). For the persons belonging to the labour force, the broad activity status of either 'working' (employed) or 'not working but seeking and/or available for work' (unemployed) is then ascertained again on the basis of the same criterion, viz., relatively longer time spent during the 365 days preceding the date of survey. If the person whose usual principal status is determined on the basis of the 'major time criterion' pursued some economic activity for a shorter time throughout the reference period of 365 days preceding the date of survey or for a minor period (not less than 30 days) during the reference year, then the person is designated as the usual subsidiary status worker (US-SS). The usual status determined on the basis of the usual principal activity and usual subsidiary economic activity of the persons taken together is considered as the usual activity status of the persons and is referred to as the usual status (US-PS+SS or UPSS) workers. Thus, UPSS refers to the usual status workers who performed some work activity either in the principal status or in the subsidiary status. As against this concept, a person is designated as employed as per the current weekly status (CWS) concept if he/she was engaged in any economic activity for at least one hour on any day of the week preceding the survey. The other concept of the current daily status (CDS) gives an idea about level of employment on each day for the week preceding the date of survey. A person is designated as employed as per the CDS on a day if he/she has worked for 4 hours or more during the day. However, if a person worked for one hour or more but less than 4 hours, he/she is to be considered as employed for half day.

Corresponding to the above concepts of employed, one could visualise three different concepts of unemployed - usually unemployed, unemployed as per current weekly status and unemployed according to daily status concept. Again the usually unemployed may be categorised as (i) usually unemployed according to the principal status [known as Unemployed (US-unadjusted)], which include those who are unemployed according to the US-PS definition, but they may be engaged in any subsidiary activity and (ii) the unemployed (US-adjusted) which is a measure of number of unemployed according to the US-PS minus the number of those who are engaged in any subsidiary activity (among usually unemployed according to PS). Then there is unemployment estimates according to the CWS and CDS that capture respectively average weekly picture of unemployment and average level of unemployment on a day during the survey year.

In this study, however, we have considered data based on the usual principal plus subsidiary status (UPSS) basis to build our understanding about changing employment/unemployment scenarios for the youth *vis-à-vis* non-youth in India and her states. This is because the data based on this concept are more helpful to understand inter-temporal changes in youth employment/ unemployment and also provides a more stable and enduring picture of unemployment than the one thrown up by weekly or daily status data [Chadha, 2000, p. 592].

Our approach has been to compute absolute figures of employed and unemployed at our chosen points of time for the youth and non-youth groups and the combined group after adjusting the data available from NSSO reports. This becomes necessary as the NSSO reports on employment/unemployment furnish data only in terms of 'rates' - labour force participation rate, workforce participation rate, unemployment rate and so on (these are expressed in terms of per thousand population). To compute the absolute numbers of employed and unemployed, both in all-India and the states, we first computed population levels at the midpoints of our reference years, (i.e., on 1st July, 1983, 1st January, 1994 and 1st January, 2010). For this purpose, we used population data available from the reports/website of Census of India for the years 1981, 1991, 2001 and 2011. Using these data, we computed annual compound growth rates of population for three decades that we subsequently used to find out, through the method of interpolation, the population figures corresponding to the midpoints of the reference years. Having obtained the population figures thus, we use the NSSO data on various 'rates' (including, of course, those by age groups) to work out the absolute numbers of employed and unemployed. These numbers have been distributed over different age groups in proportion to their respective share in total population, employed and unemployed.

In order to ensure inter-temporal comparability among the states, we made some additional adjustment to data for the year 2009-10. As the states of Jharkhand, Uttaranchal and Chhattisgarh have been carved out of Bihar, Uttar Pradesh and Madhya Pradesh respectively, the NSSO report for the year 2009-10 provided data for all these states separately. So to attain inter-temporal comparability, we have merged Bihar with Jharkhand, Uttar Pradesh with Uttaranchal and Madhya Pradesh with Chhattisgarh. The absolute figures on employed and unemployed that we worked out for the individual states helped to arrive at the figures for these combined states. Thus, the figures of Bihar, Uttar Pradesh and Madhya Pradesh for all chosen years refer to those of the undivided states.

Another important methodological issue relates to the definition of 'youth' to be followed. Actually, the definition of youth varies from country to country and sometimes within a country [International Labour Organisation, 2005, p. 3]. The international organisations like the United Nations and the Commonwealth defined youth as somebody between 15-24 and 15-29 years of age, respectively. The Twelfth Five Year Plan document for India designated the latter as the youth. However, recently released Draft National Youth Policy [2012] proposed a change in age-bracket for the youth, including all those in the age group 15-35 years. Considering all pros and cons, in this study, we define youth as all those in the age group of 15-29 years and non-youth as the rest of population (excluding infants). Such a definition seems helpful as the group of youth includes all those who have completed or are about to complete their education, and are presumably eager to join the labour force. The method of age-group classification followed by the NSSO also lends support for such a categorisation. All through our discussion, we highlight the differences in employment and unemployment situations between the groups of youth and non-youth notwithstanding the intra-group differences that are likely to persist for these categories.[6]

III. AGE GROUP-WISE DISTRIBUTION OF POPULATION, EMPLOYED AND UNEMPLOYED

All-India Situation

Population Distribution

We begin by looking at age group-wise distribution of total population (5 years and above), employed/workers (on UPSS basis) and unemployed (US-Adj.) in All-India at three points of time - 1983, 1993-94 and 2009-10. As regards the distribution of population, Table 1A shows that, in 2009-10, nearly 30 per cent of total population (≥ 5 years) in India belonged to the category of youth (15-29 years). Among the non-youth, the share of children (5-14 years), senior adults (30-59 years) and old-aged (≥ 60 years) being about 24, 38 and 9 per cent respectively. The share of children in total population declined over time (declining from 31 per cent in 1983 to 24 per cent in 2009-10). Such a decline is accompanied by a rise in the share of 30-59 years category (rising from 32 per cent in 1983 to 38 per cent in 2009-10). The increase in the share of old-aged during this period has been marginal (rising by one percentage point only). On the other hand, the share the youth remained almost unchanged, hovering around 30 per cent.

Table 1A: Age Group-wise Distribution of Population (5 years & above) in All-India

Region	Category	Year	Age Group (in years)						
			5-14	15-29	30-59	≥60	15-59	5-14 + ≥ 60	≥5
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Rural	Male	1983	32.69	28.26	31.37	7.69	59.62	40.38	100
		1993-94	28.93	29.62	33.75	7.69	63.38	36.62	100
		2009-10	26.54	28.63	36.34	8.48	64.98	35.02	100
	Female	1983	30.19	29.52	32.37	7.91	61.90	38.1	100
		1993-94	26.72	30.50	34.86	7.91	65.37	34.63	100
		2009-10	23.95	29.03	38.08	8.94	67.11	32.89	100
	Person	1983	31.48	28.87	31.86	7.80	60.73	39.27	100
		1993-94	27.86	30.05	34.29	7.80	64.34	35.66	100
		2009-10	25.28	28.83	37.19	8.70	66.01	33.99	100
Urban	Male	1983	28.07	33.44	32.61	5.89	66.05	33.95	100
		1993-94	25.36	32.63	35.87	6.15	68.49	31.51	100
		2009-10	21.02	31.85	39.22	7.91	71.07	28.93	100
	Female	1983	28.17	33.25	31.39	7.20	64.64	35.36	100
		1993-94	25.14	32.51	35.08	7.26	67.60	32.4	100
		2009-10	19.20	31.34	40.13	9.33	71.48	28.52	100
	Person	1983	28.11	33.35	32.04	6.50	65.39	34.61	100
		1993-94	25.26	32.57	35.49	6.68	68.07	31.93	100
		2009-10	20.15	31.61	39.65	8.58	71.26	28.74	100
Rural + Urban	Male	1983	31.54	29.55	31.67	7.24	61.22	38.78	100
		1993-94	28.01	30.39	34.30	7.29	64.69	35.31	100
		2009-10	24.99	29.54	37.15	8.32	66.69	33.31	100
	Female	1983	29.72	30.40	32.14	7.74	62.54	37.46	100
		1993-94	26.33	31.00	34.92	7.75	65.92	34.08	100
		2009-10	22.65	29.66	38.64	9.05	68.30	31.7	100
	Person	1983	30.66	29.96	31.90	7.48	61.86	38.14	100
		1993-94	27.20	30.69	34.60	7.51	65.29	34.71	100
		2009-10	23.86	29.60	37.87	8.67	67.47	32.53	100

Source: Author's calculation using data taken from NSSO reports on Employment/Unemployment for 38th, 50th and 66th Rounds.

The age group-wise distribution of population does not vary much when considered separately for the males and females. However, when rural and urban areas are considered separately, we find that the share of children has been lower and the shares of youth and senior adults higher in urban areas compared to those in rural areas. The share of old-aged remains almost the same between rural and urban areas. Another point that needs mention is that the share of children in total population declined over time while the share of senior adults increased, both in rural and urban areas. As regards the share of the youth category in total population, no change is visible in rural areas while in urban areas, it increased marginally.

Table 1A also shows that the share of the prime working age-group of 15-59 years in total population (≥ 5 years) has been increasing and the share of dependent population (children and old-aged) declining steadily in India during the period under consideration (1983 to 2009-10). At present, nearly two-thirds of total population belonged to the former category. Such share has always been higher in urban areas compared to rural areas, and for females compared to males.

Distribution of Employed

The information regarding age group-wise distribution of employed persons (on UPSS basis) in all-India has been presented in Table 1B. The main points to be noted here are the following:

(1) Nearly 30 per cent of all employed persons in all-India belonged to the age-group of 15-29 years in 2009-10 which is almost proportional to their share in total population. On the other hand, the share of 30-59 age-group in total employed in the same year has been 61 per cent which is much higher compared to their share in total population (38 per cent). The child workers' share stood at 1.11 per cent in 2009-10 while the share of old-aged workers is found to be 7.49 per cent.

(2) Over the year, the youth (15-29 years) lost out in terms of their share in total employed. This is true irrespective of area (rural and urban) considered and sex of workers. Considering all areas (rural + urban) and male and female workers together, it is found that the share of the youth in total employed declined from 37.18 per cent in 1983 to 35.77 per cent in 1993-94. A more drastic reduction in youth's share in total employed is visible in 2009-10 when the figure stood at 30.36 per cent.

(3) The incidence of child workers also declined drastically during our study period, declining from 7.10 per cent in 1983 to 1.11 per cent in 2009-10. The main beneficiaries from these changes have been the senior adults (30-59 years) whose share in total employed persons increased from 49 per cent in 1983 to 61 per cent in 2009-10. The share of old-aged in total employed persons, however, improved marginally, increasing from 6.47 per cent on 1983 to 7.49 per cent in 2009-10.

(4) The shares of different age-groups in total employed do not differ much when considered separately for rural and urban areas and males and females.

Distribution of Unemployed

Contrary to the picture obtained for distribution of employed persons, the youth shared a much higher proportion of unemployed persons in India. In 2009-10, as high as 88.52 per cent of all unemployed (US-Adj.) persons in all-India belonged to the category of youth (15-29 years) (see Table 1C). The share of youth in total unemployed increased over time, increasing from 84.67 per cent in 1983 to 88.52 per cent in 2000-09. The share of those belonging to age

Table 1B. Age Group-wise Distribution of Usual Status Workers (UPSS basis) in All-India

Region	Category	Year	Age Group (in years)				
			5-14	15-29	30-59	≥60	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Rural	Male	1983	6.97	36.84	48.10	8.08	100
		1993-94	3.30	36.10	52.00	8.60	100
		2009-10	1.10	30.94	58.88	9.08	100
	Female	1983	9.59	37.31	48.55	4.55	100
		1993-94	5.10	36.30	53.50	5.10	100
		2009-10	1.70	29.07	62.24	6.99	100
	Person	1983	7.94	37.02	48.27	6.78	100
		1993-94	3.95	36.17	52.54	7.34	100
		2009-10	1.28	30.36	59.93	8.43	100
Urban	Male	1983	2.94	38.32	53.66	5.09	100
		1993-94	1.60	34.67	59.04	4.70	100
		2009-10	0.50	30.40	64.50	4.60	100
	Female	1983	6.17	35.98	52.09	5.76	100
		1993-94	3.60	32.63	59.06	4.70	100
		2009-10	0.80	30.17	64.64	4.40	100
	Person	1983	3.61	37.84	53.33	5.23	100
		1993-94	2.02	34.23	59.04	4.70	100
		2009-10	0.56	30.36	64.53	4.56	100
Rural + Urban	Male	1983	6.03	37.19	49.40	7.38	100
		1993-94	2.89	35.75	53.70	7.66	100
		2009-10	0.93	30.79	60.43	7.85	100
	Female	1983	9.18	37.15	48.97	4.69	100
		1993-94	4.90	35.81	54.24	5.05	100
		2009-10	1.55	29.25	62.63	6.57	100
	Person	1983	7.10	37.18	49.25	6.47	100
		1993-94	3.55	35.77	53.87	6.80	100
		2009-10	1.11	30.36	61.05	7.49	100

Source: Same as in Table 1A

Table 1C. Age Group-wise Distribution of Unemployed (US-Adj.) in All-India

Region	Category	Year	Age Group (in years)				
			5-14	15-29	30-59	≥60	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Rural	Male	1983	9.00	83.12	7.37	0.51	100
		1993-94	2.00	90.90	7.10	0.00	100
		2009-10	3.10	92.90	3.90	0.10	100
	Female	1983	7.70	84.92	6.46	0.91	100
		1993-94	2.20	88.59	9.21	0.00	100
		2009-10	1.40	87.59	10.81	0.20	100
	Person	1983	8.72	83.50	7.18	0.59	100
		1993-94	2.05	90.36	7.60	0.00	100
		2009-10	2.58	91.28	6.00	0.13	100
Urban	Male	1983	4.98	85.10	9.50	0.42	100
		1993-94	1.70	87.60	10.40	0.30	100
		2009-10	1.50	85.19	13.11	0.20	100
	Female	1983	2.07	88.21	9.64	0.08	100
		1993-94	1.00	86.11	12.79	0.10	100
		2009-10	0.60	83.18	16.12	0.10	100
	Person	1983	4.40	85.72	9.53	0.35	100
		1993-94	1.49	87.16	11.11	0.24	100
		2009-10	1.21	84.54	14.09	0.17	100
Rural + Urban	Male	1983	6.86	84.17	8.50	0.46	100
		1993-94	1.86	89.31	8.69	0.14	100
		2009-10	2.46	89.80	7.60	0.14	100
	Female	1983	4.84	86.60	8.08	0.49	100
		1993-94	1.53	87.20	11.22	0.06	100
		2009-10	1.06	85.72	13.06	0.16	100
	Person	1983	6.45	84.67	8.42	0.46	100
		1993-94	1.77	88.75	9.36	0.12	100
		2009-10	2.02	88.52	9.31	0.15	100

Source: Same as in Table 1A

group 30-59 years in total unemployed persons is found to be 9.31 per cent in 2009-10, which is slightly higher than the figure in 1983 (8.42 per cent). Such increases in the share of unemployed persons are followed by reduction in the share of unemployed persons for the age group 5-14 years. This group accounted for only about 2 per cent of all unemployed persons in the country in 2009-10.

Table 1C also shows that the shares of the male and female youth in total unemployed increased during the period from 1983 to 2009-10. However, the rate of increase in the share of total unemployed has been greater for the male youth compared to female youth. Considering both regions together, it is found that while the share of male youth in total male unemployed increased from 84 per cent in 1983 to 90 per cent in 2009-10, the shares of the female youth are found to be 87 and 86 per cent for the two years, respectively.

Yet another observation from Table 1C is that, between rural and urban areas, the youth's share in total unemployed has been greater in rural areas compared to urban areas. In 2009-10, while nearly 91 per cent of total unemployed (male and female put together) in rural areas belonged to the category of youth, the corresponding figure for urban areas is found to be about 85 per cent. Further, the rural areas witnessed an increase in the youth's share in total unemployed (male and female combined); increasing from 84 per cent in 1983 to 91 per cent in 2009-10.[7] On the other hand, the urban areas observed a marginal fall in youth's share in total unemployed; declining from 86 per cent in 1983 to 85 per cent in 2009-10.[8]

Shares of Youth in Total Population, Total Employed and Total Unemployed in the States

Table 2 presents information on shares of the youth (15-29 years) in total population, total employed and total unemployed in 15 major states of India at three points of time. As regards the share of the youth in total population, the main points to be noted are: (*i*) In 1983, the youth's share in total population has been highest in Punjab (33.46 per cent) and lowest in Bihar (26.52 per cent). In 2009-10, the youth's share in total population is found to be highest in Haryana (33.12 per cent) and lowest in Kerala (25.21 per cent). (*ii*) During 1983 to 1993-94, the youth's share in total population increased, though marginally, in 11 out of 15 major states. However, an opposite picture is seen in the next period (1993-94 to 2009-10) when 11 out of 15 states registered decline in percentage share of the youth in total population. The highest decline in the share of youth in total population during this period occurred in Kerala (5.52 percentage point). In fact, this state has been experiencing decline in the share of youth population right from the start of our study period. The four states that experienced rise in the youth's share in total population during 1993-94 to 2009-10 are Haryana, Uttar Pradesh, Rajasthan and Maharashtra.

Table 2. Percentage Shares of Youth (aged 15-29 years) in Total Population (≥ 5 years), Total Employed (UPSS basis) and Total Unemployed (US-Adj.) in Major States of India

(Rural-urban & male-female combined)

State	Percentage Share of Youth in								
	Total Population			Total Employed			Total Unemployed		
	1983	1993-94	2009-10	1983	1993-94	2009-10	1983	1993-94	2009-10
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Andhra Pradesh	30.36	31.10	30.36	37.79	36.63	31.37	81.44	90.69	88.36
Assam	31.47	32.00	29.37	37.84	35.05	28.67	83.30	94.22	93.89
Bihar	26.52	29.48	26.75	33.05	32.96	26.65	73.62	91.59	87.79
Gujarat	31.68	32.61	29.62	40.51	39.16	32.66	85.68	84.84	87.71
Haryana	31.33	31.37	33.12	42.24	40.00	35.11	81.37	91.18	85.29
Karnataka	31.20	31.49	29.98	39.78	36.95	30.76	83.31	91.68	94.66
Kerala	32.61	30.73	25.21	34.16	27.41	21.42	91.12	87.23	76.25
Madhya Pradesh	29.01	30.76	30.44	37.31	37.68	33.35	76.36	92.06	89.48
Maharashtra	30.32	30.70	31.07	37.45	34.68	30.53	85.44	88.84	84.16
Orissa	30.07	31.25	27.22	37.40	36.54	27.51	84.68	89.03	96.00
Punjab	33.46	32.25	31.57	41.16	37.89	30.76	88.13	91.49	93.16
Rajasthan	31.87	29.86	30.81	38.42	36.74	32.68	81.30	92.33	88.79
Tamil Nadu	30.96	31.51	27.08	36.90	35.23	24.40	82.94	90.04	88.93
Uttar Pradesh	27.30	28.99	30.05	33.90	34.32	31.59	86.57	86.08	89.68
West Bengal	32.24	30.59	29.83	39.24	36.05	31.08	82.94	83.90	91.62

Source: Same as in Table 1A

As regards the youth's share in total employed persons in the states, it is found that all through our study period, Haryana occupied the first rank with regard to the youth's share in total employed persons. However, the lowest position in this regard has gone to Bihar in 1983 and to Kerala in two other years. Another important observation here is that during 1983 to 1993-94, 14 out of 15 major states witnessed decline in shares of youth in total employed persons (the exception being Madhya Pradesh). The situation worsened further as all states recorded fall in youth's shares in total employed persons during 1993-94 to 2009-10. It is also worth mentioning that the rate of decline in the youth's share in total employed persons has been much higher in all the states during the period from 1993-94 to 2009-10 (designated as the post-economic reforms period) compared to that from 1983 to 1993-94 (pre-reforms period). Among all states, the highest decline in the share of the youth in total employed persons during the period from 1993-94 to 2009-10 occurred in Uttar Pradesh (declining by 10.83 percentage point). The other states to record sizeable decline in youth's share in total employed persons are Orissa, Punjab, Gujarat, Assam, Bihar, Karnataka, Kerala and Andhra Pradesh. In all these states, the youth's share in total employed persons declined by more than 5 percentage points during the period from 1993-94 to 2009-10.

Contrary to above situation, the youth's share in total unemployed increased in 12 states during the period from 1983 to 1993-94 (the exceptions being Kerala, Gujarat and Uttar Pradesh) but decreased in nine states during the period from 1993-94 to 2009-10 (the exceptions being Gujarat, Karnataka, Orissa, Punjab, Uttar Pradesh and Haryana). The fall in youth's share in total unemployed in the states is consistent with fall in their share in total population. Among all states, while Kerala ranked first in terms of youth's share in total unemployed, Bihar obtained the lowest rank in 1983. However, in 2009-10, Orissa moved to the first position in terms of youth's share in total unemployed while Kerala moved to the bottom.

In this context, we may also look into the shares of different states in total youth population and total unemployed youth in the country in order to identify the states that have high concentration of unemployed youth. Table 3 shows that among all states, the highest concentration of youth population is found in Uttar Pradesh (17 per cent) and lowest in Haryana (2.32 per cent) in all the years. In 2009-10, Bihar (11 per cent) occupied second position in terms of its share in total youth population in the country. Some other states with relatively high concentration of youth population are Maharashtra (9.82 per cent), West Bengal (7.70 per cent), Madhya Pradesh (7.16 per cent) and Tamil Nadu (5.55 per cent). It is also noticeable that there are four states, namely Uttar Pradesh, Bihar, Maharashtra and Haryana, which experienced monotonic increases in share of youth population during our study period. In terms of share in country's total youth population, the most significant expansion during the period from 1983 to 2009-10 is visible in Uttar Pradesh and Bihar. It is thus no wonder that these two states together account for 28 per cent of country's total youth population in 2009-10. If Madhya Pradesh, Maharashtra and West Bengal are added to them, their combined share in total youth population in the country rises to about 53 per cent.

Table 3: States' Shares (in %) in Total Youth Population and Total Unemployed Youth (US-Adj.) in India

(Rural-urban & male-female combined)

State	shares (%) in									Ratio of Unemployed Youth Share to Youth Population Share		
	Youth Population			Unemployed Youth								
	1983	1993-94	2009-10	1983		1993-94		2009-10		1983	1993-94	2009-10
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Andhra Pradesh	7.95	7.91	7.31	5.79	(7)	4.71	(9)	6.61	(7)	0.73	0.59	0.90
Assam	2.81	2.79	2.52	2.44	(12)	6.97	(7)	4.91	(9)	0.87	2.50	1.95
Bihar	8.93	9.70	11.00	5.95	(6)	9.84	(4)	15.07	(1)	0.67	1.01	1.37
Gujarat	5.31	5.22	4.89	3.80	(9)	4.03	(11)	2.87	(12)	0.72	0.77	0.59
Haryana	1.96	1.98	2.32	2.28	(13)	1.38	(15)	1.9	(15)	1.16	0.70	0.82
Karnataka	5.62	5.47	4.45	4.58	(8)	4.45	(10)	2.75	(13)	0.82	0.81	0.62
Kerala	4.09	3.50	2.72	16.03	(1)	12.79	(1)	9.44	(4)	3.92	3.66	3.48
Madhya Pradesh	7.34	7.77	7.16	2.22	(14)	5.58	(8)	3.32	(11)	0.30	0.72	0.46
Maharashtra	9.42	9.44	9.82	9.63	(4)	10.22	(3)	7.7	(5)	1.02	1.08	0.78
Orissa	3.89	3.79	3.21	2.94	(11)	4.00	(12)	5.93	(8)	0.76	1.05	1.85
Punjab	2.74	2.53	2.46	3.15	(10)	2.15	(13)	3.87	(10)	1.15	0.85	1.57
Rajasthan	5.31	5.00	5.74	2.20	(15)	1.47	(14)	2.12	(14)	0.41	0.29	0.37
Tamil Nadu	7.34	6.77	5.55	12.70	(3)	9.72	(5)	7.16	(6)	1.73	1.44	1.29
Uttar Pradesh	14.14	15.21	17.00	7.90	(5)	7.94	(6)	10.47	(2)	0.56	0.52	0.62
West Bengal	8.65	8.05	7.70	14.54	(2)	12.25	(2)	9.48	(3)	1.68	1.52	1.23

Notes: (i) Column totals do not add up to 100 as the percentages have been calculated by considering the total for All-India; and (ii) Figures in parentheses are ranks among 15 major states.
Source: Same as in Table 1A

Table 3 also presents information about different states' share in total unemployed youth in the country. It is found that, in 1983, among all states, Kerala occupied the first position in terms of concentration of unemployed youth, which is followed by West Bengal, Tamil Nadu, Maharashtra and Uttar Pradesh. These five states together accounted for 61 per cent of total unemployed youth in the country in 1983. In this year, the share of unemployed youth has been the lowest in Rajasthan. The ranking pattern of the states remained by and large the same in 1993-94 although Haryana came last in terms of share in total unemployed youth. In 1993-94, Kerala, West Bengal, Maharashtra, Bihar, Tamil Nadu and Uttar Pradesh together represented 63 per cent of unemployed youth in the country.

The ranking pattern of the states on the basis of share in total unemployed youth in the country changed quite a bit in 2009-10. In this year, Bihar (15.07 per cent) moved to the first position in terms of its share in total unemployed youth, which is followed by Uttar Pradesh (10.47 per cent), West Bengal (9.48 per cent), Kerala (9.44 per cent), Maharashtra (7.70 per cent), Tamil Nadu (7.16 per cent), Andhra Pradesh (6.61 per cent), Orissa (5.93 per cent) and Assam (4.91 per cent). These nine states together accounted for about 77 per cent of total unemployed youth in the country in 2009-10. In each of the remaining states, the share of unemployed youth is found to be less than 4 per cent.

The concentration of unemployed youth in the states can also be assessed by considering the ratio of the states' shares in unemployed youth in the country to their shares in total youth population. On this basis, Kerala comes first in all the years. In this state, the share of unemployed youth has been three and half times greater than its share in youth population even in 2009-10. Other states with relatively high concentration of unemployed youth in relation to concentration of youth population are Assam, Orissa, Punjab, Bihar, Tamil Nadu and West Bengal. In all these states, the concentration of unemployed youth in 2009-10 has been greater than their share in youth population.

IV. TRENDS AND PATTERNS OF YOUTH AND NON-YOUTH EMPLOYMENT

In this section, we seek to understand the trends and patterns of employment for the youth and non-youth groups in all-India and 15 major states during our study period (1983 to 2009-10).For this purpose, we consider indictors like labour force participation rate,[9] workforce participation rate,[10] growth rate of employment, sectoral composition of employment and modes of employment, separately for the youth and non-youth categories.

Labour Force and Work Force Participation Rates in All-India

Table 4 presents data on labour force participation rates (LFPR) for the youth and non-youth[11] groups in all-India at three points of time, 1983, 1993-94 and 2009-10. It is found that all through our study period, the LFPR for the group of youth was greater than the same for non-youth group irrespective of the category of population (male/female and rural/urban) considered. However, the LFPR declined for both the youth and non-youth groups over time. Of course, the decline was much higher for the youth compared to non-youth, especially after 1993-94. Although the post-economic reforms period in India (1993-94 to 2009-10) witnessed sharp decline in LFPR for all population, the decline was really sharp for the youth group.[12] As shown in Table 4, the LFPR (in per cent) for the youth persons declined from 63.0 in 1983 to 58.3 in 1993-94 and again to 46.2 in 2009-10. On the other hand, corresponding figures for the non-youth persons were 43.8, 44.4 and 42.5 for the three years, respectively. Another point that needs mention is that the LFPR of the males (both youth and non-youth) was greater than the LFPR of females in all the years. Further, the LFPRs of the rural youth and non-youth groups were greater than the LFPRs of their urban counterparts.

Table 4. Labour Force Participation Rates (UPSS basis) for Youth and Non-Youth in All-India (in %)

Category	Youth			Non-Youth			All Ages (Youth + Non-Youth)		
	1983	1993-94	2009-10	1983	1993-94	2009-10	1983	1993-94	2009-10
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Rural Male	85.4	80.3	68.0	56.1	57.7	58.6	64.4	64.4	61.3
Rural Female	50.4	45.6	30.2	35.0	34.5	28.9	39.6	37.9	29.2
Rural Person	68.0	63.2	49.5	45.9	46.5	44.2	52.3	51.6	45.7
Urban Male	74.6	68.3	61	54.6	56.9	60.2	61.3	60.6	60.5
Urban Female	21.0	20.5	16.8	16.7	17.5	14.8	18.1	18.5	15.4
Urban Person	49.6	45.8	39.5	36.8	38.3	38.6	41.1	40.7	38.9
Male (Rural + Urban)	82.3	76.8	65.7	55.7	57.5	59.1	63.6	63.4	61.1
Female (Rural + Urban)	42.8	38.7	25.7	30.9	30.2	24.7	34.5	32.8	25.0
Person (Rural + Urban)	63.0	58.3	46.2	43.8	44.4	42.5	49.6	48.6	43.6

Source: Same as in Table 1A.

Almost a similar picture is obtained with respect to the work force participation rates (WFPR) for the youth and non-youth groups in all-India. Thus, the WFPR was much higher for the youth compared to non-youth in 1983 (Table 5). Over time, the WFPR declined for both the categories. But the decline was much more severe for the youth group compared to non-youth. Considering all persons (rural + urban), the WFPR for the youth was 60.3 in 1983, 55.5 in 1993-94 and 43.4 in 2009-10. The corresponding figures for the non-youth are 43.6, 44.2 and 42.2 for the three years, respectively. Thus, the advantage the youth used to enjoy with regard to high WFPR got wiped out by 2009-10 and the difference between the youth and non-youth groups is reduced to just one percentage point. Further, when we look separately for rural and urban areas, it becomes apparent that the youth in urban areas has lower WFPR compared to non-youth although they still enjoy higher WFPR in rural areas. It is also observed that among the youth and non-youth groups, the WFPR of males is much higher compared to the same for females. Thus, females of all ages are in a disadvantageous position in the labour market in India. This is more clearly observed in urban areas compared to rural areas.

Table 5. Work Force Participation Rates (UPSS basis) for Youth and Non-Youth in All-India (in %)

Category	Youth			Non-Youth			All Ages (Youth + Non-Youth)		
	1983	1993-94	2009-10	1983	1993-94	2009-10	1983	1993-94	2009-10
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Rural Male	82.7	77.5	64.8	55.9	57.6	58.5	63.4	63.5	60.3
Rural Female	49.7	44.7	28.8	34.9	34.5	28.8	39.3	37.6	28.8
Rural Person	66.3	61.4	47.2	45.8	46.5	44.1	51.7	50.9	45
Urban Male	66.6	61.8	56.4	53.9	56.5	59.9	58.1	58.2	58.8
Urban Female	18.7	17.4	14.4	16.5	17.3	14.7	17.3	17.3	14.6
Urban Person	44.3	40.8	36	36.4	38	38.4	39	38.9	37.6
Male (Rural + Urban)	78.2	72.9	62	55.4	57.3	58.9	62.1	62.1	59.8
Female (Rural + Urban)	41.7	37.2	24	30.8	30.1	24.6	34.1	32.3	24.4
Person (Rural + Urban)	60.3	55.5	43.4	43.6	44.2	42.4	48.6	47.7	42.7

Source: Same as in Table 1A.

Labour Force and Work Force Participation Rates in States

Table 6 presents information regarding labour force participation rates (LFPRs) for the youth, non-youth and all-ages in 15 major states at three points of time.[13] To understand better the pattern of LFPR in the states, we have formed three notional groups based on their values of LFPRs, which are (*i*) states where the value of LFPR is greater than 60.0 (high LFPR states), (*ii*) states where the value of LFPR falls between 40.0 and 60.0 (medium LFPR states) and (*iii*) states with value of LFPR less than 40.0 (low LFPR states). Our main observations here are the following:

(1) The number of states in the high youth-LFPR category reduced over time. While 9 out of 15 major states belonged to the category of high youth-LFPR states in 1983, this number reduced to 7 in 1993-94 and to 0 in 2009-10. In 2009-10, 14 out of 15 states fell in the category of medium youth-LFPR states. Thus, following the all-India pattern, a vast majority of the states suffered from decline in the value of LFPR for the youth over time.

Table 6. States Arranged in Descending Order of Labour Force Participation Rates (UPSS basis) of Youth and Non-Youth

(Rural-urban & male-female combined)

Value of LFPR (%)	Youth			Non-Youth			All Ages (Youth + Non-Youth)		
	1983	1993-94	2009-10	1983	1993-94	2009-10	1983	1993-94	2009-10
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
> 60.0 (High)	Raj (73.7) AP (72.8) MP (70.2) TN (69.1) Kar (68.5) Maha (67.2) Guj (65.4) Pun (63.6) Ori (61.9)	AP (70.8) Raj (67.4) MP (65.6) TN (64.7) Kar (64.2) Guj (61.8) Maha (60.6)					Raj (60.5)		
40.0 - 60.0 (Medium)	Hary (58.7) UP (56.7) Ker (56.4) Bih (55.9) WB (54.7) Asm (46.3)	Ori (59.4) Hary (56.3) WB (53.4) Pun (52.3) UP (52.0) Asm (48.7) Ker (47.1) Bih (46.8)	AP (54.4) Kar (52.8) Guj (52.8) MP (51.1) Raj (49.3) Ori (49.0) Maha (48.8) Hary (46.7) TN (46.5) WB (46.2) Ker (44.5) Pun (44.5) Asm (43.5) UP (41.8)	Raj (54.5) AP (51.1) TN (49.9) MP (47.8) Maha (47.0) Kar (45.8) Pun (43.7) Guj (43.4) Ker (43.3) Ori (43.3) UP (40.5)	AP (54.1) TN (51.6) Raj (48.8) Kar (48.7) Maha (48.3) MP (46.8) Guj (45.1) Ori (44.8) Ker (44.2)	AP (49.7) TN (49.6) Kar (49.3) Maha (48.1) Guj (44.5) Ker (44.4) Raj (44.3) MP (43.7) Ori (43.5) Pun (41.9) Hary (40.9) WB (40.5)	AP (57.7) TN (55.8) MP (54.3) Maha (53.1) Kar (52.9) Guj (50.4) Pun (50.3) Ori (48.9) Ker (47.5) UP (44.9) Bih (44.1) WB (43.0) Hary (42.4)	AP (59.3) TN (55.7) Raj (54.4) Kar (53.6) MP (52.6) Maha (52.1) Guj (50.5) Ori (49.4) Ker (45.1) Pun (43.4) WB (43.3) Hary (43.3) UP (43.2) Asm (40.5) Bih (40.3)	AP (51.1) Kar (50.4) TN (48.7) Maha (48.3) Guj (46.9) MP (45.9) Raj (45.8) Ori (45.0) Ker (44.4) Hary (42.8) Pun (42.8) WB (42.2) Asm (40.8)
< 40.0 (Low)			Bih (35.8)	Bih (39.8) WB (37.4) Hary (35.0) Asm (33.4)	UP (39.6) Pun (39.1) WB (38.9) Bih (37.6) Hary (37.4) Asm (36.7)	Asm (39.7) UP (37.4) Bih (32.4)	Asm (37.4)		UP (38.7) Bih (33.3)

Notes: (i) Figures in parentheses are the values of LFPR. (ii) AP = Andhra Pradesh, Asm = Assam, Bih = Bihar, Guj = Gujarat, Hary = Haryana, Kar = Karnataka, Ker = Kerala, MP = Madhya Pradesh, Maha = Maharashtra, Ori = Orissa, Pun = Punjab, Raj = Rajasthan, TN = Tamil Nadu, UP = Uttar Pradesh, and WB = West Bengal. Source: Same as in Table 1A.

(2) The situation with regard to the LFPR for the non-youth group is different. For this group, as many as 11 states belonged to the medium-LFPR category and four in low-LFPR category in 1983. In many states, the absolute value of LFPR for the non-youth group declined over time. Nevertheless, 12 states remained in the medium-LFPR category in 2009-10. Overall, it appears that a vast majority of the states were able to maintain a more or less stable pattern with regard to the LFPR for the non-youth group during our study period.

(3) In 1983, Rajasthan (73.7) occupied the first position with regard to the value of youth-LFPR while Assam (46.3) was placed at the bottom. In 1993-94 and 2009-10, Andhra Pradesh moved to the first position in respect of youth-LFPR and Bihar to the last position. Apart from Andhra Pradesh, the states with relatively high value of youth-LFPR in 2009-10 are Karnataka (52.8), Gujarat (52.8) and Madhya Pradesh (51.1). On the other hand,

apart from Bihar (35.8), Uttar Pradesh (41.8), Assam (43.5), Punjab (44.5) and Kerala (44.5), the remaining six states recorded relatively low value of youth-LFPR in 2009-10.

(4) As regards LFPR for the non-youth group, the first and last positions went to Rajasthan and Assam, respectively, in 1983. But in 1993-94 and 2009-10, Andhra Pradesh occupied the first rank in this regard while the lowest rank went to Assam and Bihar in these years, respectively. In 2009-10, apart from Andhra Pradesh (49.7), the other relatively better placed states in terms of value of LFPR for the non-youth are Tamil Nadu (49.6), Karnataka (49.3) and Maharashtra (48.1). On the other hand, apart from Bihar (32.4), the value of LFPR for the non-youth group has been low in Uttar Pradesh (37.4) and Assam (39.7).

(5) When the youth and non-youth categories are considered together, it is found that 14 states in 1983 belonged to the medium category in terms of values of LFPR, the highest and lowest positions being occupied by Andhra Pradesh (57.5) and Assam (37.4), respectively. In 2009-10, Andhra Pradesh (51.1) continued to retain it first position in terms of LFPR for all ages (youth and non-youth combined), and 12 other states stayed in the medium category, the two left outs being Uttar Pradesh (38.7) and Bihar (33.3). However, it needs to be mentioned that the LFPR for all ages declined between 1983 to 2009-10 in all states except Haryana. Moreover, it is evident that the decline in the value of LFPR for all ages has been greater during the post-reforms period (from 1993-94 to 2009-10) compared to the pre-reforms period (from 1983 to 1993-94).

Let us now look at the work force participation rates (WFPRs) for the youth and non-youth groups in the states. Here again we have divided the states into three notional categories based on their WFPR values. The data relating to WFPR for the youth, non-youth and all-ages are presented in Table 7. The following points need to be noted specifically:

(1) The WFPR for the youth group appeared to be high (based on our classification) in 8 states in 1983 and 5 states in 1993-94. However, none of the states reported high value of youth-WFPR in 2009-10. In fact, in 2009-10, 12 out of 15 states fell in the category of medium youth-WFPR while three states fell in the low youth-WFPR category. What is more, the absolute value of WFPR for the youth declined over time in all the states. However, the magnitude of decline has been much higher during the period from 1993-94 to 2009-10 compared to that from 1983 to 1993-94. It is abundantly clear that the situation with regard to the WFPR for the youth worsened in all the states at a faster rate during recent phase of economic reforms (1993-94 to 2009-10) compared to the pre-reforms phase (1983 to 1993-94).

(2) In 1983, the highest value of youth-WFPR is recorded by Rajasthan (72.6) and lowest by Assam (43.9). However, Andhra Pradesh recorded the highest values of youth-WFPR both in 1993-94 and 2009-10 (59.7 and 51.9, respectively). On the other hand, Kerala (37.1) recorded lowest value of youth-WFPR in 1993-94, and Bihar (32.1) in 2009-10.

(3) As regards the non-youth group, Table 7 shows that none of the states fell in the high-WFPR category in any of the years considered. All through our study period, majority of the states fell in the medium category with regard to the value of WFPR for the non-youth group.

(4) The WFPR for the non-youth group also declined over time in most of the states. But here the magnitude of decline appears to be less than the decline of WFPR observed for the youth group.

(5) Considering the youth and non-youth groups together, it is found that the value of WFPR lies between 40.0to 60.0 (medium level) in majority of the states in all the years. Another important point to note is that while seven states suffered fall in WFPR for the combined group during the period from 1983 to 1993-94, all but one states suffered the same during the period from 1993-94 to 2009-10 (the exception being Assam). It is also found that the magnitude of fall in WFPR value is greater in most of the states during the period from 1993-94 to 2009-10 compared to that from 1983 to 1993-94.

Table 7. States Arranged in Descending Order of Work Force Participation Rates (UPSS basis) of Youth and Non-Youth

(Rural-urban & male-female combined)

Value of LFPR (%)	Youth			Non-Youth			All Ages (Youth + Non-Youth)		
	1983	1993-94	2009-10	1983	1993-94	2009-10	1983	1993-94	2009-10
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
> 60.0 (High)	Raj (72.6)	AP (69.2)					Raj (60.2)		
	AP (70.9)	Raj (66.5)							
	MP (69.4)	MP (63.7)							
	Kar (66.4)	Kar (62.0)							
	TN (64.5)	TN (60.8)							
	Maha (64.4)								
	Guj (63.5)								
	Pun (60.5)								
40.0 - 60.0	Ori (59.9)	Guj (59.7)	AP (51.9)	Raj (54.4)	AP (54.1)	AP (49.5)	AP (56.9)	AP (58.8)	AP (50.3)
(Medium)	Hary (55.6)	Maha (57.7)	Guj (51.2)	AP (50.9)	TN (51.4)	TN (49.4)	TN (54.1)	TN (54.4)	Kar (49.8)
	UP (55.2)	Ori (56.5)	Kar (51.1)	TN (49.4)	Raj (48.8)	Kar (49.3)	MP (54.0)	Raj (54.1)	TN (47.7)
	Bih (54.1)	Hary (54.4)	MP (49.9)	MP (47.7)	Kar (48.6)	Maha (47.9)	Maha (52.1)	Kar (52.8)	Maha (47.5)
	WB (50.2)	UP (50.6)	Raj (48.3)	Maha (46.8)	Maha (48.1)	Guj (44.4)	Kar (52)	MP (52.0)	Guj (46.4)
	Ker (45.8)	Pun (50.0)	Maha (46.7)	Kar (45.6)	MP (46.8)	Raj (44.3)	Guj (49.7)	Maha (51.1)	MP (45.5)
	Asm (43.9)	WB (49.3)	Hary (44.5)	Pun (43.5)	Guj (44.9)	MP (43.6)	Pun (49.2)	Guj (49.7)	Raj (45.5)
		Bih (44.1)	Ori (44.0)	Guj (43.2)	Ori (44.6)	Ker (43.4)	Ori (48.1)	Ori (48.4)	Ori (43.5)
		Asm (41.9)	TN (42.9)	Ori (43.1)	Ker (43.6)	Ori (43.4)	UP (44.5)	UP (42.7)	Hary (42.0)
			WB (42.8)	Ker (42.8)		Pun (41.8)	Ker (43.8)	Hary (42.6)	Pun (41.3)
			Pun (40.2)	UP (40.5)		Hary (40.7)	Bih (43.4)	Pun (42.5)	Ker (41.3)
			UP (40.1)			WB (40.4)	WB (41.2)	WB (41.8)	WB (41.1)
							Hary (41.2)	Ker (41.6)	
< 40.0 (Low)		Ker (37.1)	Asm (38.2)	Bih (39.6)	UP (39.5)	Asm (39.6)	Asm (36.5)	Bih (39.4)	Asm (39.2)
			Ker (35.1)	WB (37.0)	Pun (39.0)	UP (37.3)		Asm (38.2)	UP (38.2)
			Bih (32.1)	Hary (34.7)	WB (38.5)	Bih (32.2)			Bih (32.2)
				Asm (33.1)	Bih (37.5)				
					Hary (37.3)				
					Asm (36.5)				

Note: Figures in parentheses are the values of WFPR.
Source: Sane as in Table 1A

Growth Rates of Youth and Non-Youth Employment in All-India

We have computed annual (compound) growth rates of employment (workers) for the youth and non-youth groups both for all-India and states for the periods from 1983 to 1993-94, from 1993-94 to 2009-10 and from 1983 to 2009-10.[14] Such information for all-India is presented in Table 8A. Our main observations here are:

(1) Both in rural and urban areas, the growth rates of employment for the youth are lower than the same for non-youth. This is true irrespective of the period considered. As shown in Table 8A, while the growth rate of employment for the rural youth was 1.55 per cent per annum (considering male and female workers together) during the period from 1983 to 1993-94, the same for the non-youth was 1.88 per cent. During the period from 1993-94 to 2009-10, the growth rate of employment for rural youth turned negative (-0.27 per cent) which for non-youth, however, remained positive (1.42 per cent). In urban areas also, in both the periods, the non-youth group enjoyed higher annual growth rate of employment compared to the youth group. It is also noticeable that the growth rate of employment reduced during the period from 1993-94 to 2009-10 compared to that from 1983 to 1993-94 for both these groups. Considering rural and urban areas together, it is found that while the growth rate of employment for non-youth group during the period from 1983 to 1993-94 was 1.4 times higher than the growth rate of employment for the youth group, the growth rate of employment for the former became six times higher compared to the same for the latter during the period from 1993-94 to 2009-10. Thus, although both the groups suffered decline in the growth rate of employment during the period of economic reforms (1993-94 to 2009-10), such decline was severe for the group of youth.

Table 8A. Annual Growth Rates of Youth and Non-Youth Employment (UPSS basis) in All-India

Category	Period	Rural			Urban			Rural + Urban		
		Youth	Non-Youth	All Ages (Youth + Non-Youth)	Youth	Non-Youth	All Ages (Youth + Non-Youth)	Youth	Non-Youth	All Ages (Youth + Non-Youth)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Male	1983 to 1993-94	1.76	2.04	1.94	2.15	3.72	3.15	1.85	2.45	2.23
	1993-94 to 2009-10	0.29	1.82	1.31	2.16	3.35	2.96	0.80	2.25	1.77
	1983 to 2009-10	0.87	1.91	1.56	2.16	3.5	3.03	1.22	2.33	1.95
Female	1983 to 1993-94	1.18	1.61	1.45	2.41	3.88	3.38	1.33	1.91	1.70
	1993-94 to 2009-10	-1.42	0.64	-0.04	1.90	1.99	1.96	-0.89	0.86	0.28
	1983 to 2009-10	-0.40	1.02	0.55	2.10	2.74	2.52	-0.01	1.27	0.84
Person	1983 to 1993-94	1.55	1.88	1.76	2.21	3.76	3.2	1.68	2.27	2.06
	1993-94 to 2009-10	-0.27	1.42	0.86	2.11	3.08	2.76	0.30	1.83	1.32
	1983 to 2009-10	0.44	1.60	1.21	2.15	3.35	2.93	0.84	2.00	1.61

Source: Same as in Table 1A

(2) Even when considered separately for male and female workers, it appears that the growth rates of employment for the youth workers were lower than the same for non-youth workers. It is also observed that, for both the sub-periods, the growth rate of employment for the female youth was lower than that for the male youth. The same is also true about males and females among the non-youth. However, it seems that the gap in growth rate of employment between male and female workers is higher in the case of the youth compared to the non-youth. Yet another observation here is that although both male and female youth workers suffered from decline in growth rate of employment during the period from 1993-94 to 2009-10 compared to the previous period, such decline has been very high for the female youth, especially in urban areas (where it became negative).

Growth Rates of Youth and Non-Youth Employment in the States

Table 8B presents state-level information regarding annual growth rates of employment/workers for the youth and non-youth groups during the period from 1983 to 1993-94, that from 1993-94 to 2009-10 and during the whole period from 1983 to 2009-10. It is observed that during the period from 1983 to 1993-94, in 13 out of 15 major states, the growth rate of youth employment fell behind the growth rate of employment for the non-youth (the exceptions being Uttar Pradesh and Madhya Pradesh). During this period, employment growth rate for the youth was highest in Uttar Pradesh (2.35 per cent) and lowest in Kerala (-1.03 per cent). Some states to report impressive growth of youth employment during this period are Haryana, Andhra Pradesh and Madhya Pradesh. In all these states, the annual growth rate of youth employment exceeded 2 per cent. In all other states, except Punjab (where the growth rate was -0.13 per cent), the growth of youth employment was greater than 1 per cent per annum. However, when we consider the growth rate of employment for the non-youth, Haryana (3.26 per cent) comes first and the last position goes to Punjab (1.18 per cent). Apart from Haryana, there are 10 more states where the annual growth rate of employment for the non-youth during 1983 to 1993-94 exceeded 2 per cent. These states are Assam, West Bengal, Karnataka, Andhra Pradesh, Maharashtra, Gujarat, Orissa, Madhya Pradesh and Kerala. Considering the youth and non-youth groups together, it is found that growth rate of employment exceeded 2 per cent in as many as nine states during this period. These states, in descending order of growth of employment, are Haryana, Assam, Andhra Pradesh, West Bengal, Karnataka, Uttar Pradesh, Maharashtra, Madhya Pradesh, Gujarat and Orissa. During this period, the lowest growth rate of employment is recorded by Punjab. Thus, it appears that although the youth lagged behind the non-youth in terms of growth rate of employment, the growth rate of employment in general (considering youth and non-youth together) has been quite impressive during the period from 1983 to 1993-94 in majority of the states.

The situation, however, changed dramatically during the period from 1993-94 to 2009-10 with regard to growth rate of employment for the youth compared to that for the non-youth. During this period, not only did the growth rate of employment for the youth lag behind that for the non-youth in all the states but the gap between the two groups in terms of growth rate of employment also widened further. Of course, the growth rate of employment, in general, has been low during this period (which happens to be the period of economic reforms), but it has been much lower for the youth in all the states.[15] Table 8B shows that while in six states the growth rate of employment for the youth turned negative during this period, none of the states reported negative growth rate of employment for the non-youth as well as for the youth and non-youth combined. The six states to suffer from negative growth rate of youth employment during the period from 1993-94 to 2009-10 are Tamil Nadu (-1.57 per cent), Orissa (-0.77), Karnataka (-0.65), Andhra Pradesh (-0.46), Madhya Pradesh (-0.21) and Kerala (-0.10). It is also observed that there are only two states, namely Haryana (1.57 per cent) and Uttar Pradesh (1.08 per cent), where the growth rate of youth employment exceeded 1 per cent during this period.

Table 8B. Annual Growth Rates of Youth and Non-Youth Employment (UPSS basis) in Major States of India

(Rural-urban & male-female combined)

State	1983 to 1993-94			1993-94 to 2009-10			1983 to 2009-10		
	Youth	Non-Youth	All Ages (Youth + Non-Youth)	Youth	Non-Youth	All Ages (Youth + Non-Youth)	Youth	Non-Youth	All Ages (Youth + Non-Youth)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Andhra Pradesh	2.21	2.70	2.52	-0.46	1.01	0.51	0.59	1.68	1.30
Assam	1.98	3.15	2.72	0.62	2.49	1.89	1.16	2.75	2.22
Bihar	1.29	1.33	1.31	0.63	2.55	1.98	0.89	2.06	1.71
Gujarat	1.72	2.27	2.05	0.47	2.26	1.61	0.96	2.26	1.78
Haryana	2.35	3.26	2.88	1.57	2.91	2.40	1.88	3.04	2.59
Karnataka	1.56	2.73	2.28	-0.65	1.08	0.49	0.22	1.73	1.20
Kerala	-1.03	2.01	1.06	-0.10	1.95	1.45	-0.47	1.98	1.30
Madhya Pradesh	2.19	2.04	2.09	-0.21	0.98	0.56	0.74	1.40	1.16
Maharashtra	1.44	2.60	2.18	0.76	1.96	1.56	1.03	2.21	1.81
Orissa	1.69	2.05	1.92	-0.77	1.85	1.01	0.20	1.93	1.37
Punjab	-0.13	1.18	0.66	0.31	2.32	1.63	0.14	1.87	1.24
Rajasthan	1.06	1.76	1.49	0.69	1.82	1.43	0.83	1.79	1.45
Tamil Nadu	1.13	1.83	1.58	-1.57	1.69	0.72	-0.51	1.75	1.06
Uttar Pradesh	2.35	2.17	2.23	1.08	1.87	1.61	1.58	1.99	1.85
West Bengal	1.62	2.95	2.45	0.67	2.09	1.61	1.05	2.43	1.94

Source: Same as in Table 1A

On the other hand, the situation is drastically different with regard to the growth rate of employment for the non-youth group even during the period of economic reforms (1993-94 to 2009-10) when the growth of employment in general dwindled in the country. Not only did all states maintain positive growth rate of employment for the non-youth group during this period, but the growth rates were also more than 2 per cent per annum in six states, which are Haryana (2.91 per cent), Bihar (2.55), Assam (2.49), Punjab (2.32), Gujarat (2.26), and West Bengal (2.09). In another set of six states, the growth rates of employment for the non-youth group exceeded 1.50 per cent (these are Maharashtra, Kerala, Uttar Pradesh, Orissa, Rajasthan and Tamil Nadu) while the growth rates were less than 1.50 per cent in three states only (Karnataka, Andhra Pradesh and Madhya Pradesh).

When we consider for the whole period of 1983 to 2009-10, it appears that, in all the states, annual growth rate of employment for the youth lagged behind that for the non-youth. What is more, in two states, namely Kerala and Tamil Nadu, the gap between the two growth rates became exceptionally high, exceeding more than two percentage points. There are 10 other states, where the gap between the annual growth rates of non-youth and youth employment exceeded one percentage point. Overall, it appears that the youth lagged behind the non-youth in terms of growth of employment all through our study period, more so during the recent phase of economic reforms.

Sectoral Distribution of Youth and Non-Youth Workers

We have processed the NSSO unit-level data on employment for 66th Round to build some understanding about the sectoral distribution of youth and non-youth workers in 2009-10, both in all-India and the states. We have considered distribution of workers (UPSS basis) into three sectors, which are primary,[16] secondary[17] and tertiary.[18]

The information regarding sectoral distribution of workers pertaining to all-India and 15 major states is presented in Table 9. It appears that the proportion of workers employed in primary sector is lower and that in secondary sector is higher for the youth group compared to the non-youth group. Thus, the youth have greater involvement in secondary sector employment while non-youth workers are engaged more in primary sector employment. In the tertiary sector, the non-youth group seems to have slightly higher proportion of workers compared to the youth group.

The picture obtained for all-India by and large holds good at the level of individual states as well. Table 9 shows that, in 14 out of 15 major states, the proportions of youth workers in primary sector have been less than the same for the non-youth workers (the exception being Assam). Similarly, in equal number of states, the proportions of youth workers have been more than those of non-youth workers in the secondary sector (once again, Assam is the exception). In respect of the tertiary sector, however, in nine out of 15 states, the proportions of the non-youth workers have been greater than those of the youth workers.

Table 9 further shows that, among the states, the highest proportion of youth workers in the primary sector is found in Madhya Pradesh (68.95 per cent) and lowest in Kerala (13.05 per cent). In five other states, namely Tamil Nadu, Punjab, Haryana, West Bengal and Rajasthan, the proportions of youth workers in the primary sector have been less than 50 per cent. In terms of proportion of workers in the primary sector, for the non-youth category, Madhya Pradesh again occupied the first position and Kerala the last position.

As regards the proportion of youth workers in the secondary sector, while Kerala (37.73 per cent) occupied the first position among 15 states, Assam (8.70 per cent) came last. Kerala also holds the first position in respect of proportion of youth workers in tertiary sector. In this state, nearly one-half of youth workers are absorbed in tertiary sector alone. As regards tertiary sector employment for youth workers, Madhya Pradesh (10.59 per cent) comes last among the states. For the non-youth group, the highest proportion of workers in the secondary sector is found in Tamil Nadu (24.45 per cent) and the lowest in Assam (10.19 per cent). In respect of proportion of non-youth workers in tertiary sector for the non-youth group, West Bengal occupied the first position and Madhya Pradesh (15.28 per cent) the last.

When all workers (youth and non-youth) are considered together, it is found that there are only five states where less than 50 per cent of the workers are involved in the primary sector. These states are West Bengal, Assam, Punjab, Kerala and Gujarat. The highest percentage of primary sector workers (69.47 per cent) is observed in Uttar Pradesh. On the other hand, the highest percentages of workers in secondary and tertiary sectors are found in Kerala and West Bengal, respectively. Madhya Pradesh and Uttar Pradesh are the states to have the lowest percentage of workers in secondary and tertiary sectors, respectively.

Table 9. Sectoral Distribution of Youth and Non-Youth Workers (UPSS basis) in All-India and Major States in 2009-10 [Percentage]

(Rural-urban & male-female combined)

State	Youth			Non-Youth			All Ages (Youth + Non-Youth)		
	Primary	Secondary	Tertiary	Primary	Secondary	Tertiary	Primary	Secondary	Tertiary
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Andhra Pradesh	51.02	26.85	22.13	60.97	17.07	21.96	64.38	19.32	16.29
Assam	68.11	8.70	23.19	61.32	10.19	28.49	45.94	25.35	28.71
Bihar	58.69	23.57	17.73	59.48	19.33	21.20	57.78	20.20	22.01
Gujarat	53.77	21.65	24.58	57.65	17.57	24.78	46.76	23.02	30.22
Haryana	40.20	34.09	25.71	49.11	22.42	28.48	55.81	25.54	18.65
Karnataka	53.41	20.38	26.21	61.37	15.25	23.38	56.38	18.91	24.71
Kerala	13.05	37.73	49.21	39.23	24.17	36.60	46.54	27.14	26.31
Madhya Pradesh	68.95	20.46	10.59	69.74	14.98	15.28	63.24	9.77	26.99
Maharashtra	50.85	20.89	28.25	57.78	14.19	28.03	58.75	22.10	19.14
Orissa	61.67	24.58	13.75	65.46	17.25	17.29	55.70	16.20	28.10
Punjab	39.17	33.30	27.53	48.93	21.83	29.24	46.03	26.45	27.52
Rajasthan	48.78	35.20	16.02	59.62	20.31	20.08	58.89	16.85	24.26
Tamil Nadu	35.62	35.69	28.69	49.99	24.45	25.56	59.26	20.50	20.24
Uttar Pradesh	52.86	27.85	19.29	61.39	19.53	19.08	69.47	16.88	13.65
West Bengal	43.63	31.99	24.38	48.31	18.60	33.09	33.87	26.95	39.18
All-India	51.54	26.44	22.01	57.64	18.40	23.95	55.77	20.87	23.36

Source: Author's calculation using NSSO unit-level data on Employment for 66th Round.

Modes of Employment of Youth and Non-Youth Workers

To understand the quality of employment the youth and non-youth workers are engaged in, we looked into their modes of employment. The workers are divided into three groups according to their modes of employment, which are self-employed, regular employed and casual labour. The data on modes of employment of the youth and non-youth workers for all-India and 15 major states are presented in Table 10. It appears that, at the all-India level, the proportion of workers in casual employment is high and that of self-employment is low among the youth workers compared to non-youth workers. As regards the proportion of workers in regular employment, however, not much difference seems to exist between the youth and non-youth groups.

There exists wide inter-state variation regarding proportions youth and non-youth workers under different modes of employment. For instance, for the group of youth, the highest proportion of self-employed workers is found in Assam (65.75 per cent) and lowest in Kerala (23.24 per cent). Some other states with high proportion of youth self-employed workers are Uttar Pradesh, Rajasthan, Madhya Pradesh and Orissa. In these states, more than one-half of the youth workers are self-employed. Apart from Kerala, Tamil Nadu (23.58 per cent) also reported a very low percentage of youth self-employed workers. However, as regards percentage of youth workers in casual employment, Tamil Nadu (48.14 per cent) comes first, which is followed by Andhra Pradesh, Bihar, West Bengal, Kerala, Madhya Pradesh, Orissa and Karnataka. In all these states, more than 40 per cent of the youth workers are engaged in casual employment. Among all states, the lowest percentage of youth workers in casual employment is found in Haryana (23.26 per cent). As regards percentage of youth workers in regular employment, Kerala (33.13 per cent) tops the list, followed by Haryana, Tamil Nadu and Maharashtra. In these states, more than one-fourth of the youth workers are engaged in regular employment. The percentage of youth workers in regular employment has been the lowest in Bihar (4.24 per cent). Madhya Pradesh, Orissa, Assam, Uttar Pradesh and Rajasthan are the other states where less than one-tenth of youth workers are engaged in regular employment.

Table 10. Distribution of Youth and Non-Youth Workers (UPSS basis) by Modes of Employment in All-India and Major States in 2009-10 [Percentage]

(Rural-urban & male-female combined)

State	Youth			Non-Youth			All Ages (Youth + Non-Youth)		
	Self-employed	Regular Employed	Casual Labour	Self-employed	Regular Employed	Casual Labour	Self-employed	Regular Employed	Casual Labour
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Andhra Pradesh	36.93	15.36	47.71	41.62	11.59	46.79	40.16	12.77	47.08
Assam	65.75	7.20	27.06	69.59	13.34	17.07	68.50	11.61	19.88
Bihar	48.83	4.24	46.93	57.74	6.45	35.81	55.28	5.84	38.88
Gujarat	43.89	19.67	36.43	56.89	15.42	27.69	52.51	16.85	30.64
Haryana	46.74	30.01	23.26	59.59	21.56	18.85	55.13	24.49	20.38
Karnataka	40.66	19.14	40.20	49.79	12.80	37.40	46.91	14.80	38.28
Kerala	23.24	33.13	43.63	45.95	18.30	35.75	41.43	21.25	37.32
Madhya Pradesh	50.48	6.13	43.39	53.39	10.23	36.38	52.41	8.85	38.73
Maharashtra	38.16	25.23	36.61	48.81	19.57	31.62	45.60	21.28	33.12
Orissa	50.29	6.43	43.27	56.81	8.03	35.16	55.01	7.59	37.41
Punjab	45.44	22.97	31.59	56.81	20.30	22.89	53.29	21.12	25.58
Rajasthan	57.36	9.82	32.82	63.17	9.45	27.38	61.29	9.57	29.14
Tamil Nadu	23.58	28.28	48.14	35.59	16.58	47.83	32.73	19.37	47.90
Uttar Pradesh	61.31	9.41	29.28	68.74	7.93	23.33	66.43	8.39	25.18
West Bengal	44.16	11.09	44.75	49.08	14.52	36.41	47.48	13.40	39.11
All India	46.50	14.98	38.52	53.53	12.97	33.50	51.40	13.58	35.02

Source: Same as in Table 9.

Among the non-youth workers, the highest percentage in self-employment is found in Assam (69.59 per cent) and lowest percentage in Tamil Nadu (35.59 per cent). In eight other states the percentage of non-youth workers in self-employment exceeded 50 per cent. These states are Uttar Pradesh, Rajasthan, Haryana, Bihar, Gujarat, Orissa, Punjab and Madhya Pradesh. On the other hand, the percentage of non-youth workers in casual employment is highest in Tamil Nadu (47.83 per cent) and lowest in Assam (17.07 per cent). In seven other states, namely Andhra Pradesh, Karnataka, West Bengal, Madhya Pradesh, Bihar, Kerala and Orissa, more than one-third of non-youth workers are engaged in casual employment. The percentage of non-youth workers in regular employment varied between 21.56 in Haryana to 6.45 in Bihar.

Another interesting point that emerges from Table 10 is that the percentages of youth workers in casual employment exceeded the percentages of non-youth workers in casual employment in all the states. The opposite picture is observed in respect of percentages of self-employed workers which were greater for the non-youth compared to the youth in all the states. Thus, the observation that the youth workers are involved more in casual employment and the non-youth workers in self-employment gets vindicated not only for all-India but also for all the states under consideration. Further, the other hand, in all the states, the percentages of youth self-employed workers fell short of percentages of non-youth self-employed workers. As regards regular employment, in 10 states the non-youth group has higher percentage compared to the youth group. Among these states, the most significant difference is observed in Kerala and Tamil Nadu where the percentages of regular-employed workers for the non-youth groups exceeded the percentages of regular-employed workers for the youth groups by more than 10 percentage points.

V. YOUTH AND NON-YOUTH UNEMPLOYMENT RATES

After discussing several dimensions of youth and non-youth employment, in this section, we look into the unemployment rates[19] for the youth and non-youth groups, both at all-India level and in 15 major states.

All-India Situation

Table 11A presents information on unemployment rates for the youth and non-youth groups in all-India at three points of time, by rural-urban and male-female divides. The most striking observation emerging from the table is that for all time points, the unemployment rates for the youth are much higher compared to those for non-youth. It is found that the unemployment rate of all youth persons was nine times greater than the unemployment rate of non-youth persons in 1983. The ratio of the two unemployment rates increased further to 15 and 18 in 1993-94 and 2009-10, respectively. It is thus clear that, over time, the unemployment rate for the youth increased at a high rate while the changes in the unemployment rate for the non-youth have been almost negligible. Table 11A shows that the unemployment rate for all (rural and urban combined) youth persons increased from 4.27 in 1983 to 4.67 in 1993-94 and further to 5.89 in 2009-10. On the other hand, the unemployment rate for all non-youth persons declined from 0.48 in 1983 to 0.31 in 1993-94 and increased marginally thereafter to 0.33 in 2009-10.

Table 11A. Unemployment Rates (US-Adj.) of Youth and Non-Youth in All-India

Category	Youth			Non-Youth			All Ages (Youth + Non-Youth)		
	1983	1993-94	2009-10	1983	1993-94	2009-10	1983	1993-94	2009-10
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Rural Male	3.14	3.50	4.70	0.38	0.17	0.16	1.42	1.40	1.60
Rural Female	1.49	1.90	4.60	0.16	0.16	0.32	0.66	0.80	1.60
Rural Person	2.53	2.93	4.67	0.30	0.17	0.21	1.14	1.19	1.60
Urban Male	10.62	9.60	7.50	1.28	0.75	0.58	5.08	4.00	2.80
Urban Female	11.10	15.00	14.30	0.93	1.09	0.96	4.84	6.10	5.70
Urban Person	10.72	10.74	8.90	1.20	0.82	0.65	5.03	4.45	3.35
Male (Rural + Urban)	5.05	5.09	5.58	0.59	0.32	0.29	2.29	2.08	1.97
Female (Rural + Urban)	2.70	3.81	6.72	0.25	0.30	0.43	1.18	1.58	2.38
Person (Rural + Urban)	4.27	4.67	5.89	0.48	0.31	0.33	1.92	1.92	2.09

Source: Same as in Table 1A.

Another important point to note is that the unemployment rate of the youth is greater than the same for non-youth both in rural and urban areas. However, the unemployment rate of urban youth turned out to be much higher compared to that of rural youth. Another important observation is that the unemployment rates of both male and female youth are greater than those of male and female from the non-youth category. Yet another observation here is that both male and female youth have much higher unemployment rate in urban areas compared to their unemployment rates in rural areas.

Youth and Non-Youth Unemployment Rates in the States

The information regarding unemployment rates of the youth and non-youth groups in 15 major states of India are presented in Table 11B. In this table, we have arranged the states in descending order of unemployment rates (in per cent) for the youth and non-youth groups at our chosen time points (1983, 1993-94 and 2009-10). The point that stands out very clearly is that the unemployment rate has been much higher for the youth group in all states compared to the non-youth group. This is true for all the time points. As shown in the table, youth unemployment rate exceeded 5.0 in five states and it ranged between 2.0 to 5.0 in 10 states, both in 1983 and 1993-94. The number of states having youth unemployment rate greater than 5.0 increases to seven in 2009-10. There is also clear evidence of unemployment rate for the youth increasing over time in majority of the states. In this process, two states in 1983 and one state in 1993-94 where youth unemployment rates were less than 2.0, moved to the higher group (2.0 - 5.0) of unemployment rate in 2009-10. In contrast, in none of the states (except West Bengal and Kerala in 1983 and Kerala in 1993-94), the unemployment rate for the non-youth group ever exceeded 2.0. In fact, except two states in 1983 and one state in 1993-94, the unemployment rate for the non-youth group remained below 1.0.

Table 11B. States Arranged in Descending Order of Unemployment Rates (US-Adj.) of Youth and Non-Youth

(Rural-urban & male-female combined)

Unemployment rate (%)	Youth			Non-Youth			All Ages (Youth + Non-Youth)		
	1983	1993-94	2009-10	1983	1993-94	2009-10	1983	1993-94	2009-10
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
> 5.0	Ker (18.70) WB (8.26) TN (6.73) Hary (5.32) Asm (5.05)	Ker (21.15) Asm (13.97) WB (7.75) TN (6.09) Bih (5.90)	Ker (21.22) Asm (12.17) Bih (10.41) Ori (10.24) Pun (9.60) TN (7.55) WB (7.25)				Ker (7.94) WB (4.09)	Ker (7.77) Asm (5.70)	Ker (7.03)
2.0 - 5.0	Pun (4.85) Maha (4.09) Ori (3.28) Bih (3.20) Kar (3.20) Guj (2.94) AP (2.69) UP (2.65)	Maha (4.86) Ori (4.83) Pun (4.44) Kar (3.45) Guj (3.40) Hary (3.38) MP (2.98) UP (2.73) AP (2.29)	Hary (4.77) AP (4.52) Maha (4.37) UP (4.01) Kar (3.18) Guj (3.02) MP (2.46) Raj (2.03)			Ker (2.23)	TN (3.11) Hary (2.83) Asm (2.36) Pun (2.33)	WB (3.48) TN (2.45) Bih (2.21) Ori (2.04)	Asm (4.06) Bih (3.41) Pun (3.39) Ori (3.17) WB (2.58) TN (2.19) Hary (2.02)
< 2.0	Raj (1.51) MP (1.16)	Raj (1.19)		WB (1.18) Ker (1.15) Hary (0.93) TN (0.96) Asm (0.65) Bih (0.58) Pun (0.48) Kar (0.44) Maha (0.43) AP (0.38) Ori (0.37) Guj (0.34) Raj (0.22) UP (0.22) MP (0.22)	Ker (1.46) WB (0.90) Asm (0.53) Guj (0.40) TN (0.39) Ori (0.36) Maha (0.34) Bih (0.28) Pun (0.26) UP (0.24) Hary (0.23) Kar (0.19) MP (0.16) AP (0.14) Raj (0.06)	Bih (0.58) Hary (0.47) Maha (0.38) Asm (0.36) Pun (0.34) TN (0.33) WB (0.32) AP (0.28) UP (0.22) Guj (0.21) Ori (0.18) MP (0.15) Raj (0.13) Kar (0.08)	Maha (1.84) Kar (1.55) Ori (1.48) Bih (1.46) Guj (1.41) AP (1.27) UP (1.05) Raj (0.72) MP (0.57)	Maha (1.95) Pun (1.89) Guj (1.60) Hary (1.51) Kar (1.42) MP (1.24) UP (1.11) AP (0.94) Raj (0.48)	AP (1.65) Maha (1.63) UP (1.45) Guj (1.15) Kar (1.05) MP (0.93) Raj (0.76)

Note: Figures in parentheses are the values of unemployment rates.
Source: Same as in Table 1A.

As far as youth unemployment rate is concerned, Kerala occupied the first position at all time-points. In this state, the youth unemployment rates are found to be exceptionally high at 18.70, 21.15 and 21.22 in 1983, 1993-94 and 2009-10, respectively. On the other hand, the states reporting lowest values of youth unemployment rate are Madhya Pradesh (1.16) for 1983 and Rajasthan (1.19 and 2.03) for 1993-94 and 2009-10. Some other states reporting very high youth unemployment rate in 2009-10 are Assam (12.17), Bihar (10.41), Orissa (10.24), Punjab (9.60), Tamil Nadu (7.55) and West Bengal (7.25). In comparison to these states, apart from Rajasthan, the youth unemployment rate in 2009-10 remained relatively low in Madhya Pradesh (2.46), Gujarat (3.02), Karnataka (3.18), Uttar Pradesh (4.01), Maharashtra (4.37), Andhra Pradesh (4.52), and Haryana (4.77).

The states to occupy the first position with regard to unemployment rate for the non-youth group are West Bengal (1.18) in 1983, Kerala (1.46) in 1993-94 and Bihar (0.58) in 2009-10. On the other hand, unemployment rate for the non-youth group was lowest in Madhya Pradesh (0.58) in 1983, Rajasthan (0.06) in 1993-94 and Karnataka (0.08) in 2009-10. Another important point to note is that, contrary to the situation for the youth, the unemployment rate for the non-youth group declined over time in most of the states.

When the youth and non-youth groups are considered together, it is found that the unemployment rate is the highest for Kerala at all points of time, and the lowest for Madhya Pradesh in 1983 and Rajasthan in 1993-94 and 2009-10. Some other states reporting high overall unemployment rates are Assam, Bihar, Punjab, Orissa, West Bengal and Tamil Nadu. Interestingly, these are also the states that reported high unemployment rates for the youth.

VI. DETERMINANTS OF THE YOUTH BEING EMPLOYED

The purpose of this section is to identify some determinants of the youth being employed as against remaining unemployed. For this purpose, we have run a logit regression exercise using the unit-level data extracted from the data files for the 66th Round (or, for the year 2009-10) of the NSSO survey on Employment/Unemployment.[20] The dependent variable in our logit regression model represents employment status (EMP) of the youth,[21] which is a binary variable that is assigned value 1 if the youth is employed and 0 if unemployed. The explanatory variables considered are the following:

(i) AGE: age of the youth (in years).

(ii) SEX: sex of the youth, which is a dummy variable that takes value 1 for male youth and 0 for female youth.

(iii) MARRI: marital status, which is also a dummy variable that takes value 1 if the youth is married and 0 if unmarried.

(iv) EDU1, EDU2, EDU3 and EDU4: education dummies. EDU1 takes value 1 if education of the youth is up to primary and 0 otherwise; EDU2 = 1 for education above primary but up to secondary and 0 otherwise; EDU3 = 1 for education above secondary but up to graduation and 0 otherwise; and EDU4 = 1 if post-graduate and 0 otherwise. Thus, the reference category is the illiterate.

(v) SG1, SG2 and SG3: social group dummies. SG1 takes value 1 for the scheduled caste youth and 0 otherwise; SG2 takes value 1 for the scheduled tribe youth and 0 otherwise; and SG3 takes value 1 for the OBC youth and 0 otherwise. The reference category here is the general caste youth.

(vi) REL1 and REL2: religious group dummies. The value of REL1 is 1 for Muslim youth and 0 otherwise; REL2 = 1 if the youth is from the community other than Hindu and Muslim and 0 otherwise. The reference category is Hindu.

(vii) REG: region dummy whose value is 1 for rural and 0 for urban.

Logit Regression Results

Table 12 presents the logit regression results. It appears that the probability of being employed is greater if the youth is a male and married. The probability of being employed also goes up with increasing age of the youth. However, as the slope coefficients of all education dummies are negative and statistically significant, it appears that better educated among the youth are more likely to remain unemployed compared to the illiterate youth. For instance, on the basis of the odds-ratio for EDU1, it appears that the probability of the youth having primary education being employed is 0.67 times less than the probability of the illiterate youth being employed. Similarly, the probability of the post-graduate youth being employed is 0.09 times less than the probability of the illiterate youth being employed. This finding surely raises question about the quality of education from the point of view of fetching employment for the youth. The slope coefficients of first two social group dummies being negative and statistically significant implies that the probabilities of SC and ST youth being employed is less than the probability of the general caste youth getting employed. The odds-ratios here imply that the probabilities of SC and ST youth getting employed are respectively, 0.83 and 0.71times less than the probability of the general caste youth getting employed. However, no statistically significant difference seems to exist between probabilities of the OBC and general caste youth being employed. Similarly neither religion nor the place of residence (rural/urban) seem to play any statistically significant role to determine employment status (employed or unemployed) of the youth.

Table 12. Binary Logit Regression Results of Determinants of the Youth Being Employed (Dependent Variable: EMP = 1 if employed; 0 if unemployed)

Explanatory Variables	Beta-coefficients	S.E.	Wald-statistic	df	Sig.	Odds-ratio
(1)	(2)	(3)	(4)	(5)	(6)	(7)
AGE	0.11	0.01	193.81	1	0.00	1.12
SEX	0.85	0.05	246.24	1	0.00	2.33
MARRI	0.91	0.07	170.98	1	0.00	2.49
EDU1	-0.40	0.15	7.51	1	0.01	0.67
EDU2	-1.05	0.13	61.75	1	0.00	0.35
EDU3	-2.09	0.14	236.17	1	0.00	0.12
EDU4	-2.42	0.16	230.45	1	0.00	0.09
REL1	-0.03	0.07	0.13	1	0.72	0.98
REL2	0.13	0.09	2.11	1	0.15	1.14
SG1	-0.19	0.08	6.21	1	0.01	0.83
SG2	-0.34	0.10	12.16	1	0.00	0.71
SG3	0.00	0.06	0.00	1	0.99	1.00
REG	-24.23	213.05	0.01	1	0.91	0.00
CONSTANT	-0.02	0.21	0.01	1	0.91	0.98
Nagelkerke R^2 = 0.897			LR-statistic = 52083.87 (df = 13) [sig: 0.00]			
% of correct prediction = 95.7			No. of observations = 50651			

Source: As in Table 9.

VII. SUMMING UP

We observed that the share of the youth (15-29 years age) in total population (5 years & above) remained more or less unchanged in all-India over the period 1983 to 2009-10. However, the share of the senior adults (30-59 years age) in total population increased and that of children (5-14 years) declined during this period. In 2009-10, the youth constituted about 30 per cent of total population; the senior adults' share in total population was about 67 per cent. Although the youth did not gain anything in terms of their share in total population over time, they surely lost out in terms of their share in total employed in the country. As a consequence, their share in total unemployed increased over time. In 2009-10, the group of youth represented about 89 per cent of total unemployed persons in the country. In contrast, their share in total employed persons in the country was only 30 per cent in 2009-10. On the other hand, the group of senior adults represented nearly 61 per cent of the total employed persons and only 9 per cent of unemployed persons in the country in 2009-10. Another important finding is that the share in total unemployed increased over time at a much faster rate for the group of male youth compared to female youth group, and also for the youth group from rural areas compared to those from urban areas.

Our state-level analysis reveals that, in majority of the states, the youth's share in total population changed marginally over time. However, Kerala is an exception where youth's share in total population has been declining continuously since 1983. On the other hand, the states like Haryana, Uttar Pradesh, Rajasthan and Maharashtra recorded some improvement in youth's share in total population in recent years. As against this scenario, the youth's share in total employed persons declined in 14 out of 15 major states during 1983 to 1993-94. The situation moved from bad to worse during the period from 1993-94 to 2009-10 when all states recorded further fall in the the youth's share in total employed persons. What is more, the magnitude of decline in youth's share in total employed was much higher during this period compared to the previous period (1983 to 1993-94). Some of the states that recorded high decline in the youth's share in total employed in the recent period of 1993-94 to 2009-10 are Uttar Pradesh, Orissa, Punjab, Gujarat, Assam, Bihar, Karnataka, Kerala and Andhra Pradesh. As regards the youth's share in total unemployed in the states, we found that it increased in 1993-94 compared to 1983 in 12 states. However, the youth's share in total unemployed declined in 9 states during the period from 1993-94 to 2009-10. Such a decline is consistent with decline in their shares in total population.

In order to identify the states which have high concentration of unemployed youth, we looked into shares of different states in the pool of total unemployed youth in the country. It is found that while Kerala occupied the first position in terms of its share in total unemployed youth in the country in 1983, the same position is held by Bihar in 2009-10. The distribution of unemployed youth across states of India has been skewed so that only eight states (Bihar, Uttar Pradesh, West Bengal, Kerala, Maharashtra, Tamil Nadu, Andhra Pradesh and Orissa) accounted for nearly three-fourths of total unemployed youth in the country in 2009-10. Further, when we considered the ratio of states' shares in total unemployed in the country to their share in country's population, it was revealed that Kerala, Assam, Orissa, Punjab, Bihar, Tamil Nadu and West Bengal (in descending order of concentration of unemployed youth) are the states which really have high concentration of unemployed youth in 2009-10. For these states, the share in country's total unemployed exceeded their respective share in population.

Comparison of the unemployment rates for the youth and non-youth groups revealed that the unemployment rates for the former are much higher compared to latter at all points of time. This is true both for all-India and individual states. Further, the youth unemployment rate increased over time while the same for the non-youth have not changed much. As a consequence, the ratio of unemployment rates for youth and non-youth groups in all-India increased from 9 in 1983 to 15 in 1993-94 and 18 in 2009-10. The fact that the unemployment rate for the youth is much higher compared to the same for the non-youth is true for both rural and areas as well as for males and females. However, it also needs to be mentioned that unemployment rate for the male youth has generally, (i.e., for combined region) been greater than the same for female youth at all points of time although the situation is just the reverse in the urban areas (where the female youth has higher unemployment rate compared to the male youth).

The contrast between the unemployment rates of the youth and non-youth groups is brought out more glaringly by our state-level analysis. It is found that the number of states reporting ‘high’ youth unemployment rate (greater than 5 per cent) increased from five in 1983 and 1993-94 to seven in 2009-10. The remaining eight states fell in the category of ’medium’ unemployment rate (2.0 - 5.0 per cent) in 2009-10. On the other hand, in no state (except West Bengal and Kerala in 1983 and Kerala in 1993-94) did the unemployment rate for the non-youth group ever exceed 1.0 per cent. In fact, in all the states, the non-youth unemployment rate reduced to very low level (less than 0.6 per cent) by 2009-10. On the other hand, the unemployment rate for the youth increased in 12 out of 15 major states during 1983 to 2009-10. Among these states, most significant increase in the value of youth unemployment rate is visible in Bihar, Assam, Orissa, Punjab and Kerala (the increases were more than 2.5 percentage points) while Andhra Pradesh, Uttar Pradesh and Madhya Pradesh also experienced sizeable increase in youth unemployment rate (more than 1.3 percentage points).

Among the states, the youth unemployment rate is found to be the highest in Kerala at all points of time while it was the lowest in Madhya Pradesh for 1983 and Rajasthan for the two subsequent years. We must also mention that given the high unemployment rates among the youth, the ranking of the states by overall unemployment rate gets shaped by their respective positions with regard to their youth unemployment rate and the percentage of youth in their population. Thus, Kerala topped the list of states in respect of overall (youth and non-youth combined) unemployment rate at all time-points, and Madhya Pradesh and Rajasthan stayed at the bottom.

We examined the trends and patterns of youth employment in all-India and the states in considerable detail, using indicators like labour force participation rate (LFPR), work force participation rate (WFPR), growth of employment, sectoral composition of employment and modes of employment. It is found that both the LFPR and WFPR were high for the youth compared to non-youth in all-India at all time-points. However, although the LFPR and WFPR declined over time for both the youth and non-youth groups in all-India, the decline was more severe for the former compared to the latter, especially during 1993-94 to 2009-10 (designated as the post-economic reforms period in India). The fact that the group of youth has high LFPR and WFPR compared to the non-youth group gets further confirmed by our state-level analysis. However, it was also revealed that, following the all-India trend, LFPR and WFPR for the youth declined in vast majority of the states over time. On the contrary, the LFPR and WFPR for the non-youth group seemed to have maintained more or less a stable pattern over our study period in majority of the states.

The observation that employment situation for the youth worsened both in absolute and relative terms gets further corroborated from the fact that the growth rate of youth employment, at the all-India level, reduced drastically during the period from 1993-94 to 2009-10 (0.30 per cent per annum) compared to 1983 to 1993-94 (1.68 per cent). Although the non-youth group also suffered reduction in employment growth rate over time, the rate of decline was much less for them compared to the youth group. Moreover, the growth rate of employment for the youth was less than the non-youth employment growth rate for both the periods. This was true irrespective of the sex of workers (male/female) and the region (rural/urban) considered.

The adverse employment situation for the youth gets further reflected by the fact that not only was the growth rate of youth employment less than the growth rate of employment for the non-youth in all the states, but the gap between the employment growth rates for two groups also widened over time, most notably during the period of economic reforms (1993-94 to 2009-10).[22] What is more, while none of the states reported negative growth of employment for the non-youth group as well as the combined (youth+non-youth) group during this period, the growth rate of youth employment turned negative in six states, which are Tamil Nadu (-1.57 per cent), Orissa (-0.77), Karnataka (-0.65), Andhra Pradesh (-0.46), Madhya Pradesh (-0.21) and Kerala (-0.10). The growth of employment exceeded more than one per cent for the group of youth in two states only during the period of economic reforms (these are Haryana and Uttar Pradesh), which happened for all the states in respect of the non-youth group. Finally, we must mention that there is clear evidence of gender discrimination even with regard to the youth employment growth rate. Thus, not only did the employment growth of female youth lag behind the same for male youth but the gap between the two growth rates also widened over time.

Examining the sectoral composition of workers, we found that, at the all-India level, compared to the group of non-youth, the youth has relatively a high proportion of workers in the secondary sector and a low proportion of workers in the primary sector, and the proportion of workers in the tertiary sector does not differ much between the two groups. However, there exists wide inter-state variation in this regard. Among the states, the highest proportion of youth workers in primary sector is found in Madhya Pradesh (69 per cent) and the lowest in Kerala (13 per cent). On the other hand, the highest proportions of youth workers in secondary and tertiary sectors are in Kerala (38 and 49 per cent, respectively). The proportions of youth workers in secondary and tertiary sectors are the lowest in Assam (9 per cent) and Madhya Pradesh (11 per cent), respectively.

The modes of employment also differed between the youth and non-youth groups. At the all-India level, the proportion of casual employment is high and self-employment is low among the youth workers compared to the non-youth workers. The proportion of workers in regular employment, however, differed only marginally between these two groups. Another important observation here is that the percentage of youth workers in casual employment exceeded the percentage of non-youth workers in casual employment for all the states. Clearly, the intensity of casual employment among the youth workers is greater compared to that for the non-youth workers. However, there exists wide inter-state variation with regard to modes of employment of youth workers. For instance, the highest proportion of youth in casual employment is found in Tamil Nadu (48 per cent) and the lowest in Haryana (23 per cent). On the other hand, the highest proportion of youth workers in self-employment is found in Assam (66 per cent) and the lowest in Kerala (23 per cent). However, Kerala (33 per cent) topped the list as regards the proportion of youth workers in regular employment; Bihar (4 per cent) is placed at the bottom.

What determines the status of the youth in the labour market, (i.e., whether the youth would get employed or remain unemployed) is an issue that we addressed econometrically. Here we estimated a logit regression model using the unit-level data from 66th Round of the NSSO survey (i.e., for 2009-10) on employment/unemployment. In our logit regression model, the dependent variable is a binary variable that is assigned value '1' if the youth is employed and '0' if unemployed. The explanatory variables considered are age, sex and marital status of the youth, educational, social and religious backgrounds of youth, and the youth's place of residence (rural/urban). It clearly appeared that in the labour market, the probability of being employed is high for the youth who is male and married. The probability of being employed also goes up with seniority (higher age). The caste status of the youth is also important as the youth from SC/ST community has lower probability of being employed *vis-à-vis* the general caste youth. On the other hand, religious background and the place of residence do not play any significant role in determining the youth's employment status. However, the most disturbing result from our econometric exercise is that the probability of the youth getting employed goes down with increasing levels of education.[23] This finding raises serious doubt about the efficacy of present system of education in improving skill levels of the youth (as also others) which is so essential to fetch employment for them.[24] This is an area that needs serious introspection by the policy-makers. In any case, more research is needed to understand to what extent the recently launched skill improvement programmes[25] are being effective to bring about good fortune for the youth in the labour market.

NOTES

1. Morsy [2012] observed that rising youth unemployment in recent years has increased the value of Gini-inequality coefficient of income distribution by 4 percentage points in all advanced countries and by 8 percentage points in Greece, Ireland, Italy, Portugal and Spain, which are hit hard by the global economic and financial crisis of 2007-09.

2. Generational poverty is said to occur when three generations within a family experience poverty [Crowder, 2011].

3. Ghosh, Chandrasekhar and Roychowdhury [2006] drawing from [Miles, 2006] observed that such a trend would continue at least until 2040. The same view is held by the Working Group on Employment for the Twelfth Five Year Plan. The World Bank [2010, p. 7] projected that the working-age population in India will increase by about 12 million persons per year in the decade of 2010s of which about 8 to 9 million will look for employment.

4. See Visaria (1998), Chadha (2000) and Mahendra Dev and Venkatanarayana (2011).

5. It is to be noted that 2009-10 is not a 'normal' year as some parts of the country witnessed drought in that year. Using 2009-10 as the terminal year invites the criticism that our conclusions regarding changing employment/unemployment scenarios for the youth, especially during the period 1993-94 to 2009-10, might not be correct. In this context, our submission is that although 2009-10 is not perfect from climatic point of view, data for this year are still useful for cross-sectional (male-female, youth/non-youth, etc.) comparisons. Further, we observed elsewhere that the general conclusion regarding adverse employment/unemployment situation in the country post-1993-94 remains by and large valid even when the data for 2007-08 (NSSO 64th Round) are considered, which is a normal year (also the sample size for this round is almost same as that for any other quinquennial round). Nevertheless, it would be better to use the data for 2011-12 (NSSO 68th Round) to understand the changes in labour market situations for different groups of people (including the youth) during the post-1993-94 period. Till the time of writing this paper, the NSSO has published only one report that gives some 'Key Results' out of the survey data for 2011-12. Hence, it was not possible to examine the issues dealt with in this paper with limited data available from that report. However, our preliminary assessment is that no significant improvement in employment situation for the country as a whole is visible for the post-1993-94 period even when

2011-12 is considered as the terminal year (see Bhaumik, 2013).

6. This is not to say that the issue of intra-group difference in employment/ unemployment characteristics for the youth and non-youth groups is unimportant. Such details could not be worked out using data available from the published NSSO reports.

7. It is to be noted that most of the increase in the youth's share in total unemployed that is observed in rural areas for the period 1983 to 2009-10 has taken place during the first sub-period of 1983 to 1993-94. Although some part of this increase may be attributed to increase in their share in total population, there were other factors also which caused much higher increase in their unemployment rate (compared to growth rate of population) during this sub-period. One such factor could be overall decline in labour absorption in agriculture since early 1990s, which affected employment prospects for all sections of rural population, including the youth. However, we admit that this is just a conjecture and the issue needs much deeper investigation which we have not been able to carry out here.

8. Similar to the rural areas, the youth's share in total unemployed in urban areas also increased appreciably during 1983 to 1993-94. However, a reversal of this trend is observed for the sub-period of 1993-94 to 2009-10. This is consistent with the overall picture of the urban employment for this later sub-period, which is that the employment scenario did not worsen as much in the urban areas as it did in the rural areas during the post-1993-94 (post-reforms) period (see Table 8A above).

9. The labour force participation rate (LFPR) is defined as the ratio of (employed + unemployed) to total population multiplied by 100.

10. The work force participation (WFPR) is defined as the ratio of employed to total population multiplied by 100.

11. The non-youth category includes all those in age-groups 5-14, 30-59 and = 60. Exclusion of age-groups 5-14 and = 60 from the non-youth category would not alter our conclusions much as their combined share in total employed has been less than one-tenth of total employment. Therefore, we have formed the non-youth category by pulling all these age-groups together to highlight how the youth fared in terms of employment/ unemployment characteristics *vis-à-vis* the rest of population.

12. The declining trend in the youth's LFPR has been more visible in the rural areas compared to the urban areas, especially for the female youths. To what extent this is due to their preference for more (higher) education (which is termed as the 'education effect') and/or improvement in earnings levels of their families in recent years (the 'income effect') is an issue that deserves serious research scrutiny. We would like to mention here that although the issue of declining LFPR, especially for the females, has drawn considerable research attention in recent years [see, for example, Rangarajan *et al.*, 2011; Neff *et al.,* 2012), this issue has not yet been pursued with reference to the youth. This is an important research gap, which we too failed to address in this paper.

13. No break-ups are provided here for males and females and rural and urban areas to save space.

14. For calculation of growth rate of employment, the following formula has been used:

$X_j = X_i\,[1+r]^n \Rightarrow r = [X_j/X_i]^{1/n} - 1$

where 'r' is the rate of growth and 'n' is the time length between two NSSO survey rounds. Using this formula, 'r' when multiplied by 100 provides growth rate in percentage terms.

15. It is necessary to examine more rigorously to what extent the economic policies pursued during the post-economic reforms period have been detrimental for the growth of employment opportunities for the youth. In this connection, it is also necessary to look into any possible shift in the 'job-preference' of the youth who are receiving modern education. Future researchers may address these issues.

16. The primary sector includes crop production and other activities like forestry, fishing and hunting.

17. The secondary sector includes mining & quarrying, manufacturing, electricity, gas & water supply and construction.

18. The tertiary sector is composed of wholesale & retail trade, transport, storage & communication, and all kinds of services.

19. The unemployment rate is defined as the ratio of unemployed to (employed + unemployed) multiplied by 100.

20. For the econometric exercise, we considered the principal status (PS) workers only.

21. Note that the sample units considered here are restricted only to those in the age group of 15- 29 years only.

22. Let us reiterate that our conclusion regarding worsening employment situation for the youth is drawn from a comparison of growth rates of employment for the two time-periods: pre-reforms (1983 to 1993-94) and post-reforms (1993-94 to 2009-10). We admit that this is not a satisfactory way to draw inferences about the employment-effects of economic reforms policies. Ideally, one should begin by theorising possible relation between the economic reforms policies and employment growth, and then examine the causal relation between the two econometrically. Our present study is devoid of such type of analysis.

23. Gumber [2000] also arrived at the same conclusion on the basis of his analysis of survey data for the rural household collected by the NCAER in 1994. In another recent study, using the NSSO data for the same 66th Round, Mitra and Verick [2013] carried out an econometric exercise to identify the determinants of youth labour force participation. They observed, among other things, that the youth labour force participation goes down with their increasing levels of education. This finding (as also ours) is also consistent with the tabulation of NSSO data that shows that the unemployment rate is the lowest for the illiterates, and it goes up with increasing levels of education (see Kumar and Sahu, 2013).

24. The 12th Five Year Plan identified "the dearth of vocational and technical education leading to skill mismatch in the job market" as the prime reason behind high unemployment rate among the youth in the country [see Planning Commission, 2013, p. 139]. Also see, in this context, Ministry of Labour and Employment [2012, Pp. 3-4], Sinha [2013], and Majumder and Mukherjee [2013].

25. The issue of skill improvement and employment started getting highlighted in recent years, more vigorously in course of the 11th and 12th Five Year Plans in India. A notable initiative in this respect is formation of the Prime Minister's Council on Skill Development in 2008 and subsequent formulation of the National Skill Development Policy, 2009.

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AN ENQUIRY INTO EMPLOYMENT IN THE ORGANISED SECTOR IN INDIA

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The paper attempts to analyse the trends in the organised sector employment of India for the period 1961 to 2010. It is found that, employment in the organised sector, is in a state of decline, exhibiting a downward trend throughout the period of analysis. The era of socialistic growth pattern (till mid 1980s) was more favourable for the public sector development than the private sector. Despite this, the share of public sector employment has been modest, and decreased after 1990s. Employment in the organised sector was expected to surge in the post-reform period; however, the adoption of reforms has worsened its employment generation potential. The public sector exhibits poor performance in the post-reform era, while employment creation capacity of the private sector has not increased to the level expected, in spite of its broadened scope. Within the industry groups, manufacturing is the worst performer in both the segments. The services sectors, mainly finance and transport, helped generating substantial employment in the aftermath of the reforms. This holds true, however, in the case of private sector only.

1. INTRODUCTION

As an economy moves upwards the economic ladder, the growth process is usually accompanied by the shift of the labour force from the informal to the formal sector. This transition is of significant importance for the development path to be inclusive and productive. Generation of employment in the formal sector has, therefore, been of utmost importance for the policy makers in India since independence. One also looks to the formal sector to generate decent jobs on an adequate scale.

At the eve of independence, the Indian economy was primarily an agrarian one, with majority of the population dependent on agriculture. Thus, the policy efforts were aimed at creating employment opportunities in the non-farm sector and enhancing the absorption capacity of the organised sector, to accommodate maximum labour force. With the adoption of the socialistic pattern of development, the public sector was entrusted the responsibility of creating substantial employment in the organised sector. This set up, however, starved the economy of its vital nutrients resulting in the poor performance of all the macroeconomic indicators, including employment. Though, the contribution of the agriculture sector to GDP declined; employment structure of the economy remained comparatively informal in nature.

With the move towards liberalisation in the 1990s, the burden of all round development was shifted to the private sector. High growth rates, due to added benefits of globalisation, were expected to create substantial employment in the economy. However, though the reforms succeeded in achieving ascent in the growth rates of GDP, employment potential of the economy did not enhance to the level expected. The organised sector employment was found to be decelerating, encrypting the post-reform period as an era of 'jobless growth'. The absorption capacity of the organised sector, therefore, did not improve at all, making it one of the weakest contributors to employment generating process.

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This is a revised version of the paper presented at the National Seminar on 'Globalisation, Labour market and Employment Relations in India (In Honour of Professor L. K. Deshpande)', organised by the Institute of Human Development and Indian Society of Labour Economics on July 9-10, 2012 at Mumbai. The authors are very grateful to Professor Nilakantha Rath, Professor V. S. Chitre and an anonymous referee for their suggestions and incisive comments. However, the authors are solely responsible for any errors.

The present paper attempts to analyse the performance of employment in the organised sector and tries to provide plausible explanations thereof. The paper is organised into six sections. Section *two* reviews employment scenario of the country with respect to the industrial policies and the subsequent five year plans. Section *three* deals with the data and methodology applied for the purpose of analysis. The examination of the trends in employment in organised sector is studied in depth in the *fourth* Section. The *fifth* Section tries to find out theoretical justifications for the analysed trends, while the last Section concludes the paper.

2. EMPLOYMENT IN THE INDIAN ECONOMY

With the advent of freedom in 1947, India inherited an economically drained and a politically unstable economy. The country faced several problems like wide spread poverty, inequality, unemployment, weak and underdeveloped industrial base, low saving and investment rates and inadequate infrastructure. All these factors, along with the great fascination with the Soviet experiment in socialist development, led the then policy makers to adopt a socialistic pattern of development, with the government assuming the role of the supreme controller of key economic activities. High growth rates were thought to be the immediate focus of the development policies for marching towards sustainable and inclusive growth in the long term. A gradual change from a primitive agrarian economy to an industrialised one with a dynamic service sector was aimed at. The industrial policies of 1948 and 1956 laid emphasis on heavy industrialisation for achieving rapid economic growth by assigning the public sector a fundamental role in the growth process. All industries of strategic importance were assigned to the public sector, in view of the weak resource base. The private sector, on the other hand, was expected to work in concordance with the public sector, thereby limiting its role as a supplement wherever the public sector fell short [Burange and Yamini, 2011]. The industrial policies and the initial Five Year Plans were, therefore, skewed towards the public sector development by imposing strict and stringent controls on the private sector.

Employment, however, did not form the basis of planning. The focus was on growth, which along with industrialisation was expected to generate employment, sufficient enough to absorb the moderately growing labour force, considering the small rate of open unemployment prevalent at that time [Papola, 1994, 2007, 2008]. It was acknowledged in the First Five Year Plan (1951-56) that, population growth and inadequate development of non-agricultural sectors were the major deterrents in generating employment [GOI, 2011a]. Employment growth necessary to absorb the surplus labour from agriculture was expected to be achieved through reliance on labour-intensive techniques in the existing vast informal sector and the development of small scale industries. The infrastructure development activities like construction of dams, irrigation projects and metallurgical industries were presupposed to act as an additional cushion in generating employment opportunities for the masses. Meanwhile, the public sector was considered to be the 'model employer' in the organised segment, while the role of the private sector was secondary. A number of regulations guaranteeing labour welfare and protection were enacted to ensure a healthy and competitive work atmosphere. The Second Five Year Plan (1956-61) set a target of generating 6.3 million employment opportunities in the urban areas and 9.0 million opportunities in the rural areas to eradicate unemployment by the end of its tenure. Since, the Second Plan created 6.5 million additional employment opportunities outside agriculture, the Third Plan (1961-66) envisaged to increase this to 10.5 million, in addition to the 3.5 million opportunities in the agriculture sector. Employment increased from 12.09 million in 1960-61 to 15.46 million in 1965-66, during the

Third Plan [GOI, 2011a]. As against the economic growth rate of 3.5 per cent per annum, the rate of growth of employment was 2 per cent; considered adequate to tackle the unemployment rates at that time. However, due to continuous surge in population, labour force grew at the rate of 2.5 per cent creating a severe backlog of employment opportunities [Papola, 1991].

The first quinquennial survey by the National Sample Survey Organisation (NSSO), published in the year 1973, exposed the unsatisfactory economic and demographic performance by indicating high unemployment rates of 8.4 per cent as per the current daily status and 4.3 per cent as per the current weekly status [Papola, 2006]. The magnitude of unemployment had doubled from 5 million in 1956 to 10 million in 1972. The trend indicated alarming casualisation of work, accompanied by stagnant organised sector employment. It was after this, that the policy makers realised that for growth to be sustainable and inclusive, issues of employment and unemployment must be incorporated in the planning agenda of the government. The original draft of the Fifth Five Year Plan (1974-79) clearly mentioned that, "the main causes of abject poverty were open unemployment, under employment and low resource base of very large number of producers in agriculture and services sector" [Datt and Mahajan, 2011, p. 228]. This draft, however, did not materialise and the revised draft placed importance on self reliance through high economic growth, proper distribution of income and by raising domestic savings [Datt and Mahajan, 2011]. Nevertheless, the plan emphasised the need to re-orient the development policies towards employment generating sectors, with emphasis on manufacturing and a number of special employment programmes were launched and channelised towards the relatively dominant informal sector. Public sector dominated the growth scenario of organised employment and the industrial policies announced from time to time impeded private sector growth by enforcing several enactments like the Monopolies and Restrictive Trade Practices (MRTP) Act (1969), Foreign Exchange Regulation (FERA) Act (1973), etc.

The latter half of the 1970s was marked by political turmoil. In economic planning, the emphasis still remained on self reliance through inward oriented policies and excessive state control. The Sixth Plan (1978-83) framed by the Janata Party Government, outlined the objective of higher productivity through enhancement of employment potentials in agriculture and small scale industries. With the collapse of the Janata Government in 1980, the plan was revised and the traditional policy of poverty reduction with the Nehru model of growth was back [Datt and Mahajan, 2011]. Agriculture (95.251 million opportunities by 1984-85), manufacturing (expected to create 27.759 million employment opportunities by 1984-85 from 22.012 million in 1979-80), construction and services were expected to generate substantial employment during the Plan tenure. As revealed in the Seventh Plan, the growth rate of employment during the Sixth Plan was 4.32 per cent per annum, indicating employment generation of the order of 186.705 million standard person years (SPY) in 1984-85 as against the predetermined order of 185.389 million SPY [GOI, 2011a]. Nevertheless, by the mid 1980s, concerns about stagnation and technological backwardness due to high amount of controls, licenses and bureaucratic red tape surfaced, paving a way for decentralisation and partial liberalisation of the economy. Growth in employment lagged severely behind that of GDP. In addition, it was found that the aim of structural change was accomplished in terms of the composition of GDP, but not in terms of employment. From 1972 to 1988, the share of agriculture in GDP declined from 75 per cent to 21 per cent but increased in case of employment from 8 per cent to 11 per cent [Papola, 1991]. It was thus, acknowledged that there is an immediate need to internalise employment in the core development strategies and the Seventh Plan (1985-90) emphasised gainful and productive employment opportunities as one of its important objectives. An annual growth rate of 4 per cent in employment was projected in the plan [Papola, 2007]. An impetus to industry and rural non-farm sectors, along with the small scale industries and village and cottage industries was assigned in order to generate additional employment in the economy. Technological up-gradation and efficiency enhancement were also thought of as important instruments in boosting the country's employment levels.

The Eighth Plan (1992-97) was set against the background of the severe balance of payments crisis that engulfed the economy in the late 1980s. This, in turn, forced India to adopt an open door policy. The New Economic Policy of 1991 distinctly mentioned that the way for India to develop further would be through liberalisation, privatisation and globalisation. Several norms in the areas of trade, finance, investment and infrastructure were relaxed and the license system was abolished. The reforms ended many public monopolies thereby laying substantial emphasis on the role of the private sector. Generation of gainful employment was assigned a prime role in the policy statement and was reflected in the concurrent Eighth Plan too. Indeed, this was the first time that employment was allotted a special chapter. The Plan pointed out the decelerating contribution of the organised sector in total employment of the economy. The growth rate of employment was found to have declined from 2.48 per cent during 1977-83 to 1.38 per cent during 1983-88. The growth rate of organised manufacturing was also revealed to be stagnant during this period. Thus, the target of achieving 2.6 per cent to 2.8 per cent employment growth per annum was set in order to achieve 'employment for all' by 2002 [GOI, 2011a]. Sectors like construction, manufacturing and services were promoted to act as the support systems to agriculture in generating additional employment in the economy.

The Ninth Plan (1997-2002) placed employment amongst one of the three upper most objectives of the state policy. It emphasised that higher economic growth during the preceding decade had enhanced employment opportunities in the productive sectors. Accordingly, the focus of the Plan was to target the sectors with high employment opportunities and simultaneously encourage labour-intensive techniques of production in order to boost employment generation [Papola, 2007]. It was decided to bring down the average rate of unemployment to 1.66 per cent compared to 1.87 per cent during the Eighth Plan. A growth rate of 2.77 per cent in employment was thought to be necessary in order to achieve employment for all by the year 2007 [GOI, 2011a]. In the mean time, the NSSO survey report, 1999-2000, once again exposed the stark reality of Indian employment scene. It was found that, out of the total workforce of the country; only 7 per cent was employed in the organised sector while the rest was entirely in the unorganised sector. It also indicated the limited labour absorption capacity of the organised sector [GOI, 2000]. As revealed by Papola [2006], out of 21 million employment opportunities generated during 1994-2000, only 4 per cent were in the organised sector, suggesting a trend towards the informalisation of employment scenario. Thus, the fears of 'jobless growth' as a consequence of the reforms began erupting. The Planning Commission appointed two committees, 'The Task Force on Employment Opportunities' in 2001 and 'Special Group on Targeting Ten Million Opportunities per Year' in the year 2002. The 2001 Report [GOI, 2001] expressed concern about the shrinking organised sector employment, due to the limited job creating capacity of the newly adopted technology, post-reforms. It emphasised faster development of private sector as employment provider, since the public sector continued to be the victim of over-crowding. An impetus to accelerated growth, to help create additional demand for labour, coupled with sound macroeconomic policies, higher rates of investment and infrastructure advancement were some of the measures suggested to boost employment in the economy. Similarly, the report of the Special Group [GOI, 2002] focused on the poor employment profile of the organised sector and considered skill development and appropriate policies to enhance labour absorption capacity of the organised sector as the vital elements in employment generation.

Against this background, the Tenth Five Year Plan (2002-07) laid the target of creating 50 million employment opportunities to replete the unemployment backlog of 35 million persons, 9 percent of the total labour force. It admitted that the growth in the 1990s created less work opportunities than expected and unless the pace of job creation is accelerated, it signalled ever mounting unemployment. It was argued that increased capital intensity and labour productivity in the economy in the aftermath of globalisation, especially in the organised sector, has reduced employment generation potential of the output. Therefore, sectors like agriculture and allied activities, social services and small and medium enterprises were assigned the role of creating additional employment opportunities for the masses. Generation of gainful employment to take care of the additions to the labour force, therefore, formed the basis of the plan [GOI, 2010].

The Eleventh Five Year Plan (2007-12) encapsulated the creation of productive employment, with decent working conditions, in order to absorb the growing labour force, as an important element of the growth strategy. The Plan openly confessed about the permanent decline in organised sector employment, especially since 1994, thereby signalling its deteriorating quality. It also indicated that, the decline was mainly in the public sector. Moreover, though employment in the organised private sector surged in the post-reform period, the rise was insufficient to offset the public sector decline. The Plan also revealed that, the Tenth Plan had set an ambitious target of generating 50 million employment opportunities, out of which, only 47 million actually materialised. Sectors like agriculture, manufacturing, trade and transport fell short of their predetermined targets, while employment in the service sector exceeded the decided target. Amongst the entire industry groups, the largest shortfall was in the manufacturing sector (8.64 million employment opportunities generated against the target of 11.62 million) [GOI, 2011a].

Thus, the creation of employment in the organised sector was placed high in the priorities of the 11th Plan. It was intended to create 58 million employment opportunities in 21 high growth sectors to bring down the unemployment rate to 4.83 per cent by the end of its tenure. The unemployment rate was further projected to be brought down to 1 per cent by the end of the Twelfth Plan. Sectors like manufacturing (expected to generate employment opportunities at the rate of 4 per cent per annum from 2007 to 2016), construction (employment generation at the rate of 8.2 per cent per annum) and transport (7.6 per cent per annum) were expected to play a pivotal role in employment generation process. Within the services sector, IT enabled services, healthcare, education, tourism, financial services and entertainment industry were envisioned to create substantial employment. Therefore, the main aim was to reduce the dependence of employment on the agriculture sector and shift it towards industry and the tertiary sectors. In addition to this, reduction in informalisation within the organised sector, social security measures and skill development were amongst the long term objectives of the Plan. The recently published 'Annual Report to People on Employment, 2010' also argued for increasing the share of the organised sector in employment generation process by laying emphasis on manufacturing and services. Considering the impressive growth rates during the present decade, it targeted employment growth of at least 2.5 per cent per annum as its short term strategy [GOI, 2011d].

It can be, therefore, deduced that employment in India's development path evolved as an internalised factor step by step and plan by plan. In the initial years it did not figure in the priority list of Indian planning. However, with the revelation of ever-increasing backlog in providing suitable job opportunities and the concomitant failure of the industrial policies to perform up to its mark, employment began to emerge as an important element of the planning goal. After the opening up of the economy, it was distinctly spelt out that employment generation remains at the core of development policy for the economic growth to be inclusive and sustainable. At present, decent, productive and gainful employment generation has become the crux amongst all the policy measures aimed towards fruitful development.

In spite of this, employment scenario of the country continues to be daunted by an alarming unorganised segment and the limited role of the organised sector. It can be deduced that the organised sector has failed to absorb significant amount of labour and generate sufficient employment opportunities, which is clearly reflected by the Five Year Plans too. The structural change in employment for India does not seem to have taken place despite the high GDP rates and the declining share of primary sector in GDP [Hazra, 1991; Papola, 1991; Kumar and Dixit, 2009; Datt and Mahajan, 2011]. Moreover, the quality of non-farm employment generated appears to be poor, in view of the increasing informalisation and growing casualisation of work. Thus, unless and until apt employment policies with an ultimate aim of creating a vibrant organised sector are adopted, employment scenario of India will not be promising in the coming years.

3. DATA COVERAGE AND METHODOLOGY

The present study uses the data on employment in the organised sector, published in the *Economic Survey* [GOI, 2012] of the Ministry of Finance, Government of India, for the period 1961 to 2010. Employment at an aggregate level for the public and private sectors as well as its disaggregation across the industries is covered under the domain of the organised sector. In addition to this, employment by branch is also reported for the public sector in the *Economic Survey*.

However, there are some limitations of the data. First, there is inadequate coverage for the construction sector, particularly on the private account. Second, employment in private sector relates to non-agricultural establishments in the private sector employing 10 or more persons, while that in public sector relates to all establishments irrespective of the size. Third, the data excludes states like Sikkim, Arunachal Pradesh, Dadra and Nagar Haveli and Lakshadweep. Fourth, Jammu and Kashmir, Manipur, Puducherry, Mizoram, Daman and Diu are not included in totals due to non-availability of data as per NIC 1998. For the purpose of analysis, the paper relies on the following basic tools:

1. Annual (Y-o-Y) growth rates.
2. Average annual (Y-o-Y) growth rates.
3. Compound annual growth rates (CAGR) (Appendix A).
4. Moving averages.
5. The Hodrick-Prescott (HP) filter (Appendix B).

4. EMPLOYMENT TRENDS IN THE ORGANISED SECTOR

The organised sector is a bunch of legally entitled firms, following the rules and procedures framed by the government, with an active labour union ensuring all the benefits, prudent wages and safeguards to its employees. The public sector and the organised private sector are the two major components of the organised segment. While the public sector makes up for almost two-thirds of the organised employment, the scope for private sector has broadened since the 1991 reforms. Figure 1 represents the shares of public and private sectors in total employment in the organised sector. It can be seen that the public sector was a dominant employer within the organised segment till 1990. Since then, its role and importance in employment creation reduced (especially from 2005 onwards) while that of the private sector increased. Nevertheless, the public sector still occupies almost 60 per cent of the share in the employment of the organised sector. Table 1 further helps in understanding the shares of the

Figure 1. Share of Public and Private Sectors in Total Employment (Per cent)

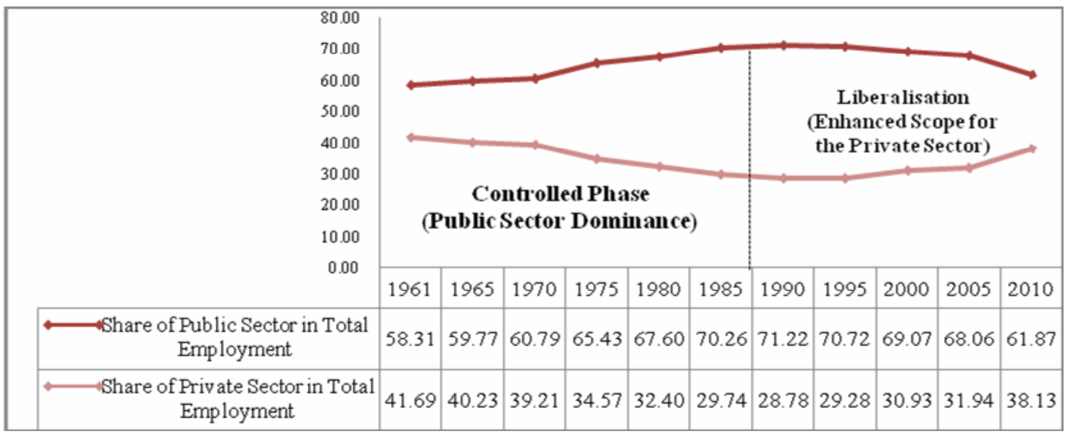


Table 1. Industry-wise Total Employment (Per cent share)

Industry/Decade	1960s	1970s	1980s	1990s	2000s	Average
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. Agriculture, Livestock, Forestry and Fishing	6.93	5.88	5.48	5.22	5.24	5.76
2. Mining and Quarrying	4.29	3.95	4.17	3.89	4.12	4.09
3. Manufacturing	27.71	26.60	25.17	23.86	22.06	25.10
4. Electricity, Gas, Water and Sanitary Services	2.29	2.92	3.30	3.54	3.38	3.08
5. Construction	6.09	5.52	4.89	4.35	3.62	4.91
6. Wholesale and Retail Trade, Etc.	2.82	2.49	1.66	1.70	2.04	2.14
7. Transport, Storage and Communications	14.15	12.46	11.93	11.35	10.54	12.11
8. Financing, Insurance, Real Estate*	0.00	2.29	4.84	5.69	7.80	4.10
9. Community, Social and Personal Services	35.74	37.89	38.56	40.39	41.20	38.72
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

* Financing, insurance and real estate were included from 1975 onwards, with the adoption of NIC 1970

various industries in total employment. It can be inferred from the above table that the average share of community, social and personal services in total employment is the highest, followed by manufacturing, transport and agriculture. These sectors are, therefore, of prime importance in employment generation process of the organised segment. In addition to this, mining and construction also contribute modestly to employment share. For the individual decades, it can be noticed that the share of services, finance and transport seems to be increasing, while the rest exhibit a declining share. Studying the behavioural patterns of these industries is, therefore, very crucial to gain a rigorous understanding of the overall employment scenario.

However, the empirical literature on the trends in organised sector employment is scarce, since it constitutes a very small portion of total employment. The NSSO annual and quinquennial surveys are the back bone of most of the studies addressing issues relating to employment. Results of two studies that analyse employment trends in the organised segment can be stressed. The first study is by Hazra [1991] and the recent one is by Kumar and Dixit [2009].

Hazra [1991] analysed employment trends in India for the period 1977-78 to 1987-88. The study strongly pointed out the failure of organised manufacturing, construction, electricity, transport and communication and trade to generate employment. In case of manufacturing, both public and private sectors were the worst performers. The study also revealed an asymmetry between employment growth and GDP growth. Thus, it clearly indicated the weak labour absorption capacity of the organised sector as the major cause for the prevalence of various types of unemployment within the organised segment.

Kumar and Dixit [2009] analysed the trends and patterns in employment growth from 1961 onwards, with a special focus on the post-reform period. The study deciphered an absolute decline in organised sector employment post-reforms (1991 to 2005), the major sectors contributing to this being the public sector and manufacturing. It stated that the structural reforms have adversely impacted both, the organised as well as unorganised segment of the economy. Tendency towards informalisation, retrenchment and casualisation of employment in the organised sector was also depicted.

It will, therefore, be useful to further explore organised sector employment by examining the actual trends and drawing inferences about the assessed behaviour. Since the existing literature on employment in the organised sector is limited, the present study will help in filling the empirical gap. Moreover, the study aims to undertake an in-depth analysis of all the elements of the organised sector, making it more comprehensive than the others. In addition to this, it is also intended to find out appropriate reasons behind the observed trends and draw implications from them, which the present studies do not cover. Thus, the overall analysis will definitely be an improvement over the existing ones and add significantly to the literature.

4.1. Employment Trends in the Total Organised Sector:

Table 2 shows the average annual (Y-o-Y) growth rate and the CAGR of total employment, for the decades from 1960s to 2000s. It may be observed that, the average growth rate continuously declined from the 1960s and was at its worst during the post- reform years. The growth rate decreased from an average rate of 3.54 per cent in the 1960s to 1.68 per cent in the 1980s. However, after the initiation of the reforms in the 1990s, the descent is steep. In fact, it is lowest for the decade of the 2000s (0.13 per cent). Similar trends can be observed in case of the CAGR. The CAGR was 3.78 per cent in the 1960s, falling sharply thereafter. The post-liberalisation era was marked by further deceleration, with growth of 0.35 per cent in the 1990s and a negative rate (-0.27 per cent) for the decade of 2000s. Figure 2 further presents the actual employment series and the estimated kinked exponential series from 1961 to 2010 [Boyce, 1986]. The downward inclination of employment can be distinctly traced, especially for the post-reform period.

Table 2. Average Annual (Y-o-Y) Growth Rate and CAGR for Total Organised Employment (Per cent)

Decade	Average Annual Growth Rate	CAGR
(1)	(2)	(3)
1960s	3.54	3.78
1970s	2.72	2.50
1980s	1.68	1.82
1990s	0.60	0.35
2000s	0.13	- 0.27

This declining pattern can be also confirmed with the help of Figure 3, where total employment trends are measured using simple annual (Y-o-Y) growth rates, the five year moving averages and finally by the HP filter [Hodrick and Prescott, 1997]. As depicted in the graph, the Y-o-Y growth rate in employment saw a spurt from the period 1961 - 1965, sharply collapsing for the years 1966 - 1967. Thereafter, it accelerated till 1971, remaining above average (1.73 per cent) till the period 1981-82. After that the growth rate is below average throughout and has worsened in the post-reforms years, especially since 1993. In fact, it was negative for the period 1997 - 2004; thereby indicating the inability of the reforms to create employment. Similar trends are indicated by the moving averages and the HP filtered series, with slow convergence to average growth rate from 2005 onwards. A final insight into total employment can be sought by examining the CAGR for total employment across various industries.

From the table (Table 3) it is evident that the CAGR for total employment across all the industries exhibits a downward trend. The growth rates have fallen the sharpest in the aftermath of reforms of 1991. In fact, for the decade of the 2000s, manufacturing, electricity, construction, transport, storage and communication and community, social and personal services have registered a negative CAGR, with the only exception of mining and quarrying, trade and finance. The finance and insurance industry performs better amongst all the industry groups. The CAGR for agriculture is also dismal (0.06 per cent). This indicates that employment generation in most of the organised sector industries has definitely deteriorated over the period of time. An in-depth analysis of this degradation can be undertaken by dissecting its two major components, the public sector and the private sector.

Table 3. CAGR of Employment in the Organised Sector by Industry (Per cent)

Industry/ Decade	1960s	1970s	1980s	1990s	2000s
(1)	(2)	(3)	(4)	(5)	(6)
1. Agriculture, Livestock, Forestry and Fishing	1.88	1.26	1.44	-0.22	0.06
2. Mining and Quarrying	-1.39	4.84	1.53	-1.35	2.67
3. Manufacturing	3.31	2.26	0.82	0.08	-1.16
4. Electricity, Gas, Water and Sanitary Services	6.66	4.26	3.12	0.62	-1.48
5. Construction	2.30	1.25	0.86	-1.00	-2.50
6. Wholesale and Retail Trade, Etc.	11.36	-6.26	2.47	0.87	2.20
7. Transport, Storage and Communications	2.09	1.64	1.43	0.09	-1.75
8. Financing, Insurance, Real Estate	--	32.47	2.03	1.46	5.23
9. Community, Social and Personal Services	5.45	2.32	2.34	0.88	-0.56
Total	3.78	2.50	1.82	0.35	-0.27

Figure 2: Decadal CAGR for Total Employment in the Organised Sector of India (1961 to 2010) (Persons in Lakh)

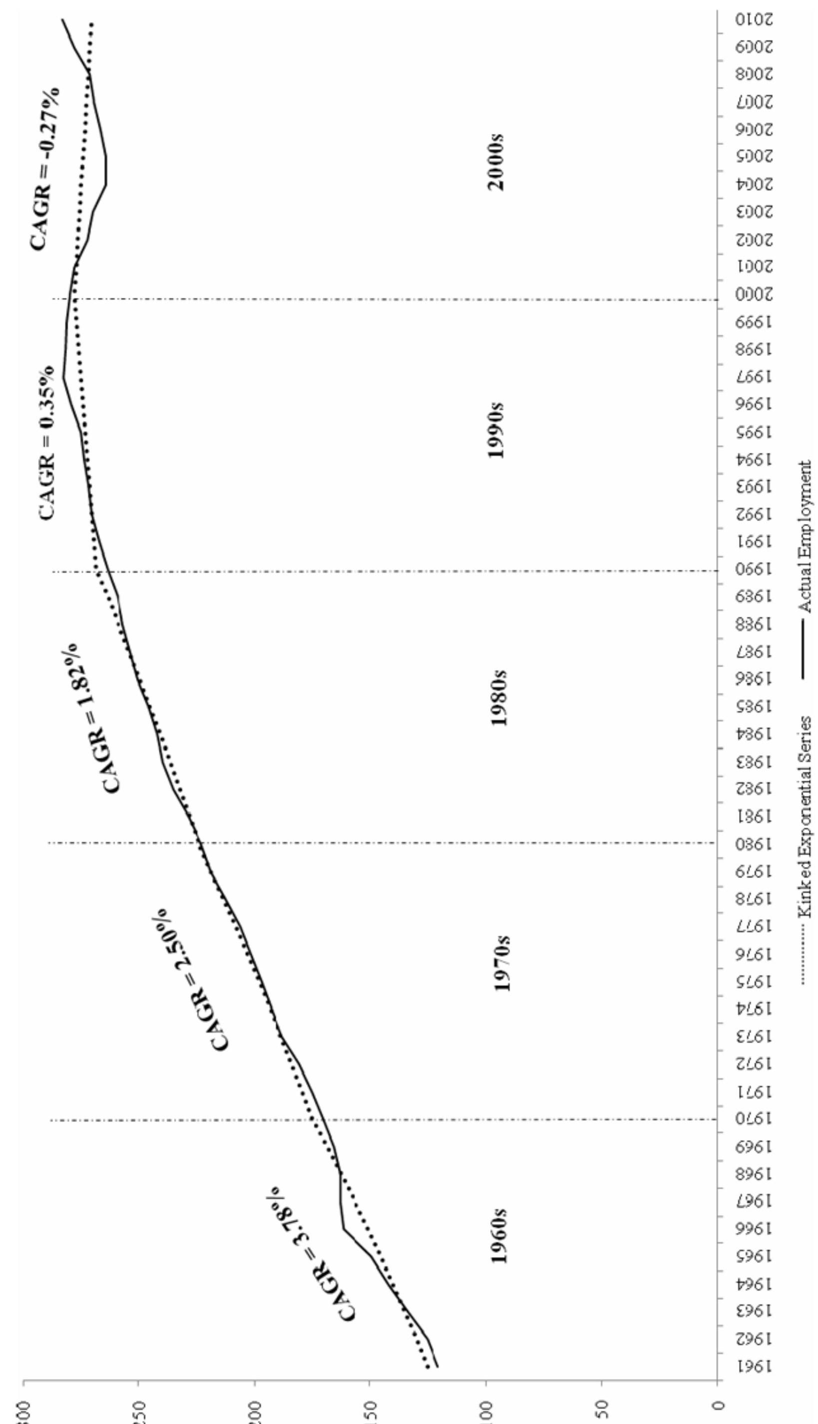
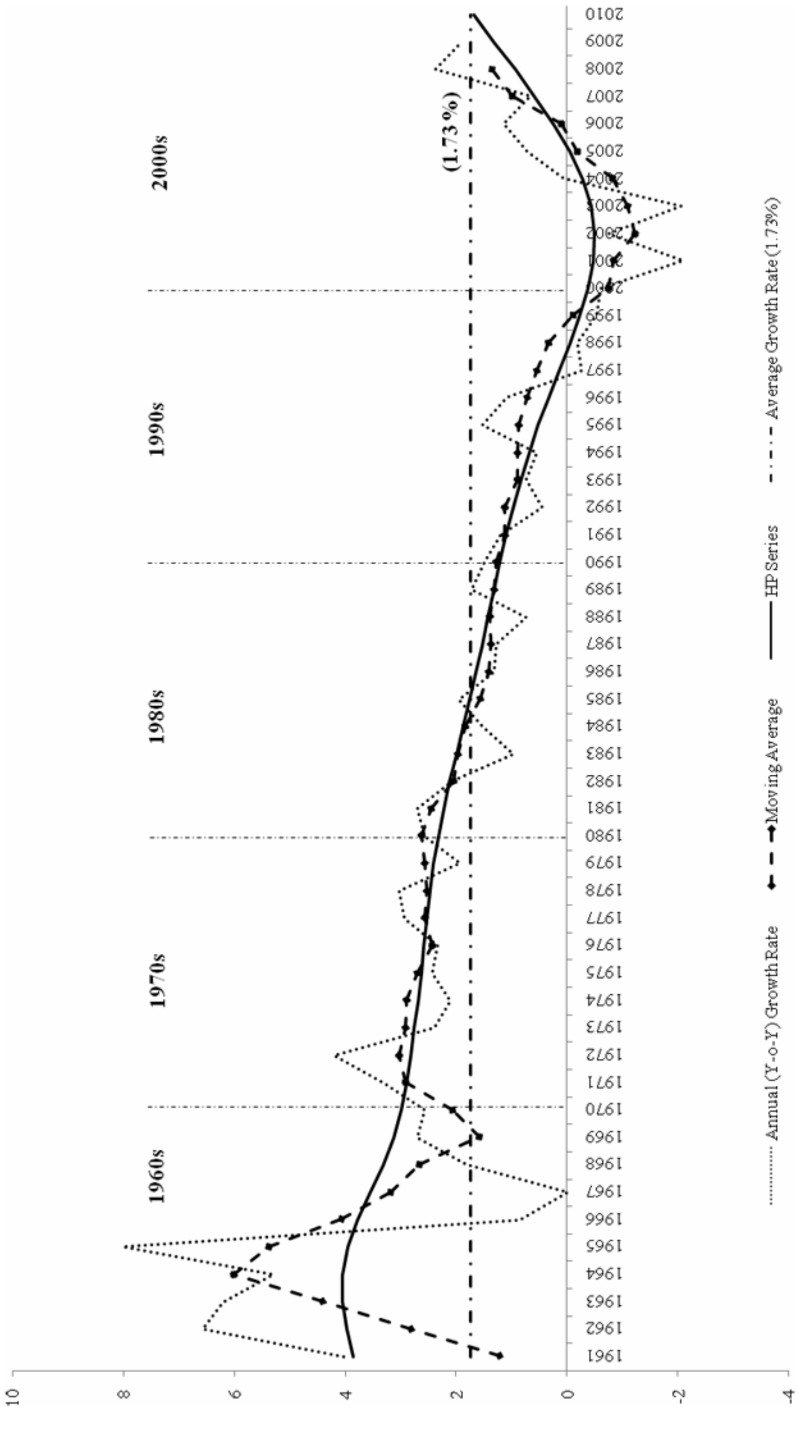


Figure 3: Trends in Total Employment in the Organised Sector of India (1961 to 2010) (Percent)



4.2. Employment Trends in the Public Sector:

Public sector has been the most favoured sector and often reckoned as the change and development agent since independence. It constituted significant proportion of the total organised segment, until the embarkment of the neo-liberal reforms. Since then, its role as an exemplar of development has reduced. Yet, it is the sector assuring highest safety and protection to its employees. In terms of reporting employment, the sector is split into two parts; one is the public sector employment by industry and the other is by branch. It will be therefore useful to understand the behaviour of this sector by separately scrutinising its two sub-segments.

4.2.1. Employment in the Public Sector by Industry:

Table 4 represents the average annual (Y-o-Y) growth rates and the CAGR for the public sector. From the table, it is evident that there has been a descent in the public sector employment in spite of placing enormous importance on it. The average (Y-o-Y) growth rates exhibited a downward trend from being 3.96 per cent in the 1960s to 3.82 per cent in 1970s and further to 0.29 per cent in the 1990s. It was negative for the decade of the 2000s (-0.97 per cent). A similar trend is repeated for the CAGR, where the decade of the 2000s is characterised by a negative rate of growth (-1.24 per cent). Figure 4 helps in showing the above indicated trends with the help of the actual and the estimated kinked exponential series.

Table 4. Average Annual (Y-o-Y) Growth Rate and CAGR for the Public Sector Employment (Per cent)

Decade	Average Annual Growth Rate	CAGR
(1)	(2)	(3)
1960s	3.96	4.31
1970s	3.82	3.66
1980s	2.21	2.29
1990s	0.29	0.11
2000s	- 0.97	- 1.24

Thus, despite the deliberate measures to promote public sector as an epitome of all round development in the pre-liberalisation period, there was a definite policy failure in regard to employment. This can be seen from Figure 5. The annual (Y-o-Y) growth rate shows an upward trend from 1961 to 1963, steeply declining then till the year 1968. It surged again from 1969 to 1972, falling sharply for the year 1974. Thereafter, it remained above average (1.86 per cent) till 1986. From then onwards, there has been a sharp deceleration in the growth rate. From 1995 onwards, in the period post-liberalisation, the growth rate is below average and negative from the year 1997, without showing any tendency to return to the average annual growth rate level. This cycle is repeated for moving averages as well as the HP filtered series.

A final investigation in this sub-segment can be done with the help of CAGR (Table 5) across the various industry groups. It can be inferred from the table that there has been an overall decline in employment levels for all the industry groups. None of the industries display a rising connection with employment. The contribution of agriculture, forestry and fishing, which form the back bone of the primary sector, declined over the period of analysis. The CAGR for this industry was 4.89 per cent in the decade of the 1960s, falling to 2.90 per cent in the 1980s. Since then it was negative through the post-liberalisation period. Mining reached its peak in the decade of the 1970s (CAGR of 16.57 per cent) but declined thereafter, showing a recovery only in the 2000s. Manufacturing has been considered as a vital ingredient in employment generation process since independence. It is an indicator of a healthy industrial sector and real growth of the economy. Though this criterion is fulfilled in case of output contribution to the economy, in case of organised

Figure 4: Decadal CAGR for the Public Sector by Industry (1961 to 2010) (Persons in Lakh)

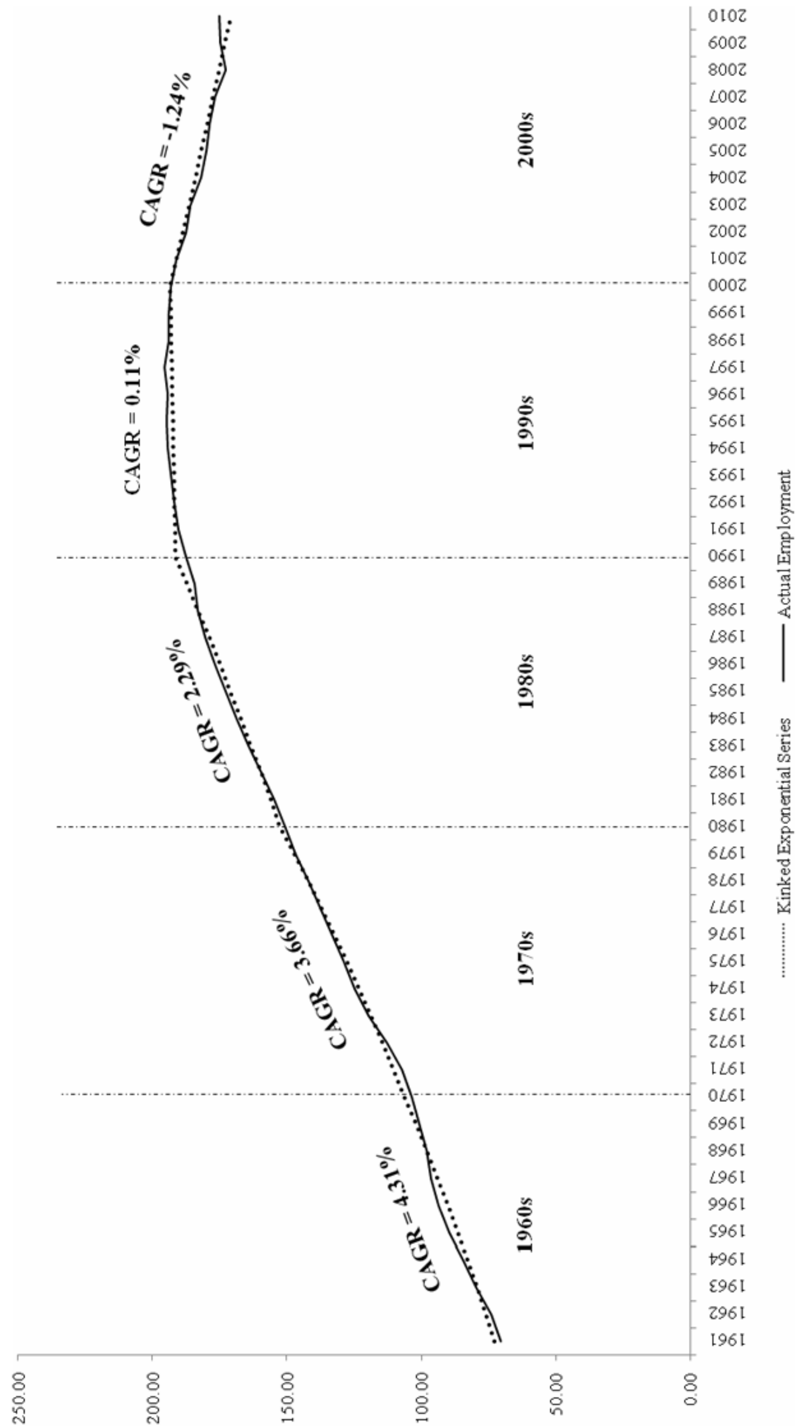
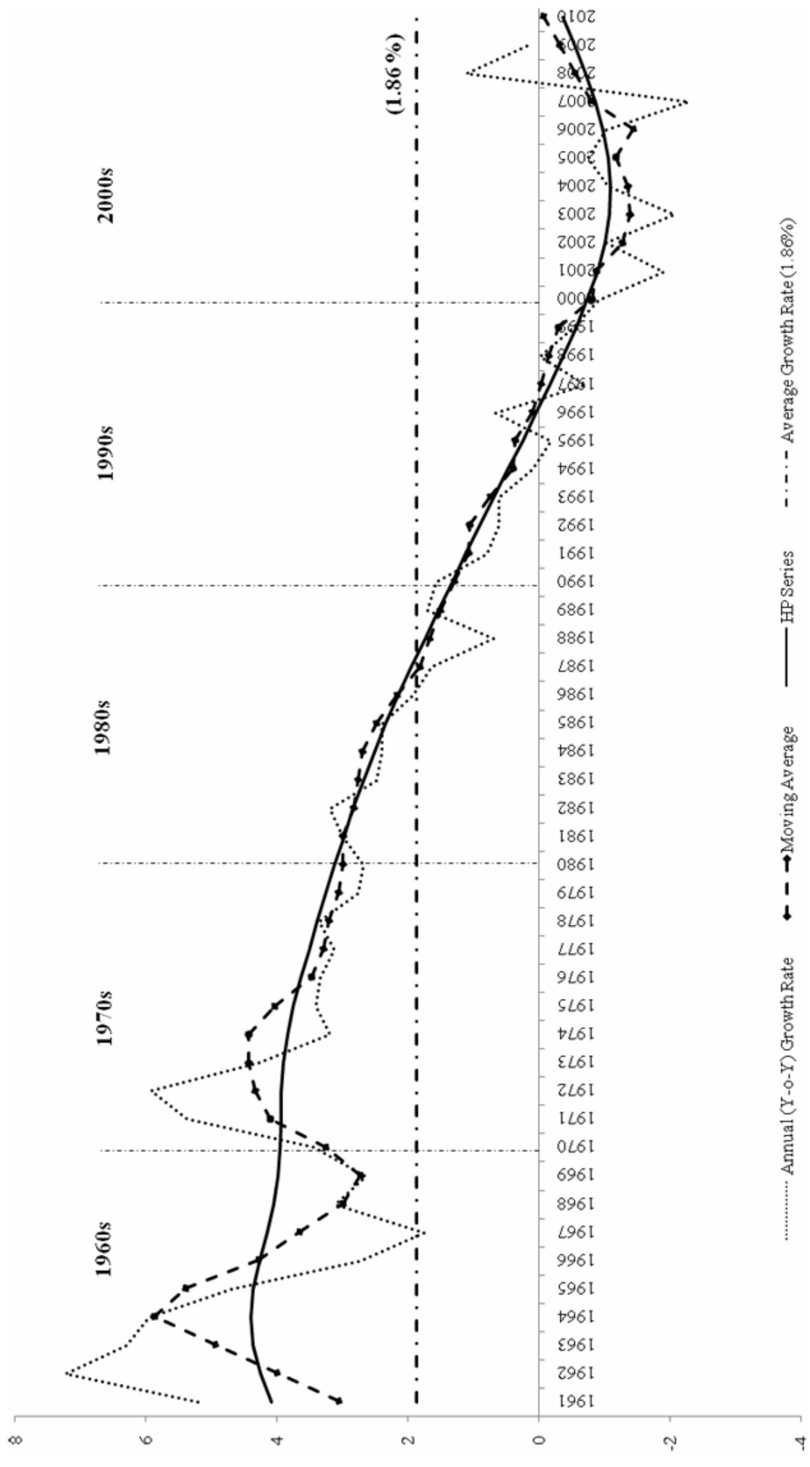


Figure 5: Trends in the Public Sector Employment by Industry (1961 to 2010) (Percent)



employment, the situation is bleak. The contribution of manufacturing sector towards employment generation is not at all encouraging. From a CAGR of 7.48 per cent in the 1960s, it declined to 3.01 per cent in the 1980s. Since then it has registered a negative CAGR, the values indicating worst performance across all industry groups. Even for electricity and construction industries, the CAGR is on a downward path.

Table 5. CAGR of Employment in the Public Sector by Industry (Per cent)

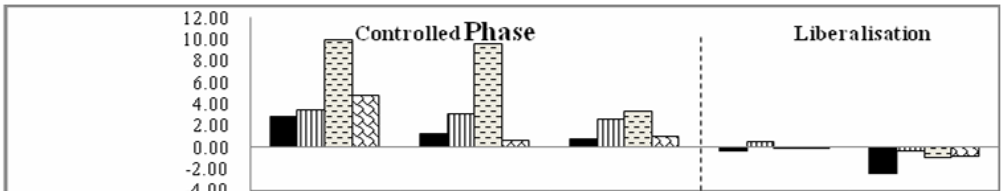
Industry/Decade	1960s	1970s	1980s	1990s	2000s
(1)	(2)	(3)	(4)	(5)	(6)
1. Agriculture, Livestock, Forestry and Fishing	4.89	5.02	2.90	-1.26	-0.83
2. Mining and Quarrying	5.48	16.57	-0.12	-0.71	2.59
3. Manufacturing	7.48	6.11	3.01	-2.83	-4.14
4. Electricity, Gas, Water and Sanitary Services	7.36	4.83	3.16	0.65	-1.75
5. Construction	3.63	2.44	0.89	-0.90	-2.90
6. Wholesale and Retail Trade, Etc.	15.10	-12.21	6.83	0.20	0.82
7. Transport, Storage and Communications	2.28	1.88	1.48	0.06	-2.05
8. Financing, Insurance, Real Estate	--	28.5	3.18	1.28	0.55
9. Community, Social and Personal Services	4.31	2.54	2.30	0.81	-1.30
Total	**4.31**	**3.66**	**2.29**	**0.11**	**-1.24**

Within the services component, the trade and the transport and communication industries also exhibit a downward trend. The decade of 1970s was not fruitful for employment generation for trade. Though the CAGR is not negative for trade post-liberalisation, the positive factor is not encouraging enough. Financing, insurance and real estate was a late starter amongst all the industry groups, recording a CAGR of 28.50 per cent for the decade of the 1970s. This can be attributed mainly to the nationalisation of banks in 1969 and the insurance companies in the early 1970s. Since then, the CAGR is declining continually but is positive throughout. In case of community, social and personal services, the CAGR is 0.81 per cent for the decade of the 1990s and is negative at -1.30 per cent for the decade of the 2000s. This is more serious because it is not a part of the New Economic Policy of 1991. Employment growth remains poor in this category also.

4.2.2. Employment in the Public Sector by Branch:

Public sector by branch comprises four segments. They are the Central Government, the State Government, the Quasi Government and the Local Bodies. Figure 6 gives the CAGR for employment in the public sector by branch. The fall in employment can be precisely distinguished for all the branches. Out of the four segments, Quasi Government employed the highest for the decades of the 1960s and the 1970s. Since then, the declining trend began for all the segments. The decline is the greatest for the Central Government and the Local Bodies. Furthermore, the post-reform era exposes the ugly picture of the organised employment. The CAGR is negative for all the segments for the decade of the 2000s and 1990s (except for the State Government in the 1990s).

Figure 6. CAGR of Employment in the Public Sector by Branch (Per cent)



	1960s	1970s	1980s	1990s	2000s
Central Government	2.83	1.22	0.74	-0.35	-2.40
State Government	3.33	3.04	2.57	0.48	-0.42
Quasi Government	9.83	9.49	3.20	-0.07	-1.07
Local Bodies	4.77	0.57	0.96	-0.05	-0.90

Therefore, it is clear that employment performance of the Central Government, which is again the segment with the highest benefits and safeguards, is dismal. For Quasi Government, there is a steep decline post 1970s; the same is true in case of the State Government. For the Local Bodies, only the decade of 1960s was promising in terms of employment. The overall picture of this sub-segment of the public sector is not positive. Employment scenario for the entire public sector is thus, quite distressing and should be a matter of immediate concern of policy and planning as it constitutes major portion of the total organised employment.

4.3. Employment Trends in the Private Sector:

Trends in the private organised sector can be analysed with the help of industry wise classification as there exists no other categorisation for this sector. The private sector was always assigned a secondary role in the development process. Its progress was restricted by the use of restraining measures; until the start of reforms in 1991, which envisaged a better growth prospect through private sector development. Table 6 presents the average annual (Y-o-Y) growth rates and the CAGR for the private sector for the decades from the 1960s to the 2000s. It can be observed that in both the cases, the growth rates show an increasing trend since liberalisation. The average annual growth rate for private sector has steadily increased at a modest pace since the 1980s. For CAGR also, the decade of the 2000s shows the highest increase (1.63 per cent) in employment, after a continual rise from the 1980s to the 1990s. This can also be studied from Figure 7 where such a rising and declining pattern is clearly visible.

Table 6. Average Annual (Y-o-Y) Growth Rate and CAGR for the Private Sector Employment (Per cent)

Decade	Average Annual Growth Rate	CAGR
(1)	(2)	(3)
1960s	2.96	3.01
1970s	0.78	0.46
1980s	0.49	0.66
1990s	1.34	1.00
2000s	2.28	1.63

Further understanding of the matter can be gained by carefully examining the trends in employment in the private sector. This can again be done with the help of the annual Y-o-Y growth rates, the five yearly moving averages and the HP filter. It can be inferred from Figure 8 that employment growth in the private sector is highly fluctuating, without any long term trend. For most of the time periods, it is below average (1.57 per cent). The annual Y-o-Y growth rate accelerated from 1961 to 1963, decelerating in the year 1964 and again rising for 1965 and climbing down for the year 1966. It is negative for the year 1967. For the decade of the 1970s, it is below average from 1971 to 1976, with rise and fall cycle continuing till 1982. From then onwards, it is below average till 1992, with small peaks above the average growth line (1.57 per cent) for some years. There is an escalation in the growth rate from 1992 onwards the period after the adoption of reforms, till the year 1997, after which the growth rate is negative till 2004. From there onwards, the continual upward swing for the private sector begins. This fluctuating nature of the growth of employment is explained by the moving averages and HP filter also. The growth in the private sector employment is therefore not stable. Even for the period post-reforms, it did not ascend as expected. In fact, the ‘rise-fall’ cycle continues almost every three years, making the private sector employment relatively unstable in nature.

Lastly, Table 7 gives the CAGR for the private sector employment across the various industries. It can be inferred from the following table that the CAGR for employment exhibits positive trends for the period after the reforms. The CAGR was negative for the 1960s and the 1970s for most of the sectors, improving since then. Though the performance of agriculture suffered due to severe draughts in the 1970s, it is positive for the remaining decades. Manufacturing has again been a huge disappointment in case of employment in the private sector too. Its contribution in the private sector employment is decreasing since the 1960s and is negative for the decade of the 2000s (CAGR of -0.44 per cent). Construction also exhibits negative growth till the 1990s, improving for the decade of the 2000s. For electricity, the decades of the 1960s, the 1980s and the 2000s seem better.

Amongst the services segment, transport, finance and community and personal services performed better, post-liberalisation. The CAGR for transport and services are on a surge since the 1990s, though in case of services, the positive growth rate is not as high as in case of transport. The CAGR in finance, insurance and real estate is remarkably high, especially for the decade of the 2000s (CAGR of 15.21 per cent). In the case of wholesale and retail trade, apart from the decade of the 1960s (CAGR of 7.60 per cent), the growth rate, though positive, is not assuring aftermath the reforms.

Figure 7: Decadal CAGR for the Private Sector (1961 to 2010) (Persons in Lakh)

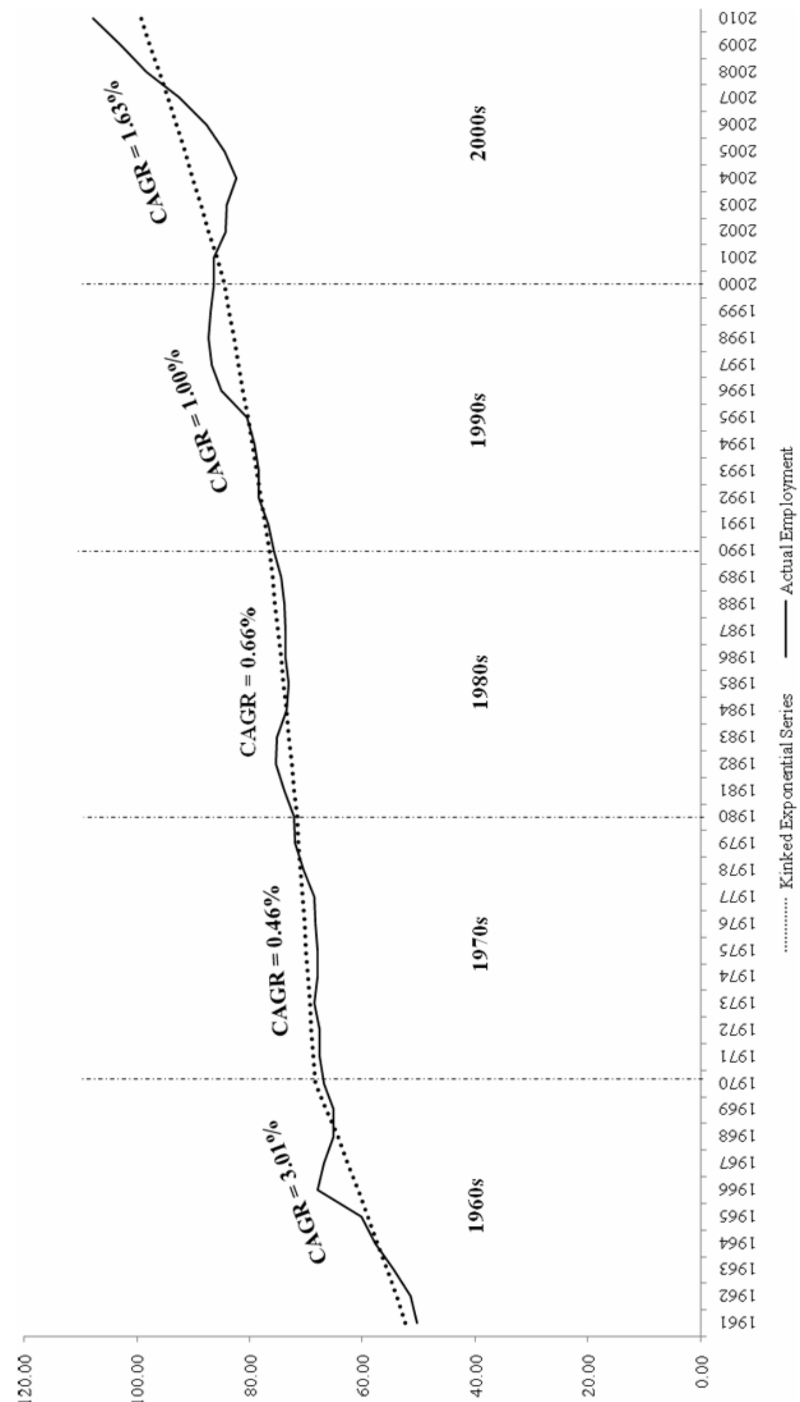


Figure 8: Trends in the Private Sector Employment (1961 to 2010) (Percent)

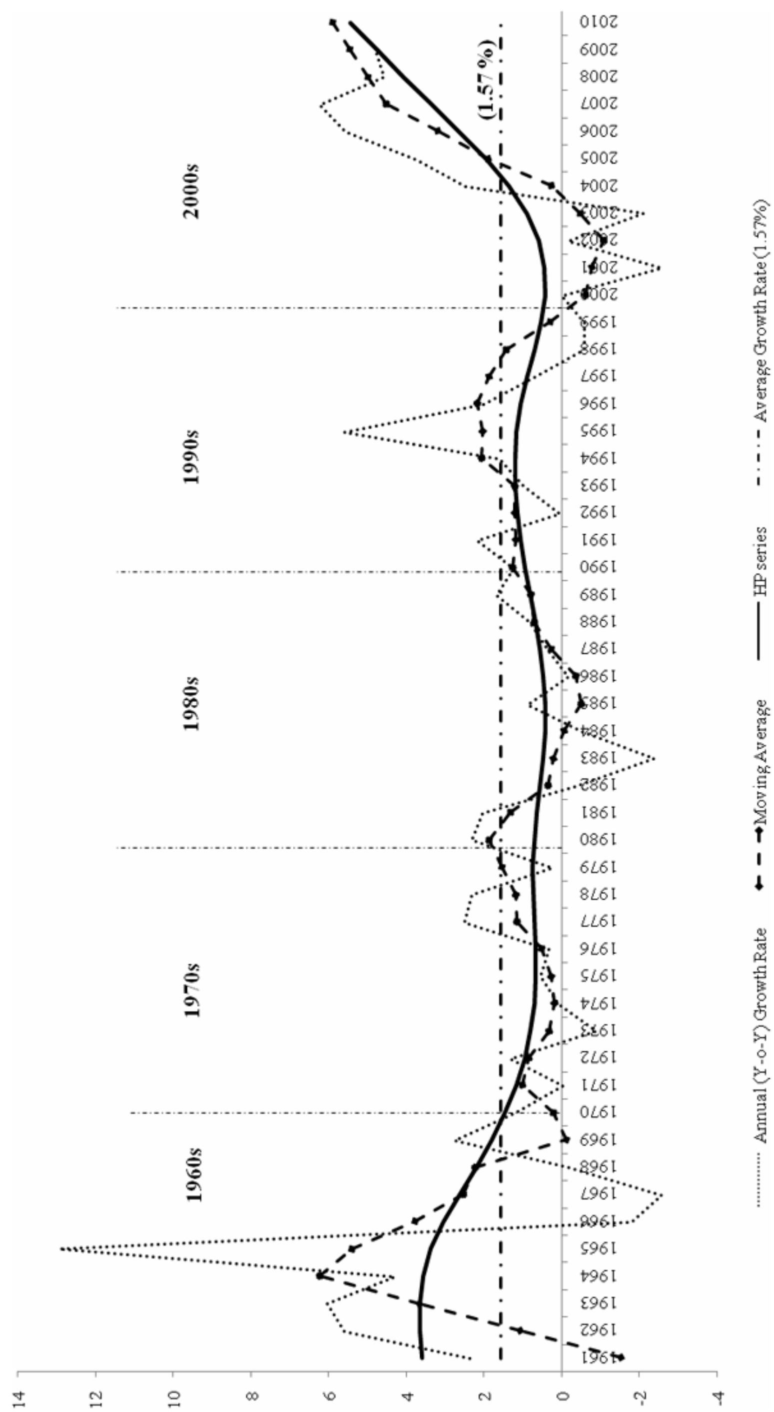


Table 7. CAGR of Employment in the Private Sector by Industry (Per cent)

Industry/Decade	1960s	1970s	1980s	1990s	2000s
(1)	(2)	(3)	(4)	(5)	(6)
1. Agriculture, Livestock, Forestry and Fishing	1.11	-0.23	0.54	0.41	0.52
2. Mining and Quarrying	-4.51	-12.11	0.58	-3.79	4.73
3. Manufacturing	2.68	1.24	0.01	1.17	-0.44
4. Electricity, Gas, Water and Sanitary Services	2.03	-2.86	1.71	0.23	3.43
5. Construction	-2.90	-8.44	-0.76	-2.23	3.25
6. Wholesale and Retail Trade, Etc.	7.60	-2.34	0.82	1.12	2.78
7. Transport, Storage and Communications	-1.12	-4.91	-2.00	2.81	7.04
8. Financing, Insurance, Real Estate	--	8.97	1.61	2.76	15.21
9. Community, Social and Personal Services	15.04	0.72	2.63	1.34	2.15
Total	**3.01**	**0.46**	**0.66**	**1.00**	**1.63**

Thus, the analysis for the private sector yields diverging results. The CAGR portray a better and an optimistic picture for the post-liberalisation era, with the impetus coming mainly from the tertiary sector. The manufacturing sector fails to contribute to employment in the private sector. The trends, on the other hand, depict the unpredictable nature of employment growth. Overall, the decade of the 2000s; especially post 2004, seems to be assuring and conducive for employment growth in most of the industries of the private sector; especially related to the infrastructure and services. The manufacturing sector is nevertheless the real worrisome sector, which should normally be the driving force in employment generation.

5. AN INVESTIGATION OF THE TRENDS IN EMPLOYMENT

An in-depth scrutiny of the organised employment, leads to the conclusion that, the performance of the organised sector in employment generation has been weak throughout the period of analysis. This weak performance can be attributed to the demographic, economic and social changes that the country has gone through in the past 64 years. In addition to these factors, the development and the industrial policies adopted from time to time have also played a crucial role in moulding employment structure of the country. It can be certainly deduced that the developmental policies have failed to absorb more labour in the formal sector. The structure of organised employment is thus, influenced by a host of factors and has, in turn, acted upon them.

The major threat to the potential performance of the organised sector employment stems from its weak absorption capacity to accommodate substantial number of employees from the informal sector. Mounting population has further added to the challenge of maintaining a harmony between the growing labour force and decent employment opportunities, pushing the economy in-to further informalisation, casualisation and degradation of quality employment. Therefore, the formal sector's growth has proved grossly inadequate to absorb the growing labour force being driven into the non-farm sector.

The phase of absolute control (till the mid 1980s) was highly conducive to the growth of the public sector, with the private sector playing a subsidiary role by design. The industrial policies during this phase were tuned towards the public sector, leading to the establishment of a large number of public sector enterprises in the core areas and extensive nationalisation of many industries (crude oil, coal, iron and steel, railways, defence, electricity, etc.). The public sector employment in this period was, therefore, substantial. This rise can also be ascribed to the nationalisation of 14 major commercial banks (1969) and industries like coal (1971, 1974) and oil (1974). The economy also witnessed nationalisation of General Insurance Companies as the wholly government owned public sector enterprises. The year 1980 further saw the nationalisation of 6 additional commercial banks. However, the growth in the public sector enterprises was highly characterised by low productivity, mainly due to over-staffing in these enterprises. Moreover, most of the public sector enterprises were daunted by technological backwardness leading to low profitability and surging losses. As a result of this, an initiative towards reviving the efficiency of the public sector enterprises in areas like capacity expansion up to 5 per cent per annum, finance, operations, management, marketing, information systems, etc. leading to partial liberalisation was launched in the late 1980s [Jadhav, 2005]. Employment growth rate in public sector remained modest at 2.29 per cent in the 1980s. The reforms of 1991, however, further connoted these enterprises as a 'national burden than an asset' due to their low productivity, lack of technological up-gradation and over-manning [Tendulkar and Bhavani, 2007]. The public sector growth model was replaced by the one based on market oriented open economy.

Under the New Economic Policy of 1991, efficiency was accorded the highest place, leading to the process of downsizing by the public sector enterprises by shedding the excess labour. Voluntary retirement schemes and compulsory retirement schemes (also known as the 'Golden Handshake') were implemented on a massive scale and the use of contract labour and outsourcing was encouraged. Moreover, the technology acquired in the name of up-gradation was capital-intensive, that is, one with limited employment generation capacity. This resulted in a dip in the public sector employment, the decline being more pronounced since the decade of the 2000s. In addition to this, our analysis also pointed out the distressing performance of the public sector employment by branch (particularly in the segment of the 'White-collar Employees' [Tendulkar and Bhavani, 2007]). This clearly indicates during the post 1991 period Reform unwillingness of the government towards employment generation within the public sector. Though downsizing of the public sector employment was one of the objectives of the New Economic Policy, with the rise in population, it was necessary to accelerate employment in this segment to enhance the efficiency in service provision, particularly in education, health, law and order and administration, as it forms an important element of the state machinery. Thus, re-structuring should have really meant rationalisation of the use of labour and expanded output and public services. However, the results indicate a descent, implying that the functioning of the state is not at its optimal level of employment.

The private sector, on the other hand, was promoted as a complement to the public sector wherever necessary. The industrial policies of 1948 and 1956 did emphasise the importance of private sector along with foreign companies as the development agents. The share of private sector in employment was, therefore, considerable till the year 1965. However, after the devaluation of the rupee due to foreign exchange crisis in 1966, the domestic environment became more restrictive and selective, not conducive to the private sector development. As a consequence of the stringent stance, the share of the private sector in employment generation began to collapse. This situation changed with the neo-liberal reforms of 1991, as a part of which the scope of the private sector was up-lifted and was made the corner stone of the development policy. The reforms also opened doors to foreign investors in most of the private sector industries, thereby encouraging many collaborations and joint ventures with the Indian firms. Employment in the private sector thus began to rise, especially in the tertiary sector ('services led growth').

However, it is often argued that, the private sector was expected to generate much more employment after liberalisation than what materialised. The private sector enterprises are also casting off their labour, in order to be competitive and, in a quest to up-grade themselves, are embracing technologies which do not cater to employment growth. For example, the *Report of the Task Force on Employment Opportunities* of the Planning Commission (GOI, 2001) states that due to increased competition in the post liberalisation period, existing private sector units are shedding their labour and relenting to technologies which are more automated and do not help job creation. Also, the proportion of contracting and outsourcing is enormous in the private sector (twice that of the public sector), adding to informalisation within the organised segment rather than the growth of quality employment [Anant, 2004; Datt, 2007].

One of the notable findings of the paper is the disappointing contribution of the manufacturing sector amongst all industry groups, especially since the 1980s. Most of the studies [Papola, 1991; Goldar, 2000; Anant, 2004; Rangarajan, 2004; NCEUS, 2009] point out that the use of highly capital-intensive imported technology with limited employment generation capacity, job security regulations and rise in contract labour are some of the reasons behind this underperformance. However, Papola [1991] argues in this context that, while assessing employment potential of the manufacturing sector, it is important to note that most of the manufacturing employment is in the unorganised sector, leaving little scope for the organised one. He further points out that the Indian industry is witnessing a structural change from primary raw material based to metal based processed industries. This involves the use of high technology to ensure high productivity, thereby restricting employment generation potential of the output. He attributes part of the decline in the organised manufacturing to this change. According to him, organised manufacturing will, therefore, not help in creating substantial employment in the near future. Moreover, in the late 1990s, many industries in the manufacturing sector adopted business process re-engineering (BPR), where plant is redesigned to bring about an organisational and a structural change. This also led to the reduction in the workforce previously required. In the late 1990s, Mahindra and Mahindra, an Indian company primarily engaged in the manufacturing of automotive components and farm equipments undertook BPR for its organisational restructuring. It was found that in the post BPR period, around 100 officers produced 35 engines a day compared to 1,200 workers producing 70 engines in the period before BPR [Mahindra, 1996]. Similar evidence can be encountered in case of Ford Motors also [Ford, 2013].

Considering the weak performance of the manufacturing sector, the Government of India, for the first time, announced a separate policy, known as the 'National Manufacturing Policy (NMP)' [GOI, 2011b]. It has been recognised in the NMP that employment generation in the manufacturing sector is of crucial importance as jobs created in this sector have multiplier effect of creating additional jobs in related activities. Moreover, it is observed that India has a vast pool of human resources, with majority of population in the age group of 15 to 59. Thus, the manufacturing sector has the potential of generating around 220 million job opportunities by 2025. In order to achieve this, NMP emphasised on employment intensive industries such as textiles and garments, leather and footwear, gems and jewellery and food processing. Significant importance has also been placed on the small scale enterprises as they provide employment to diversified sets of people. Increase in the rate of job creation is considered necessary to create additional employment opportunities of about 100 million by 2022. Setting up of National Investment and Manufacturing Zones (NIMZ) is proposed in the policy to absorb surplus labour force [GOI, 2011b]. The policy further states that only six per cent of population in India receives proper vocational and skill development training, thereby leading to constrained growth. Therefore, imparting necessary skills through skill development programmes has been given substantial importance in the NMP. However, the NMP implicitly focuses on the private sector and small scale enterprises for employment generation.

The tertiary sector, on the other hand, displays better performance during the post-reform period, with the impetus coming mainly from the private sector. The share of the public sector, on the other hand is dismal. The process of liberalisation triggered services led growth in India and the contribution of services to total output is continuously growing since then. The service sector also encourages, foreign direct investment inflows of the country [GOI, 2011c]. Despite this, most of the studies [Gordon and Gupta, 2003; Joshi, 2004; Joshi, 2008] indicate that the contribution of the service sector to employment generation is much less compared to its share in total output. They further point out that, unlike manufacturing, the services sector also consists of massive informal sector in the industries like trade and personal services (beauty shops, laundry, tailors, barbers, hawkers, dressers, washer men, maids, etc.). The main impulse to the growth in organised services sector comes from the financial and business services, followed by transport and communication and wholesale and retail trade. Within the financial services, banking and especially the NBFCs lead the growth, while road transport and telecommunications dominate the transport and communication industry. On the other hand, the contribution of public administration, defence, storage and dwellings in real estate is much less compared to the others. In the social services segment, education and health care are the frontrunners, followed by other services like recreation, radio, TV broadcast, sanitary services, etc. [Gordon and Gupta, 2003; Joshi, 2004; Joshi, 2008; Eichengreen and Gupta, 2010]. Therefore, employment in these segments is considerable as depicted in Table 7. In addition to it, foreign direct investment in these sectors is also enormous, lending a supportive hand in employment generation. For example, FDI inflows are the highest in the financial and non-financial services segment [GOI, 2011c]. The analysed trends also indicate high employment growth rate in this sector.

6. CONCLUSIONS

The examination of employment in the organised sector of India brings out its deteriorating condition throughout the entire period of analysis from 1961 to 2010. The sector has never displayed an improving trend, in spite of the adoption of numerous dynamic policy measures for its upliftment. The maximum burden of employment generation in the economy is, therefore, borne by the informal sector. The period of socialistic growth was contributive towards the public sector development. However, unlike the decade of the 1960s, its performance was not up to the mark in the decade of the 1970s and the 1980s. The private sector employment was also dismal during this phase, especially during the 1970s, as a consequence of the rigid approach towards it. With the initiation of the reforms, the organised employment was expected to takeoff, with the private sector leading this change. The analysis has nevertheless revealed a further deterioration, especially in the public sector. The public sector employment has been severely hit due to the reforms, possibly necessitated to keep the fiscal deficit under control, despite huge unemployment in the economy. The private sector employment has enhanced after 13 years of liberalisation, that is, since 2004. The rise is mainly in the tertiary segment but has failed to fill in the huge employment gap in the industrial sector.

The era of liberalisation is, therefore, characterised by jobless growth in most of the sectors. The industrial sector, particularly manufacturing, is not contributing enough towards generating employment in the economy. Employment in the services sector is modest, but the whole responsibility is carried out by the private sector and not the public sector. It can be further argued that India being a labour abundant country, the technology implemented in order to ensure high efficiency, has worked against employment growth due to its capital-intensive nature. This, in turn, has added to the growing informalisation and casualisation of work. Many firms are resorting to contract labour and outsourcing to bypass the labour laws which make the application of 'Hire and Fire' principle difficult. However, the added pressures of industrial unrest forced many industries to go for flexible labour force to meet the cyclical swings in demand for their products and to be competitive in the global market, for example, Maruti Suzuki, Hero Honda, Rico, Hyundai, Sona Koya, etc. [FICCI, 2012]. Under these circumstances, as India marches upwards its economic ladder, employment generation potential of the organised sector is expected to worsen further and is bound to be limited.

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Appendix: A

Kinked Exponential Models:

The kinked exponential models [Boyce, 1986] are useful to estimate the 'discontinuous' growth rates of the various sub-periods in the time series. In the conventional method, the growth rates for each sub-period are computed separately through OLS techniques, which lead to a discontinuous trend line. The kinked model eliminates this discontinuity between the segments by imposing linear restrictions on them. If the time series is then estimated with the help of log linear models, this approach yields kinked exponential functions and the resulting growth rate is connoted as the kinked exponential growth rate.

In the first step, the time series to be estimated is broken at point 'k', that is, it is separated from one sub-period to the other and each sub-period is assigned a dummy variable 'D_j. This dummy variable takes the value 1 in the j[th] period and 0 otherwise. The discontinuity between the trend lines of the sub-periods is then eliminated through a linear restriction that makes these lines intersect at the break point 'k'.

Let 't' be the time series such that t = 1, 2..., n. If the number of sub-periods are m, we will derive at m - 1 kinks which can be denoted as $k_1, k_2, ..., k_{m-1}$. The sub period dummies accordingly will be $D_1, D_2, ..., D_m$. If the general unrestricted model is,

$$\ln Y_t = \alpha_1 D_1 + \alpha_2 D_2 + \ldots + \alpha_m D_m - (\beta_1 D_1 + \beta_2 D_2 + \ldots + \beta_m D_m)t + u_t \quad \ldots(A1)$$

Applying the m-1 restrictions as, $\alpha_i + \beta_i k_i = \alpha_{i+1} + \beta_{i+1} k_i$ the generalised kinked exponential model can be expressed as,

$$\begin{aligned}\ln Y_t = {} & \alpha_1 + \beta_1(D_1 t + \textstyle\sum_{j=2}^{m} D_j k_1) \\ & + \beta_2(D_2 t - \textstyle\sum_{j=2}^{m} D_j k_1 + \sum_{j=3}^{m} D_j k_2) + \ldots\ldots \\ & + \beta_i(D_i t - \textstyle\sum_{j=i}^{m} D_j k_{i-1} + \sum_{j=i+1}^{m} D_j k_i) + \ldots\ldots \\ & + \beta_m(D_m t - D_m k_{m-1}) + U_t \qquad (A2)\end{aligned}$$

This model can be estimated with the help of standard OLS techniques. There is a kink between the two trend lines whenever $\hat{\beta}_1 \neq \hat{\beta}_2$ and so on, depending upon the number of sub-periods. The advantage of this model over the simple OLS model is that, it is less affected by instability and cyclical fluctuations as it eliminates the discontinuity bias. Moreover, it takes in-to account the full set of information of the time series to be analysed.

The paper makes use of the kinked exponential model up to four kinks, where Y_t is the number of persons employed in the time period t. The CAGR are calculated by the semi-log method, b first taking antilogs of the slope coefficients and then subtracting one from it. This value is then multiplied by 100, to express it in the percentage form [Gujarati, 1995].

Appendix: B

The Hodrick-Prescott Filter:

The Hodrick - Prescott filter is a tool designed to represent a given time series as the sum of a growth component that varies smoothly over the period of time and a cyclical component. A smoothed non linear time series trend is obtained as a result of it. This tool was first devised by Robert Hodrick and Edward Prescott in the year 1997. The time series can be stated as,

$$Y_t = g_t + c_t \quad \text{for } t = 1, 2, \ldots\ldots, T \qquad \ldots.. (B1)$$

Where, g_t is the growth component and c_t is the cyclical component.

The decomposition procedure for determining the growth process can be stated as,

$$\min_{(g_t)} \sum_{t=1}^{T} (Y_t - g_t)^2 + \lambda \sum_{t=2}^{T-1} [(g_{t+1} - g_t) - (g_t - g_{t-1})]^2 \qquad \ldots\ldots(B2)$$

The first term measures the fitness of the series. The parameter λ is a positive number which penalises the variability in the growth component. It determines the smoothness of the series. Hodrick and Prescott (1997) argue that larger the value of λ, smoother is the obtained filtered series. If the value of λ is close to zero the growth trend is equivalent to the original series and it converges to a linear trend as the value of λ reaches infinity. Hodrick and Prescott used 1600 as the value of λ for the quarterly data in their analysis. But often for the annual data a λ value of 100 is used. The paper makes use of this value for the calculation of the HP filtered series using Microsoft Office Excel Add in package.

Appendix: C

Table C1. Total Employment

(Persons in Lakh)

Year	Public Sector	Private Sector	Total Employment
(1)	(2)	(3)	(4)
1961	70.50	50.40	120.90
1962	74.17	51.60	125.77
1963	79.53	54.50	134.03
1964	84.54	57.80	142.34
1965	89.57	60.30	149.87
1966	93.78	68.10	161.88
1967	96.34	66.90	163.24
1968	98.02	65.20	163.22
1969	101.06	65.10	166.16
1970	103.73	66.90	170.63
1971	107.29	67.70	174.99
1972	113.05	67.70	180.75
1973	119.74	68.60	188.34
1974	124.85	68.00	192.85
1975	128.83	68.07	196.90
1976	133.22	68.45	201.67
1977	137.67	68.69	206.36
1978	141.98	70.43	212.41
1979	146.75	72.08	218.83
1980	150.79	72.27	223.06
1981	154.84	73.95	228.79
1982	159.47	75.48	234.95
1983	164.57	75.22	239.79
1984	168.65	73.45	242.10
1985	172.70	73.09	245.79
1986	176.84	73.74	250.58
1987	180.24	73.64	253.88
1988	183.20	73.92	257.12
1989	184.47	74.55	259.02
1990	187.62	75.82	263.44
1991	190.58	76.77	267.35
1992	192.10	78.46	270.56
1993	193.27	78.51	271.78
1994	194.45	79.30	273.75
1995	194.65	80.58	275.23
1996	194.30	85.11	279.41
1997	195.59	86.84	282.43
1998	194.19	87.48	281.67
1999	194.15	86.98	281.13
2000	193.14	86.49	279.63
2001	191.39	86.51	277.90
2002	187.74	84.32	272.06
2003	185.81	84.20	270.01
2004	181.98	82.45	264.43
2005	180.06	84.52	264.58
2006	178.73	87.71	266.44
2007	176.88	92.60	269.48
2008	172.84	98.38	271.22
2009	174.75	102.91	277.66
2010	175.05	107.87	282.92

Source: (GOI, 2012) (Various Issues)

Table C2. Employment in Public Sector by Industry

(Persons in Lakh)

Year	Agriculture, Livestock, Forestry and Fishing	Mining and Quarrying	Manu-facturing	Electricity, Gas, Water and Sani-tary Ser-vices	Constructio n	Wholesale and Retail Trade Etc.	Transport, Storage and Communi-cations	Financing, Insurance, Real Estate	Community, Social and Personal Services
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1961	1.80	1.29	3.69	2.24	6.03	0.94	17.24	0	37.27
1962	1.74	1.45	4.21	2.34	6.41	1.09	17.97	0	38.96
1963	1.82	1.60	5.09	2.44	6.62	1.20	18.86	0	41.90
1964	2.03	1.57	5.81	2.64	7.15	1.33	19.37	0	44.64
1965	2.09	1.61	6.35	2.91	7.40	1.43	20.44	0	47.34
1966	2.26	1.60	6.70	3.03	7.66	1.55	20.94	0	50.04
1967	2.32	1.76	6.95	3.37	7.63	1.66	21.15	0	51.50
1968	2.46	1.74	7.31	3.46	7.55	1.77	21.37	0	52.36
1969	2.61	1.74	7.57	3.69	7.88	2.64	21.59	0	53.34
1970	2.64	1.77	7.82	4.02	7.97	2.88	21.88	0	54.75
1971	2.76	1.82	8.06	4.34	8.80	3.28	22.16	0	56.07
1972	2.89	2.55	8.85	4.63	9.22	3.78	22.56	0	58.57
1973	3.05	4.36	9.62	4.94	10.17	4.16	23.03	0	60.41
1974	3.24	6.06	10.27	5.37	9.97	4.49	23.13	0	62.32
1975	3.34	6.94	10.19	5.08	9.56	0.53	23.64	5.11	64.44
1976	3.59	7.19	11.13	5.36	9.92	0.56	24.18	4.9	66.39
1977	3.66	7.57	12.26	5.63	10.09	0.76	24.67	5.34	67.69
1978	3.87	7.58	13.55	5.99	9.98	0.83	25.2	5.8	69.18
1979	4.08	7.71	14.16	6.34	10.32	0.99	25.97	6.47	70.71
1980	4.31	7.97	14.46	6.61	10.68	1.10	26.51	6.91	72.24
1981	4.63	8.18	15.02	6.83	10.89	1.17	27.09	7.48	73.55
1982	4.57	8.32	15.92	6.98	11.12	1.13	27.81	8.15	75.47
1983	4.76	8.84	16.34	7.21	11.20	1.18	28.26	8.72	78.06
1984	4.89	9.27	17.17	7.32	11.19	1.24	28.64	9.13	79.80
1985	4.98	9.74	17.61	7.60	11.46	1.31	28.94	9.83	81.23
1986	5.26	9.66	18.15	7.85	11.81	1.31	29.29	10.3	83.21
1987	5.57	9.42	18.62	7.89	11.85	1.34	29.7	10.56	85.29
1988	5.54	9.56	18.67	8.49	12.14	1.39	30.11	10.95	86.35
1989	5.55	9.56	18.63	8.69	11.46	1.50	29.74	11.23	88.11
1990	5.49	9.66	18.70	8.97	11.34	1.50	30.23	11.54	90.19
1991	5.56	9.99	18.52	9.05	11.49	1.50	30.26	11.94	92.27
1992	5.73	9.87	18.61	9.16	11.51	1.57	30.64	12.14	92.87
1993	5.62	9.97	18.51	9.31	11.54	1.48	30.55	12.52	93.77
1994	5.45	10.15	17.84	9.38	11.67	1.61	30.84	12.73	94.78
1995	5.39	10.16	17.56	9.35	11.64	1.62	31.06	12.83	95.04
1996	5.40	9.93	17.38	9.46	11.59	1.62	30.92	12.8	95.20
1997	5.33	9.78	16.61	9.56	11.34	1.64	30.92	12.94	97.47
1998	5.30	9.37	16.16	9.54	11.09	1.64	30.84	12.88	97.37
1999	5.15	9.26	15.69	9.62	11.07	1.63	30.84	12.95	97.94
2000	5.14	9.24	15.31	9.46	10.92	1.63	30.77	12.96	97.71
2001	5.02	8.75	14.30	9.35	10.81	1.63	30.42	12.81	98.30
2002	4.83	8.61	13.50	9.23	10.26	1.57	30.09	12.3	97.35
2003	5.06	8.47	12.60	9.13	9.48	1.82	29.39	13.77	96.09
2004	4.93	10.30	11.89	8.74	9.32	1.81	28.15	14.08	92.76
2005	4.96	10.14	11.30	8.60	9.11	1.84	27.51	14.08	92.52
2006	4.69	11.46	10.92	8.49	8.94	1.82	26.75	13.9	91.76
2007	4.75	11.37	10.87	8.49	8.66	1.78	26.37	13.69	90.90
2008	4.71	11.21	10.44	7.96	8.52	1.65	26.34	13.47	88.54
2009	4.77	11.12	10.60	8.39	8.45	1.74	26.01	13.56	90.11
2010	4.78	11.03	10.66	8.35	8.59	1.71	25.29	14.13	90.51

Source: (GOI, 2012) (Various Issues)

Table C3. Employment in Public Sector by Branch

(Persons in Lakh)

Year	Central Government	State Government	Quasi Government	Local Bodies
(1)	(2)	(3)	(4)	(5)
1961	20.90	30.14	7.73	11.73
1962	21.86	30.87	8.79	12.65
1963	23.29	31.98	9.95	14.31
1964	24.34	34.33	10.97	14.90
1965	25.68	35.85	12.06	15.98
1966	26.36	37.23	13.18	17.01
1967	26.87	37.67	14.02	17.78
1968	27.15	38.03	14.84	18.00
1969	27.13	39.01	16.55	18.25
1970	27.25	39.97	17.94	18.58
1971	27.71	41.52	19.29	18.78
1972	28.54	43.57	21.75	19.19
1973	29.18	45.79	25.78	19.00
1974	29.39	47.06	29.12	19.28
1975	29.89	47.68	31.92	19.41
1976	30.47	48.97	33.92	19.85
1977	30.82	50.20	36.75	19.89
1978	30.96	51.60	39.29	20.15
1979	31.34	53.09	41.70	20.63
1980	31.78	54.78	43.43	20.80
1981	31.95	56.76	45.76	20.37
1982	32.49	58.53	48.12	20.33
1983	32.66	60.38	50.40	21.11
1984	33.11	61.53	52.72	21.30
1985	33.29	62.80	54.96	21.64
1986	33.46	64.73	56.74	21.90
1987	33.50	66.66	57.95	22.14
1988	33.81	67.81	59.48	22.11
1989	33.95	68.29	59.99	22.38
1990	33.97	69.79	61.73	22.23
1991	34.10	71.12	62.22	23.13
1992	34.28	71.90	63.93	21.98
1993	33.83	72.93	64.90	21.60
1994	33.92	73.37	65.14	22.02
1995	33.95	73.55	65.20	21.97
1996	33.66	74.14	64.58	21.92
1997	32.95	74.85	65.35	22.44
1998	32.53	74.58	64.61	22.46
1999	33.13	74.58	63.85	22.59
2000	32.73	74.60	63.26	22.55
2001	32.61	74.25	61.92	22.61
2002	31.95	73.84	60.20	21.75
2003	31.33	73.67	59.01	21.79
2004	30.27	72.22	58.22	21.26
2005	29.38	72.02	57.48	21.18
2006	28.60	73.00	59.09	21.18
2007	28.00	72.09	58.61	21.32
2008	27.39	71.71	57.96	19.68
2009	26.60	72.38	58.44	20.73
2010	25.52	73.53	58.68	20.89

Source: (GOI, 2012) (Various Issues)

Table C4. Employment in Private Sector by Industry

(Persons in Lakh)

Year	Agriculture, Livestock, Forestry and Fishing	Mining and Quarrying	Manu-facturing	Electricity, Gas, Water and Sani-tary Ser-vices	Constructio n	Wholesale and Retail Trade Etc.	Transport, Storage and Communi-cations	Financing, Insurance, Real Estate	Community, Social and Personal Services
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1961	6.7	5.5	30.2	0.4	2.4	1.6	0.8	0	2.8
1962	7.4	4.8	30.5	0.4	1.8	1.9	1.2	0	3.6
1963	7.4	5.2	32.7	0.4	1.8	1.9	1.4	0	3.7
1964	9.1	5.0	34.2	0.4	1.7	2.0	1.1	0	4.3
1965	8.9	4.9	36.1	0.4	1.9	2.2	1.1	0	4.8
1966	9.0	5.1	38.6	0.4	2.5	3.3	1.2	0	8.0
1967	8.7	4.8	37.5	0.4	2.3	3.5	1.2	0	8.5
1968	8.5	4.3	37.1	0.5	1.5	3.5	1.0	0	8.8
1969	8.1	4.2	37.7	0.4	1.5	2.9	1.1	0	9.2
1970	8.2	4.3	39.0	0.4	1.5	2.9	1.0	0	9.6
1971	8.0	4.1	39.7	0.5	1.4	3.0	1.0	0	10.0
1972	8.1	3.5	39.8	0.5	1.6	3.0	0.8	0	10.4
1973	8.1	2.5	41.0	0.5	1.8	3.1	0.8	0	10.8
1974	8.1	1.3	41.8	0.4	1.2	3.2	0.8	0	11.2
1975	8.18	1.23	41.11	0.39	1.27	3.09	0.79	1.69	10.32
1976	8.27	1.32	41.58	0.35	0.94	2.87	0.74	1.83	10.55
1977	8.38	1.3	41.65	0.35	0.83	2.75	0.71	1.86	10.86
1978	8.53	1.27	43.21	0.34	0.83	2.74	0.61	1.8	11.1
1979	8.41	1.24	44.33	0.34	0.83	2.81	0.71	2.01	11.4
1980	8.6	1.25	44.17	0.34	0.73	2.74	0.71	2.06	11.67
1981	8.58	1.3	45.45	0.35	0.72	2.77	0.6	1.96	12.22
1982	8.51	1.29	46.61	0.36	0.71	2.77	0.6	2.04	12.59
1983	8.47	1.2	46.26	0.37	0.68	2.75	0.59	2.07	12.83
1984	8.19	1.13	44.73	0.39	0.66	2.76	0.57	2.14	12.88
1985	8.07	1.13	44.21	0.39	0.7	2.77	0.54	2.19	13.09
1986	8.22	1.11	44.48	0.4	0.69	2.77	0.54	2.21	13.32
1987	8.48	0.91	44.1	0.4	0.58	2.77	0.52	2.29	13.59
1988	8.44	0.93	43.95	0.41	0.5	2.83	0.51	2.38	13.97
1989	8.68	0.96	43.83	0.39	0.69	2.86	0.51	2.34	14.29
1990	8.76	0.99	44.57	0.4	0.68	2.91	0.52	2.39	14.6
1991	8.91	1.0	44.81	0.4	0.73	3.0	0.53	2.54	14.85
1992	9.12	1.07	45.66	0.4	0.78	2.96	0.54	2.66	15.27
1993	9.16	0.96	45.45	0.38	0.73	3.01	0.55	2.77	15.5
1994	8.83	1.01	46.3	0.4	0.51	3.02	0.56	2.82	15.85
1995	8.94	1.03	47.06	0.4	0.53	3.08	0.58	2.93	16.03
1996	9.19	1.07	50.49	0.42	0.53	3.17	0.6	3.06	16.58
1997	9.12	0.92	52.39	0.41	0.54	3.17	0.63	3.22	16.44
1998	9.04	0.91	52.33	0.42	0.74	3.21	0.65	3.41	16.77
1999	8.71	0.87	51.78	0.41	0.71	3.23	0.69	3.58	17.0
2000	9.04	0.81	50.85	0.41	0.57	3.3	0.7	3.58	17.23
2001	9.31	0.79	50.13	0.52	0.57	3.39	0.76	3.7	17.34
2002	8.55	0.68	48.67	0.42	0.56	3.35	0.76	3.91	17.42
2003	8.95	0.66	47.44	0.5	0.44	3.6	0.79	4.26	17.56
2004	9.17	0.65	44.89	0.47	0.45	3.51	0.81	4.58	17.92
2005	9.83	0.79	44.89	0.49	0.49	3.75	0.85	5.23	18.2
2006	10.28	0.95	45.49	0.4	0.55	3.87	0.87	6.52	18.78
2007	9.5	1.0	47.5	0.5	0.7	4.1	1.0	8.8	19.5
2008	9.92	1.11	49.7	0.51	0.69	2.72	1.04	10.96	21.73
2009	8.96	1.15	51.98	0.64	0.8	4.72	1.32	13.11	20.23
2010	9.23	1.61	51.84	0.64	0.91	5.06	1.66	15.52	21.4

Source: (GOI, 2012) (Various Issues)

PROMOTING INCLUSIVE PRODUCTION AND GROWTH THROUGH SELF HELP GROUPS

Anuradha Kalhan

This study surveyed beneficiaries over 2009-12 of a 'Sustainable Livelihood' oriented scheme, Swaran Jayanti Shahari Rozgar Yojna (SJSRY), launched in 1997. Funded by the Centre and the State in the ratio of 75:25, it aims to spawn micro enterprises, provide skills / training to individuals and Self-Help Groups and create a self-managed hierarchy of local management institutions with groups, societies and federations. The study compares the nature of human, social and physical capital generated within Self-Help Groups (SHG) sponsored by the municipal corporation with a control group of non-beneficiaries in the slums of Mumbai, to find that the beneficiaries experience an accelerated frequency of human and social capital formation. SHGs also invested in micro enterprises given access to credit and training. This is occurring despite the fact that beneficiaries were women at a lower income level, most having been targeted as poor by the Municipal Corporation of Greater Mumbai. The survey finds that the SHG members are improving their human and social capital; the paper suggests policies to strengthen and replicate the policy in other urban centers where the poor are amassing. The sustenance of inclusive production is perhaps the only viable foundation of inclusive growth.

Introduction

The discourse on policy for poverty alleviation and employment generation has now come to converge upon one position, The Sustainable Livelihood Approach [GOI, Planning Commission October 2011]. Policy, at last, recognises a bottleneck in skill development besides the need to preserve old livelihoods, wherever possible, while trying to spawn new ones at an adequate rate to absorb the substantial backlog of unemployment. It acknowledges the intimate link between loss of livelihood and poverty, the rather tenuous link between economic growth and employment and hence the need to escalate support for the tiny-sector enterprise.

Without proposing to do so, this sustainable livelihood approach provides an opportunity to reconsider the tendency of market driven growth to decrease the employment elasticity of growth while increasing the levels of concentration of economic power across all productive sectors of the economy as it drives out small and tiny enterprises.

Three forces today have the potential to conflate and provide new opportunities to the tiny sector, in addition to a counter current to economic concentration in the long run; first, the surge of a more literate, skilled, youthful work-force; second, technology driven free flow of information, ideas; and third, again technology driven possibilities of decentralised, efficient, small scale production.

For those who express concern that tiny sector inherently sacrifices economies of scale it would be worth considering that changes in technology like computer aided manufacturing, additive manufacturing, discovery of new materials that assist 3D printing, web based services, rapidly changing fashions and demand are rapidly changing the minimum efficient scale of production in many products. They are making geography and location increasingly irrelevant in production and will continue to do so. Manufacturing and service clusters of small enterprises in flexible specialisation will be the cradle of new industrial waves [*The Economist*, 21 April 2011].

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It is in this setting that the Livelihoods Approach must integrate and fashion a short, medium and long term vision for socio economic inclusion that goes beyond redistributing gains from growth to more inclusive production. This study suggests that there is potential at the bottom of the pyramid not just for consumption but for production, for ownership of the means as well as skills of production and organisation for production. The very short term agenda of a livelihood based policy must be to support self-employment for individuals or groups by providing credit and extension services. This will help accelerate the pace of human, social and physical capital formation at the bottom of the pyramid (as this field study in Mumbai slums suggests). The medium term agenda would be to identify the successful enterprises for up-skilling and up-scaling, supporting cluster formations and increasing the credit and extension services provided to them in a time bound fashion. The long term goal would be to create federations of small producers, producers' companies, cooperatives or other inclusive forms of organisations for advantages that may accrue to members in terms of economies of scale / scope and access to markets and credit. This process would have the potential of setting off an urban revolution of sorts by creating a culture of self organisation and entrepreneurship.

This paper examines the impact of one such livelihood based policy in India, Swaran Jayanti Shahari Rozgar Yojna (SJSRY) for the urban poor, by a survey of the participants and non-participants and by comparing the results. SJSRY was launched on 1 December 1997 and subsumes three earlier schemes for poverty alleviation, namely, Nehru Rozgar Yojna, Urban Basic Services for the poor, and Prime Minister's Integrated Urban Poverty eradication programme. SJSRY had three objectives: 1) encourage self-employment ventures and support their sustainability, 2) support skill development and training programme, and 3) create suitable self-managed community hierarchical-structures like neighborhood groups, committees and society.

An important component of the policy is to sponsor and support Self Help Groups (SHGs). The funds are routed through the State Government and the actual implementation is undertaken by Municipal Corporations. In Mumbai, the programme is implemented by the Urban Poverty Eradication Cell, established at the Municipal Corporation of Greater Mumbai. SJSRY is the vehicle of facilitation and delivery of micro credit. Under it, BPL members will be subsidised to set up micro enterprises as individuals or in groups, given employment to improve infrastructure, will enjoy reservation in certain work sectors, and all members will be given vocational and technical training.

The process works like this, a group of women usually living close by in slums or chawls and known to each other, form a group through self-selection, of between 10-20 members (now reduced to five), elect a president and secretary, and open a bank account in the group's name after completing the required paper work and identification formalities. They meet regularly, at least once a month, and save an agreed amount per member, per month, and deposit it in the group's bank account. A group pass book is maintained and monitored by the bank official in charge of this programme. After a year of satisfactory performance, the group is entitled to a loan of up to Rs. 2.5 lakh. The clearance depends on the project proposal and discretion of bank officials. Of the sanctioned amount not more than Rs.1.25 lakh is released to begin with. Interest is charged only on the amount released. The government subsidises their loan. The interest is usually less than or equal to 12 per cent per annum. The loan is disbursed to the group, which is responsible for repayment of interest and principal amount. The repayment is worked out within the group in the form of equal monthly installments (EMI). The group takes a collective decision on how the amount is to be used and by which member / members of the group.

The Objective

The aim of the study was to understand nature of human, social and physical capital formation in informal employment in the context of micro-finance and self-help group formations; it intersects four areas of concern in contemporary development policy in India, and in the developing world at large:

First, the informal sector is now the fastest growing sector for employment as well as survival. Report of the National Commission for Enterprises in the Unorganised Sector highlights the situation within this sector in India [GOI, National Commission for Enterprises in the Unorganised Sector 2006; Sundaram and Tendulkar 2004, Pp. 5125-32; Sundaram 2007]

Second, the pace of rural to urban migration and the resulting urban expansion are accelerating [Mohan 2005, Sridhar 2007]. Estimates indicate that it is faster than rates of urbanisation in the developed countries at similar points in their economic history. Inescapably the city slums of the developing world are becoming points of concentration for the informally employed and the poor [Davis 2005, 2007, Kundu 2007, Unni 2007, Dutt 2010]. Hence, it becomes a key sector in the consideration of ‘inclusive growth’.

Third, the efficacy and sustainability of the bank-SHG link up which is now widely recognised as a preferred mechanism for delivery of micro-finance and financial inclusion in India [Joshi 2006, NABARD 2002, MYRDA 1995, Krishna (ed) 2006, Kumaran 2002].

Fourth, the micro finance, hailed as a tool for poverty-alleviation and self-employment, has been expanding at an impressive pace and yet does not have credible evidence to back that claim, particularly in urban regions [GOI, National Commission for Enterprises in the Unorganised Sector 2006, Murdoch 1999, Ledger 2000, Srinavasan 2009, Roodman and Murdoch 2009, Prasad 1995, Pitt and Khandker 1998, Karmakar 1999, Karlan and Goldberg 2011, Chavan and Ramkumar 2002, Sinha 2005].

NABARD’s provisional report indicates that 1.71 million groups had been financed in 2008-9, the loan disbursements made to them were Rs 127.06 billion, and the number of groups saving with banks exceeded 5 million. The total number of members linked to banks through SHGs was around 45 million. Considering the tremendous investments made by banks (only partly covered by group savings), low returns on SHGs productive activity will be is a matter of concern for the policy makers as well. Therefore, the SJSRY policy cannot stand without sustained effective extension services for these new, very tiny enterprises [Srinivasan N., 2009].

The Survey

The survey was conducted in Mumbai city and suburbs over a period of three years. It accessed over 650 people in slums and chawls, the entire population surveyed were in informal employment. The purpose was to examine their experience in three dimensions; acquiring and accumulating Human, Social and Physical capital. While human capital is measured by indicators like the training they have acquired or received, their educational achievement (both pre and post-employment) and educational achievement of their children. Social capital is measured by indicators like their membership in associations - saving and loan groups, SHGs, community-based or professional associations, membership of political parties, public posts held or movements and public causes they have participated in, etc. Finally, physical capital is indicated by house, land, durable gadgets, gold, vehicles that they have acquired. Two groups were surveyed - both employed informally - one group is also a part of some SHG whether sponsored by public or private agency, or some NGO and the other is not.

Methodology

Since the aim was to examine the informally employed, the method employed was broadly one of cluster sampling. The sample frame was the corporation-wards with high percentage of slum population, and within them some slums were chosen randomly. Every fifth house / small shop was approached for response, most often when they were not willing to respond the next house / tiny shop was chosen. This process went on with the help of local contacts. The Community Development Officers (CDOs) maintain a list of SHGs in their wards. Every fifth SHG was selected; if respondents were not willing or could not be contacted in a given time frame, other SHGs were contacted by using the list of the SHGs available with CDOs. However, SHGs not sponsored by the Municipal Corporation were also found in the slums and their responses were also recorded randomly. As is obvious from the conditions in the field, strict control cannot be maintained on the randomness since every fifth house or shop does not respond and the next response may also not come from the next in sequence, and so on. Such surveys normally suffer from the bias of being able to get information only from those willing to share it and therefore usually the more confident and helpful members of the slum population. As a consequence, the sample has to be sufficiently large to take care of selection bias; normally sample size of above 30 respondents is sufficient if strict randomness can be maintained. Wards of Dharavi, Govandi, parts of Worli, Parel, Bandra, Chembur, Andheri, and Kandivali, etc., were covered. Questionnaires in English and Marathi were administered in slums and chawls of these wards. The SHG respondents and control group (CG) are from the same slums. Local contacts accompanied the investigator. The survey went on from 2009 - 2012 because of insufficient manpower and the nature of the field where schedules and availability of respondents vary from day to day. Effectively the main survey took two years but verifications and some expansion of sample occurred later.[1] We compared key parameters of the earlier with later samples and noticed that the rate of change in this sector is not rapid enough to create lack of comparability in responses. A question where less than 70 per cent of respondents had responded was discarded for purposes of detailed analysis. These questions, however, are a very useful pointer of what information the respondents did not have or flaws in the questionnaire design/ wording.

Microfinance in Urban Informal Employment and Poverty Alleviation: Background and Literature

One group of our study had access to micro finance as members of SHGs via a Micro Finance Institution (MFI); this is the most feted model of providing micro-finance. The SHGs are identified with the solidarity group (group based lending) model of Grameen Bank. Its more zealous advocates endorse it as a panacea for poverty eradication and a building block of entrepreneurship and capitalism from below. The more skeptical, regard MF as a benign form of inclusion and extreme poverty alleviation.

MF is an approved tool of the Millennium Development Goals, a 2015 strategy of reducing extreme poverty by one half, enrolling children (of both genders) in primary school, reducing maternal mortality ratios by three fourths, increased health services, reversing loss of environmental resources, reducing infant and child mortality rates by two thirds [Dunfors, 2007].

There is no unambiguous evidence from research of MFs efficacy in poverty reduction despite two decades of policy stance to promote it. The most often quoted study to show the net positive impact of MF is Khandker's massive survey of participating households over a time period of 1991-92 to 1998-99. [Khandker, 2005].

In India, impact evaluation studies of MF abound but are restricted to rural areas and groups mainly [Rajagopalan, 2007]. NABARD is the official nodal agency of the programme and related research. Metropolitan centres, which are fast becoming the largest sink pits of informal employment for rural immigrants have received less attention.

Since this study is based in Mumbai, it is worth mentioning that another door to door Survey in Mumbai (2008-09), by the municipal corporation, concluded that of the 1.3 crore individuals living in the city, around 60 lakh [or 46.15 per cent] claimed that their monthly expenditure is less than Rs 591.75. And worse, they find it difficult to access basic services such as toilets, schools and shelter. Thus, about 12.02 lakh families claim to be Below Poverty Line. These claims could be exaggerated by respondents who hoped to benefit from their BPL identification. All the same, coverage of SJSRY, so far, is inadequate and during interviews the CDOs implementing the scheme felt that targeting was stingy and excluded many poor people in the slums and deprived them the benefits of participation [Indian Express 6 May 2010, DNA 28 June 2009].

The stated Government policy (for urban poverty alleviation) is to support and sponsor SHGs. The implementation and funds are routed through the State Government and the actual implementation is undertaken by Municipal Corporations. In Mumbai the programme is implemented by the Urban Poverty Eradication Cell, established at the Municipal Corporation of Greater Mumbai. Nationalised banks are now linked to SHGs [Bansal, 2009].

The short term goal is probably to, reduce dependence of this section of the population on usurious interest rates of pawn brokers and money lenders, encourage a regular small saving habit and enable consumption smoothing (a group can lend its fund to its members). The medium term goal (3-5yrs) is to; facilitate self-employment, group income generation and participation in development. The sampled SHGs are linked to nationalised banks under their policy to do so [Harper, 2002; RBI, 2005]. SHGs are started and supported by either NGOs or officers of the corporation.

As explained earlier self-selected membership is the key features of an SHG, and the basis of trust and group-monitoring processes. Inter group interactions exploring business ideas, when and how to execute these and the allocation of resources, responsibilities and accountability follow. These are key attributes of entrepreneurship and often the members' very first exposure and participation in different roles.

Survey Results

Although the surveyed population is large at 355 women in SHGs and 166 women in non-SHGs category, the population has very poor levels of education and hence some percentages stated are of those who responded to the relevant questions.

Comparison of Data of Urban Self Help Groups with Control Group: Comparative Profile of Sample

Demographic Profile

The control group (CG) here consists of 166 women only (out of a larger sample of both genders) living in these same slums; engaged in informal-wage or self-employment, but not part of any SHG. The comparisons made here are with respect to women respondents only.

All members of SHGs were women. The median age was about 38 years. 65 per cent of all women were in the age group of 20 - 40 years, while 35 per cent were older (Table 1). This is about the age when women experience high pressures on family budgets, due to educational and other rising family expenses. In the Control Group (CG), the median age was 39. The SHGs have a significantly higher percentage of older women (over 50 years) than the CG.

The income status of the women in the CG are on an average better, they have more earning members per family, more of them are permanently wage employed and when self-employed, they hire more workers on an average. This corresponds to the fact that more of the SHG members are in the official BPL category. (Table 2) The comparisons that follow are to be understood in this background.

Table 1. Distribution of Respondents by Age

All females	Self Help Group 355 respondents	Control Group 166 respondents
Average Age	38.84	37
Median Age	38.42	39
Modal age	35	34

Age in years Less than equal to	30	40	50	More than 50	Total
Frequency-SHG	80	151	86	38	355
Percent-SHG	22.5	42.5	24.2	10.8	100.0
Frequency - CG	44	74	46	2	166
Percent-CG	26.5	44.6	24.7	1.2	100.0

Economic Status

Among SHG, family income was less than or equal to Rs. 5000 per month for 90.4 per cent of the sampled population, and for 78.3 per cent less than or equal to Rs. 3000 per month. Surprisingly, although the policy favours the BPL, 64 per cent of the respondents did not have a BPL card (Table 2 & 3). Clearly, either SJSRY policy or more likely the BPL card distribution system is skewed. Without a BPL card they cannot buy at the subsidised PDS shops, subjecting them to inflationary pressures and weakening their efforts to augment income and savings through microfinance. It can be seen that a smaller percentage (21 per cent) of the CG is in the BPL card holder category compared to 36 per cent in the SHG.

Table 2. Distribution by BPL Status

BPL Status	Yes Frequency (Hold BPL Card)	Percent in own category
(1)	(2)	(3)
SHG - 355	128	36.1
CG - 166	35	21.1

This is supported by the following table where it is clear that the income of the CG is higher since 25.3 per cent of them are in the Rs. 5000 per month or more category compared to the SHG group where 21.7 per cent are in that category. However, the differences are not drastic or sharp. This highlights the limitations of the system of targeting followed by poverty alleviation policy.

The number of dining members in CG was slightly higher (4.3 vs. 4.1) indicating marginally larger family size. On average, earning members in CG families are 29 per cent more than SHG family, accounting for their higher income.

Table 3. Distribution by Income per Month

Income less than equal to Rs.	SHG Frequency	Percent of 355	CG Frequency	Percent of 166
(1)	(2)	(3)	(4)	(5)
0	62	17.5	10	6.0
500	98	27.6	8	4.8
1000	20	5.6	33	19.9
3000	98	27.6	73	44.0
5000	43	12.1	24	14.5
7000	29	8.2	14	8.4
More	5	1.4	4	2.4
Total	355	100.0	166	100.0

Table 4. Distribution by Dining and Earning Members

Average for respondent's family	SHG	CG
(1)	(2)	(3)
Dining Members	4.1	4.3
Earning Members	1.4	1.8

Economic Activity

Most of SHG women described themselves as mainly self-employed (58.3 per cent); another 35.5 per cent were wage employed mostly with private employers (domestic or service sector) compared to 57 per cent who describe themselves as wage employed in the CG. The rest are probably unemployed or in part-time home based employment which they overlook or do not mention clearly (Tables 5 and 7). Many of the SHGs are not highly productive; those that are, do not have a reasonable or dependable flow of regular income, and most often the women in home based work do not count themselves as regular earning members.

Typically, these were first or second generation migrants into the city. Among those surveyed, 77 per cent had no land holdings in their native village. Of those who did have land, 82 per cent had less than or equal to 2 acres. This supports the hypothesis of poverty driven migration into urban slums and informal employment thereafter. Their employment and education status earmarks them for the informal sector and informal employment.

Most of the SHG respondents, 58.3 per cent, describe their economic activity as 'manufacturing' something (often at home); only 32.4 per cent of the CGs are in that category (Table 5). The CG uses more hired labour in their enterprises implying that they may have larger enterprises while SHGs used shared labour in new ventures which are smaller enterprises (Table 6). Despite this basic feature of the CG population that they are relatively better off economically and have larger size enterprises, the percentage of SHGs member loan takers are double that of CG members and SHG members take larger loans. The percentage of SHG members who take small loans of less than Rs. 50,000 is half that of CG members and the percentage of SHG members who take larger loans of more than Rs. 1 lakh is 44 times that of CG. This is due to access to cheaper credit and group solidarity (being group loans, per capita loans might be smaller for SHG). The percentage of SHG members who take loans for business is marginally greater than that for CG members; and the percentage of those taking education loans among the SHG members is five times larger than that for the CG members. This is another outstanding outcome of the policy for the beneficiaries. SHG members are also saving and investing their own money (Tables 8 and 9). At their low base level a certain trend towards capital formation is underway. The scale of activity of these SHGs can be gauged from their loan amounts. Majority (59.9 per cent) had not taken a loan, yet of those who reported taking a loan the most common amount was Rs. 2,50,000 followed by Rs.1,25,000 and Rs.1,00,000. Only 2 women in the sample reported loan amounts more than Rs. 2,50,000. The enterprises started with such amounts are classified as very tiny. (Table 8) The SHG gets the loan at 12 per cent per annum but it lends it out within the group at higher rates up to 24 per cent. The margin generates some income for the group.

The most common kind of productive activities undertaken by SHGs are catering, preparing and selling eatables, followed by garments, tailoring, sari and related garment selling, block printing, running grocery shops, cloth and jute bag making, incense sticks and candle making, phenol and cleaning agents, imitation jewelry, paper bags, folders, leather work, soft toys, dry fish and garlic, powdered spices and so on. For almost all of the above, excluding the last three activities, the SHG members have received some form of training sponsored or supported by the municipal corporation. CDOs are also trying to rope in private parties to participate in training in computer literacy, accounting skills, financial literacy, etc. Regular meetings with CDOs or NGOs inform them about the opportunities, procedures and processes and help out where ever required or feasible. Most training and exposure occurs through such fairly regular interactions.

Most revealingly, 73.4 per cent of the SHG respondents did not answer the question on the profitability of their business, due to a poor costing and accounting sense. They most often report a rough profit of Rs. 2000 to Rs. 1000 per month. A significant majority, 88 per cent, report that group members themselves maintain their accounts. Given the poor levels of their education, especially in financial skills, some manner of external professional accounting and costing support is vital for their health and long run survival. This can occur alongside with their own training in accounting methods.

In another question directed at SHG profitability, 22 per cent reported losses or negligible profits, while 17.4 per cent reported profits of about Rs. 500. The most common kind of problem faced by SHGs was losses in business and loans hard to repay and these are dangerous trends and can lead to problems for SHGs in repaying debts of banks, let alone augmenting capital formation for the members.

With their SHG income, a majority, 61 per cent, did not buy any new asset at all. Even though most have been working for at least one hour per day for the SHG, 18 per cent were working more than 4 hours per day.

Table 5. Distribution by Type of Economic Activity

Economic Activity	SHG-Females %	CG Female %
(1)	(2)	(3)
Manufacture	58.3	32.4
Repair something	4.6	6.7
Provide Service	29.2	49.6
Nil Activity	7.9	11.3

Table 6. Distribution by Use of Hired Labour

Use Hired labour	SHG-Females % of 355	CG Female % of 166
(1)	(2)	(3)
1	19.7	24.5
2-3	5.6	12.0
More	1.4	2.4

Table 7. Distribution of Wage Employed Respondents by Wage Status

Wage Employed	SHG-Females % of 355	CG Females % of 166
(1)	(2)	(3)
Wage Employed	35.5	57.4
Temporary	24.8	21.2
Contract	4.8	9.6
Badli	1.7	2.4
Permanent	4.2	24.2

* Higher percentage of CG is wage employed on what they describe as permanent basis. It may not be legally permanent status.

Table 8. Distribution by Loan Frequency, Amount and Use

Loan Takers	SHG-Females % of 355	CG Females % of 166
(1)	(2)	(3)
Percent & (frequency)	41.1 (146)	20.5 (34)
Loan Amount	**SHG % of 146**	**CG % of 34**
Up to Rs. 50000	34.9	87.0
Up to Rs. 100000	11.7	11.8
More than Rs. 100,000	53.4	1.2
Loan Use	**SHG**	**CG**
Business	79.6	76.6
Capital Assets	3.2	11.7
Education	11.8	2.9
Others	5.4	8.8

Comparative Human Capital Formation

In the SHG lot, about 40 per cent of the women were very poorly educated indeed, 22.5 per cent illiterate and 17.2 per cent fourth-graders. Another 26 per cent had passed standard X, and an additional 10.4 per cent had a high school level education. Only 3.3 per cent had any education above high school. There were fewer illiterates in the CG group at 17 per cent, higher percentage were eighth graders at 38.5 per cent (Table 10).

Table 9. Distribution by Investments and Financing of Investments

		Frequency and % of investors in category		
	Investors	Loan Takers	Loan + Own money	Only Own Money
(1)	(2)	(3)	(4)	(5)
Frequency SHG-355	187	146	117	41
Percent of SHG	*52.6*	*78.1*	*62.6*	*21.9*
Frequency CG -166	44	34	15	10
Percent of CG	*26.5*	*77.3*	*34.1*	*22.7*

Table 10. Distribution by Own Initial Education and Further Training or Education

	SHG			CG		
Education Level	Frequency & (% of SHG)	Upgrade [Training] Frequency	Upgrade %	Frequency & (% of CG)	Upgrade Frequency	% in Own Category
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Nil	80 (22.5%)	24	30.0	28 (17.0%)	0	0.0
Primary	61 (17.2%)	22	36.1	32 (19.3%)	0	0.0
VIII	72 (20.3%)	34	47.2	64 (38.5%)	10	15.6
X	93 (26.2%)	57	61.3	26 (16.0%)	4	15.4
XII	37 (10.4%)	14	37.8	14 (8.4%)	0	0.0
Higher Education	12 (3.3%)	6	50.0	2 (1.2%)	0	0.0
Total	355 (100)	157	44.2	166 (100)	14	8.4

This must be placed against the fact that 47% of the women in SHGs reported that their children were receiving post high school education. This indicates the possibility of accelerated human capital formation occurring as a result of access to microfinance for women within the format of SHGs, (Table 11) [Reddy, 2002; Manimekalai and Rajeshwari, 2000].

The most noticeable impact of the policy was on the human capital - in imparting further training to group members and in motivating SHG members to educate their children. The differences were very marked; more of the SHGs themselves received training, and more of their children were in higher education. (Table 10 and 11).

Table 11. Distribution by Children and their Education Status

SHG - 355	Families have kids	Kids In School	% of 324 in school	In Higher Edu	% of 324 in higher Edu
Frequency	324	308	95.1	168	51.9

CG - 166	Families have kids	Kids In School	% of 156	In Higher Edu	% of in 156 higher Edu
Frequency	156	139	89.1	31	19.9

Comparative Social Capital

In both the sets (SHGs and CGs) there is negligible direct participation in the political process of running for elections even to local bodies but a significantly higher percentage, 40 per cent of SHG respondents had participated in social work of some sort, 42.5 per cent of the SHG respondents said they had participated in some morcha, 33.0 per cent of respondents said they were part of some association or union (Table 12). Contrast this to only 14.5 per cent of CG having participated in social work, 3.6 per cent in morchas and 3.6 per cent in associations. There is a clear difference between the SHGs and CGs in the percentages that participate in social work or associations. An overwhelming majority 87 per cent of the members of the SHGs said that they were not part of any of the above before they became members of SHGs.

The most widespread problem within the SHG was perceived to be lack of trust (38 per cent), followed by lesser problems like lack of leadership, infighting and inadequate skills. Building networks of trust and reciprocity is the learning experience that SHGs will engender.

Table 12. Distribution by Generation of Social Capital

Public Affairs	Election candidate	Won Election	Public Office Held	Social Work
Percent of SHG	2.0	0.6	0.6	40.3
Percent of CG	0.0	0.0	0.0	14.5

	Member Morcha	Union member	Political Party member	Association member
Percent of SHG	42.5	6.2	0.6	33.0
Percent of CG	3.6	3.6	2.4	3.6

Review of the Salient Findings of the Study

SHG groupings had one most outstanding outcome; 47 per cent of them said that their children were receiving higher education (51.8

per cent if we consider only those in SHGs who have children). In sharp contrast, only 18.7 per cent of CG group reported their children receiving higher education (19.9 per cent if we consider only those who have children) (Table 11). This is a phenomenal outcome because SHG-members, on an average, had lower incomes and lower education levels than the CG-members. What has led to the diversion of funds for the continued education of children? All previous studies as well as this one suggest that this is primarily because of the fulcrum of women. Through their membership in SHGs the women increase their capacity to decide and prioritise expenditure. They also acquire associational potency, and new cultural capital (value system). Along with this, access to credit, command over accumulated savings has facilitated this enormous swing.

Many more of the SHG members themselves have received training (44.4 per cent in SHGs compared to 8.4 per cent in CG). This is yet another dimension of the human capital formation process occurring in SHGs (Table 10).

Many more of SHG members have invested in business, education, than the CG members, Investment being defined as non-consumption of wage goods from current income, resulting in the of human, physical and social capital formation. The SHGs have double the percentage of investors and four times the percentage of loan takers-(Tables 8 and 9).

* There are, therefore, some good reasons to believe that, for the present generation and for the next, human capital formation is occurring at a faster pace in the SHG sub set.
* The SHG members also had a much higher exposure to social movements, collective action and associational forms. That is the ground on which this study shows that social capital is also accumulating more rapidly under the auspices of the scheme (Table 12). The manner in which social capital will become the medium to spread useful ideas, attitudes to create a modern culture of rational thought, collective enterprise and political participation will be of consequence in the future. Social capital or networks of trust, reciprocity and aspirational kinships are now considered the missing link in development. The presence of social capital determines the ability to disseminate information and undertake collective action so as to derive benefits from government policies for their benefit.

This is to be understood in the context of the fact that many members of the better off CG report increased income but also increased spending on weddings, 44 per cent, and religious festivals, 60 per cent. The corresponding percentages for the SHG were 13 per cent and 22 per cent. Will more prosperous SHG members in future take to conspicuous consumption or investments? That would depend on the manner in which their associational capital transforms their culture. Here the character of the mentoring agency like the municipal corporation, independent NGOs and trusts and NGOs affiliated to political parties becomes decisive.

* SHG-members perceive substantial benefits of the policy in terms of accumulating savings, access to credit and gains in self-confidence and self-esteem. A large majority, 82 per cent, of the respondents scaled the scheme as good to very good.
* A majority (75 per cent) of them said that they received all the information that they need from the authorities; they also found the attitude of the banks and local officials helpful. Detailed information, for example, the information which they received, the time taken to sanction the SHG loans compared to the CG members' loans, information of the SHG members processed

by the banks, EMIs of the SHG members in relation to their incomes, etc., was not collected. A simple question was asked: Do you find the attitude of the officials helpful? Do you get the help you need? One persistent shortcoming highlighted by the CDOs was the shortage of manpower among them. There were too few CDOs and none of them had any well paid and permanent support staff; only seven or eight CDOs were serving the poor in a city of the size of Mumbai. This severely hampers their ability to prop up the SHGs they have spawned, convert them into productive ones, or to organize appropriate training and marketing facilities for an increasing number of SHGs. Adhar Centres are operated to market the products of SHGs by the corporation; however, more facilities are needed. The shortage of manpower was a limiting factor for them. Hence, planning to up-scale productive SHGs, to generate clusters of symbiotic, dynamic SHGs is not even a remote possibility here. We are likely to suffer policy failure repeatedly for lack of concern and insight into the processes / systems that make for successful implementation of programmes. This raises concerns about survival of the weaker SHGs in the absence of institutional support. It was earlier stated that 73.4 per cent do not know the profitability of their business, while 88 per cent keep their accounts. Profits are low and reported in general terms ‘roughly Rs 1000 to 2000 pm’; 22 per cent reported losses or negligible profits, while 17.4 per cent reported profits of about Rs. 500 per month. Such estimates of profits and losses as the women could provide were inadequate. The question about profitability could not be answered satisfactorily by the women themselves and we have no accurate method of doing so. With their SHG income, a majority (61 per cent) did not buy any new asset at all. Still, as reported earlier, a larger percentage of SHG members are ‘investors’. This is because loans have been taken for investing in education, health and business. The first two are considered dimensions of human capital not amenable to profit-loss computation and the last as indication of attempts at investing in physical capital. The levels of investment and profit and incomes are obviously too low at present to generate significant business / physical assets.

* Will SHGs start defaulting on loan repayment and jeopardise the scheme?
* Economic activities are of low profit margins even for the currently stronger enterprises. Unless fresh ideas for products, services and marketing are introduced, value addition will remain marginal even if they survive in changing economic scenario. The poor returns has root causes; poor accounting, marketing skills and inability to have a steady access to markets, competition multiplying SHGs producing same simple products for small markets and the resulting low profit margins. This is a core area of concern for the viability of microfinance highlighted by those who doubt the sustainability of micro production via self-employment [Bateman, 2010]. There is definitely a danger of SHGs remaining a much needed survival strategy for the poor, a device by which they can smooth their consumption cycles and a means by which they can invest in human and social capital alone unless a comprehensive support system for training and marketing is created by the government and by the banking system in the form of offering lower interest rates (12 per cent-13 per cent) than the prevailing ones. Society at large can help by patronising the products of SHGs. This experiment has been undertaken in the Kerala Model successfully.

* Hence, core areas of concern are marketing, training to produce new goods and services and improving accounting skills. New business ideas and self-supporting business clusters need to be spawned. Here again extension services by banks and local governments are critical. In response to a question on the most needed help or support, the women in productive SHGs have referred to the above in that order of need. Extension services provided by banks in terms of business models and processes are ways in which this problem can be addressed by the banks. Extension services provided by them can supplement efforts by sponsoring agencies like the municipal corporation in this case. This was done in the case of the Green Revolution in the 1970s.
* In Mumbai at least, the local government had outstripped the NGOs and other SHG promoting institutions in creating SHGs and converting them into productive groups, indicating the possibilities of replicating this model through local government bodies in other urban centers. Of the respondents, 50 per cent said their sponsoring agency was the municipal corporation against 15 per cent who said NGOs sponsored them.
* The dependence of the respondents on the PDS and the municipal hospitals is obvious. Of the SHG respondents, 46 per cent used other government schemes, the most frequent being the PDS, followed by the Municipal Hospitals. Municipal schools were a very poor third. Their ability to direct credit to human capital formation is critically linked to the cost of living, i.e., the cost of food, housing, transportation and health care. Since every increase in nominal income through SHG activity can be negated by inflation. The SJSRY cannot stand alone without other ways of supporting social sector policies because the income generating effects of the SJSRY as yet are minimal to moderate.
* Of the respondents less than half 44 per cent said their SHG had members of the mixed religion, and 51 per cent had mixed caste. This depends on the composition of neighbourhood. Nonetheless, caste and religious barriers seem to be more easily overcome in the city compared to rural SHGs where same caste SHGs were more common.

Those who work in the informal sector (both CG and SHG) deal with high levels of income and employment insecurity and consumption deficits. Without any formal or professional association, (e.g., CGs) they grapple with fluctuations alone as individuals, supported to some extent by their kinship bonds. This kind of isolated existence inhibits upward mobility. Effective and forward looking SHGs can fill a social capital gap by shifting the networks of trust steadily to the general neighborhood and out of narrow kinship groups. This is indicated by the social capital formation occurring among the SHGs. These SHG groups are not family or kinship based; and we can assume that new forms of social capital useful for survival in urban settings is being formed.

This particular policy to sponsor and support SHGs is funded publicly and implemented by the officers who are trained and qualified social workers; the role of NGOs is minimal. Given their low numbers, CDOs have managed to make an impact; formed SHGs, federations of SHGs, and imparted training and organised lectures on health, hygiene, women's rights, domestic violence, insurance and social security investments. The women seem to have grasped the importance of education by observing the valuable leadership role of those who are more educated among them. Organising and expanding this kind of workforce and raising their income levels higher does remain the famous last, arduous, frontier of social development and of any working class movement.

The members of the SHGs have some of the characteristics of Mancur Olson's effective groups [Olson, 1971]. They are small, cohesive and homogeneous by self-selection; they share a common goal of increasing their individual and collective security. The formal rules and code of conduct for self-governance made for SHGs create new kinds of networks suited to their current and future needs. Finally, these groups can potentially become the building blocks of neighbourhood and community-federations creating a much needed new structure for enhanced resource mobilisation, information and communication, and public policy implementation. These structures can and do bring social pressure on the delivery of entitlements and public goods like neighbourhood sanitation needs, operations of ration shops, municipal schools. These are new forms of social capital. Such social capital is, for one, necessary for effective implementation of social sector schemes along with social audits by independent agencies as is the case in the Kerala Model where SHGs are providing assistance in implementing NREGA [Mithra, 2010] or where they organised and led agitations [Biju and Kumar, 2013]. If that happens they can be expected to create pressure on the state to deliver public services and to include them in development. The case of Kudumbushree in Kerala provides a good example of how this may be done.

Policy Recommendations

Based on this particular study the following conclusions are germane:

* The Urban SHGs need a stronger support network for skill development, training, for example, in municipal schools on weekends.
* They need urban space for selling their products and services (for example, weekend sales in government colleges / schools or identified municipal markets / premises).
* To initiate and sustain SHGs, the local government institutions with their reach, ability to hire and maintain trained CDOs and their infrastructure are at present best suited as nodal agencies. NGOs can be partners in some aspect of the policy like training and marketing.
* The local municipal government, in this case Municipal Corporation of Greater Mumbai (MCGM) must increase the staff allocated to implementing its policies successfully. In this case, the number of CDOs and their support staff must be raised. It is impossible to create sustainability and a spread effect without more, full time, trained staff in social sector schemes such as these. This scheme, for example, requires forceful, continuous, personal intervention of CDOs who act as catalysts in group formation, paper work for opening bank accounts, making bank loan applications, creating awareness about business opportunities, checking accounts, business account maintenance, arranging training, and public relations. The CDOs also need support staff to effectively follow up and monitor this scheme. The support staff can be hired with performance based, five year renewable contracts from the target population itself.
* Policy must include some form of obligatory government purchase of their goods and services, where suitable, till SHGs become mature. Renewable contracts to purchase their services by public institutions should be one form of time bound support. This can be a fixed term, renewable contract to avoid perpetual dependence and to induce competitive spirit. Renewable contracts have been suggested, but dependency will need to be phased out or calibrated in a

planned manner. They may specify a time period beyond which over dependence will not be encouraged. The SHGs may by then gain experience and confidence to apply for contracts to prepare mid-day meals, operate ration shops, etc., along with other providers.

* Private retail outlets above a certain floor space size must be required to source some fraction of their products from SHGs and tiny enterprises. The urban space for SHGs and tiny producers is not growing rapidly. Their ability to access the middle and higher income markets is limited. Some creative affirmative action to make market space for SHGs needs to be envisioned.
* Frequent impact assessment of this policy in different class types of cities should be undertaken and published by the implementing agency so as to make available data to the public on the same. This can be followed up by independent, more specific, qualitative studies.
* As far as the policy goes, SJSRY is rated very highly by its grass root implementers, i.e., the CDOs and the members of the SHGs when they were interviewed. Overall, the SJSRY got a thumping approval from the participants as 69 per cent said it was a very good scheme, 13 per cent said it was good and 10 per cent that it was better than no scheme at all. In yet another response to a more direct question on the usefulness of SHGs, 61 per cent of respondents said it helped them save more, 19 per cent said that it helped their confidence and self-respect and changed the way others treated them. One woman coyly remarked she had become famous among her relatives. But despite this positive spin off, only 13 per cent say that it has increased their income, in response to a question on whether SHG activity has led to an increase in their net income. This is due to the low net income flows from their activity as yet. However, the SHGs are filling their needs for investment in human capital and for business survival. Both the CDOs and the members of the SHGs cite the rising level of self-confidence, availability of credit, mutual support and benefits as the main benefits of the SHGs. The members of the successful SHGs mention the fact that their families and communities have increased respect for them after their success.
* Integration of the policy in terms of short, medium and long term goals into a comprehensive Sustainable Livelihood Approach would be a step in right direction. This approach is best demonstrated by the Kudumbushree policy of Kerala which began in 1998 and networked the SHGs into local level and state level economic plans. They use suggestions and representatives of the SHG federations to achieve this integration. The state has now developed a Kudumbushree brand of products and services which includes, for example, the operation of hygienic and low cost restaurants and canteens, manufacturing of soap, garments, etc.[2] The state of Kerala has shown the way forward when it converged the various poverty eradication programmes under the umbrella of Kudumbashree in 1998.The vital elements of the policy are micro credit, self-help, entrepreneurship and empowerment. This is a policy founded in SHGs, in the removal of poverty through efforts of people themselves, and SHG involvement in local government planning. By 2002, it had spread to the whole state linking the poor (hitherto excluded from the formal banking system) to banks. The programme works in collaboration with Khadi and Village Industries Commission, Social Welfare Department, Schedule Tribes Department, Industries Department and

Spices Board. Kudumbshree is now regarded as a progressive policy reform in the league of land reforms, literacy campaigns and Peoples' Plan of the Kerala Model of Development. All aspects of welfare are now routed through Kudumbushree. According to Mithra (Mithra, 2010) the policy is regarded as one of the largest movements for women empowerment in Asia. While the local governments become implementers, the State and Centre should coordinate and network on these goals, as is achieved in Kerala, both as a result of the peoples' plan campaign and the establishment a wide network of SHG groups and their federations. These federations participate in the formation of local and district level plans. This structure and practice has been appreciated by the UNDP and listed a one of the best practices in local participation and governance [Augustine and Minu Kumar 2010; Mithra, 2010].

Finally, it is worth repeating that by implication the success of this livelihoods based policy will be crucial in dealing with four central issues of concern in development policy today, the informalisation of urban employment resulting in increasing poverty and vulnerability particularly among women and their children ; the efficacy of microfinance in dealing with urban poverty and the usefulness of SHGs in generating new kinds of institutions such as neighbourhood groups and their federations to deliver micro finance and accelerate capital formation for poverty alleviation in urban areas.

NOTES

1. As a result of suggestions from a referee of this journal to include more 'women only' in the control group, for which the author is thankful to the referee.

2. The explanation of this policy is the subject of a subsequent paper which the present author is working on.

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RULE-BASED FISCAL CONSOLIDATION IN INDIA AND EUROPEAN UNION: A RELOOK INTO THE PROCESSES

Subrata Dutta and Auke R. Leen

The emerging economies including India have shown symptoms of quicker recovery from the world-wide recession than the economies in the global north. The financial sector in euro-zone is still in deep trouble. High deficit countries, for example, Greece, Portugal, Ireland and Spain, among some others, are being blamed for the trouble. If solutions are not found to rescue the troubled zone, the developing countries may be further adversely affected. India's goods export to Europe has already moderated. Although Europe is no longer India's biggest export destination, the economy may be indirectly hit via other trading partners. Structural fiscal imbalances in the European countries are currently being tackled with common strict rules under the European "Fiscal Compact" which is the new version of the Stability and Growth Pact. Until the middle of the last decade, both the Indian central government and the state governments were found to be trapped into similar chronic problems. To address such structural issues, in India, the central and state governments have enacted the Fiscal Responsibility and Budget Management Acts in the national parliament and state assemblies, respectively. This paper looks into the fiscal consolidation processes in India and the EU and seeks to derive some understandings from the political economy perspectives of the processes.

1. INTRODUCTION

At the present juncture in euro-zone, many scholars think that Eurobonds or European Banking Deposit Guarantee (some other ideas are also floating) may quickly rescue the European Union (EU) from the present crisis and further troubles. While it is true that Eurobonds as a cosmetic solution may be a quick remedy for the EU, it seems extremely difficult that such quick measures would be able to find sustainable solutions to the problems that have stemmed from the underlying structural fiscal imbalances and the consequent debt burdens of some member countries. Until mid-last decade, both the Indian central government and the state governments were found to be trapped into the similar chronic problems. To address such structural issues, the central and state governments have enacted the Fiscal Responsibility and Budget Management (FRBM) Act in the national parliament and state assemblies, respectively. This paper looks into the fiscal consolidation processes in India and EU and seeks to derive some understandings from their political economy perspectives.[1]

Following the recommendations of the Twelfth Finance Commission (TFC), most of the states in India undertook a set of fiscal consolidation strategies through the enactment of the FRBM Bill (after the union government enacted it in 2003) which have not only helped them to come out of the structural deficit crisis but also saved them from further trouble -- which could have been much worse than what it has actually been -- amidst global slowdown. In 2003-04, (i.e., just prior to the FRBM era), only Jharkhand had been found to be the revenue surplus state among the non-special category states (special category states are located in hilly terrain and depend heavily on transfers from the Centre; we discuss this later again in this article). Most of the states enacted the FRBM in and around 2005. By 2007-08, a large number of states were found as

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The authors are grateful to an anonymous referee of this journal for his/her valuable comments and suggestions on an earlier draft of this paper. Special thanks are due to the editor of this journal for his extensive comments on an earlier draft. However, the usual disclaimers apply.

revenue surplus states. They include Bihar, Chhattisgarh, Goa, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu, Uttar Pradesh and Andhra Pradesh [Dutta, 2012a, Pp. 1-41]. After 2007-08, however, states' fiscal situation deteriorated due to global economic slowdown.

Enactments of the FRBM by the states of India were possible largely due to its strong federal construction, with the union government playing the dominant role. On the other hand, although the Stability and Growth Pact (SGP) in the EU has a long history of about 20 years, the EU has failed, at least for the last 10 years, to come up with an impressively successful use of the SGP to get out of its present crisis. At the moment, the EU as a central system is in an existential crisis which has been one main reason for why a new treaty, i.e., Fiscal Compact, has replaced SGP and thereby come into effect on 1 January 2013 for the 16 countries which completed ratification prior to this date. There are some fundamental differences between the Indian federal system and the EU federal system. The EU has a basic "birth defect" in the sense that while it is a monetary union, it is not a fiscal union. India is both a fiscal and monetary Union and the central government has a much more effective mechanism to supervise and monitor the member states. EU is not a fiscal union and there has been no mechanism to effectively supervise, monitor and review the working of the SGP or the Maastricht Treaty. In India, according to Article 293 of the Constitution, states are not allowed to borrow from outside the country and even their borrowing is domestically restricted (for example, a consent from the central government is mandatory) if they are indebted to the Union government or if they have any outstanding loans in respect of which a guarantee has been given by the Union government.

Following the recommendations of the TFC, the central government disintermediated from the borrowings of state governments from 2005-06 onwards. Loans from the National Small Savings Fund (NSSF) -- granted by the centre to the states -- have also declined substantially after 2006-07. As a result, the state governments have increasingly gone for market borrowings in the form of State Development Loans (SDL) from 2007-08 onwards [Ghosh et al., 2012]. In future, some state governments may be able to run their economic affairs without being indebted -- directly or indirectly (e.g., in the form of guarantees) -- to the central government. In that case, there should not be any problem, in principle, for the states to borrow without the consent of the central government. However, according to Article 293, the states are allowed to borrow within the limits as fixed by the Legislatures of the states concerned. Currently, such restriction is imposed by the FRBM Acts. Before FRBM, the states showed symptoms of chronic revenue deficit problem (which further contributed to the fiscal deficit problem) and high debt accumulation (which in turn kept raising debt-servicing costs). We discuss the contextual issues related to FRBM later at length in this article. But, whether a state should be allowed to borrow (without the central government as a guarantor) from outside the country is a matter for further debate. Many foreign parties may not sign a contract with a state government since a state is not a sovereign body. If the contracting party outside India does not have any problem in this respect, then it may not be imperative for the Indian law to stand as an obstacle and necessary provisions should be made at the constitutional level. But, whether external borrowing would bring in any additional benefit and what might be the risks to the Indian federation on account of the quantum and quality of its total external debt are matters which require a very serious examination and are not addressed here.

Indian central government is a sovereign and powerful entity compared to its sub-national governments, whereas the EU central body is a much weak entity compared to its sovereign member states. Indian central government is fiscally more powerful than its states, while, in the EU, the real fiscal powers lie in the hands of the member states. So, the two cases are not, in true sense, comparable, and thus we do not propose to undertake a comparative study through this essay; rather we seek to look into the two processes for our better understanding. However, in the light of the present discussion, the question that arises here is: whether the EU needs a tighter fiscal federal system, with stronger European Commission (EC) as a central body which will have greater power, than it currently does have -- in order to streamline the messy fiscal situations and thus to restore, by learning by doing, the very existence of the EU. The current sovereign debt crisis in the euro-zone emphasises that a common monetary policy needs a common fiscal policy as well. For this reason, the EU has repeatedly been engaged in reform debates to reformulate the SGP. What are the central elements that need to be contained in a new fiscal pact? In this paper, we will look into the political economy perspectives as well as main features of the Indian FRBM Act as adopted in its federal system. The political economy perspectives of the reforms of the EU's SGP will also be looked into. Keeping in view the fundamental differences between the institutional relationship of the EU with its largely sovereign member states, on the one hand, and the federal relationship of the Indian sovereign central government with its own states, on the other, we broadly intend to study the two different systems with particular reference to the European "Fiscal Compact" (or the reform process of the SGP) and the FRBM and seek to understand the strengths and weaknesses of the two processes.

Under the great market pressure, the EU is in search of a solution to its current sovereign debt crisis. Along with finding solutions to the urgent, short-term challenges, the EU, as it is realised, is in need of maintaining long-term, compact discipline as well as coordination in its fiscal domain. Since trust also works backward, a genuine fiscally stable union, which is built on long-term foundation, it is expected, will add to the trust in resolving short-term problems as well. Thus, short- and long-term problem-solving mechanisms are to go hand-in-hand. The EU member countries realise that they need to enhance the scopes for achieving higher competitiveness (for attaining higher growth) through greater social cohesion and a deeper integration in the internal market [European Commission, 2011; European Council, 2011]. In this connection, the Commission has recently laid down its proposals in its publication titled "Single Market Act II: Together for New Growth" and emphasised four drivers for new growth. The drivers which are expected to facilitate new growth in the EU through higher competitiveness of the member countries are (1) developing fully integrated networks in the Single Market; (2) fostering mobility of citizens and businesses across borders; (3) supporting the digital economy across Europe; and (4) strengthening social entrepreneurship, cohesion and consumer confidence.[2] Moreover, it is imperative to take forward stringent rule-based governance with a view to ensuring clear disciplines in the fiscal domain as some countries in the EU have recently gone messy in relation to their fiscal matters and severely interrupted economic growth of the whole region. We are going to elaborate this in further detail in the following sections. We choose to delve into the issues related to fiscal rules because fiscal domain is considered, by many scholars [see, among others, Cooper, 2011], to be the source of generation of vicious recessionary waves in the present time.

The present situation requires the euro area to have a new deal between its member states and reinforce the same in the form of a new legal framework. Since the principles of the new Fiscal Compact are in the process of being ratified by the EU member states by 2013,[3] it might be useful to look into the fiscal consolidation processes in both India and EU in the light of the natures of their fiscal federalism and see as to what goes in the positive or negative direction in the EU and in India (e.g., India translated necessary fiscal rules into legislation, i.e., FRBM Act)[4], and under what conditions (e.g., whether or not strong federal structure of India has facilitated its states to have unitary fiscal policies or, more specifically, to follow uniform fiscal rules. In this perspective, this study assumes special significance at the present juncture.

2. FROM THE (PREVIOUS) SGP TO THE (CURRENT) FISCAL COMPACT: BACKGROUND, CONTENTS AND PROBLEMS

While discussing SGP, a brief contextualisation needs to be provided. The EU has grown from six member states in 1957 (at the time of the Treaty of Rome) to its present 27 member states (Croatia is set to become the 28th member in 2013). It has about half a billion inhabitants and, at present, a gross national income (GNI) of over 13 trillion euro (17 trillion U.S. dollars). Presently, 17 member states belong to the euro single currency system. In the euro-zone, a supranational monetary policy is interacting with decentralised fiscal authorities [Leen, 2011, Pp. 203-205]. Since the 2008 sovereign debt crisis in the EU, this region has been experiencing tough time in relation to controlling ever-increasing budget deficits of especially the Southern European countries. This has instigated the EU to reform SGP and incorporate certain clauses into it in order to force the EU member states to maintain their borrowing under control in order to create stable conditions in the EU.

The SGP consisted of a set of rules that aimed at maintaining fiscal discipline in the EU member states. They are described in Articles 121 and 126 of the Treaty on the Functioning of the European Union (TFEU) and Protocol 12 attached to the TFEU and the *Consolidated Version of the Treaty on European Union* [European Union, 2008]. The rules consist of preventive and dissuasive arms. Under the provisions of the preventive arm, the member states must submit annual stability or convergence programmes. In response, the Union can issue an early warning to prevent the occurrence of excessive deficit and can directly offer policy recommendations to a member state. The dissuasive arm governs the excessive deficit related matters. The budget deficit cannot exceed 3 per cent of GDP. The exemption is allowed if the excess is relatively small, temporary and exceptional. Also, for short-term exemption, the overall trends of the deficit should be regarded as continuously as well as substantially declining. Generally, the government debt cannot exceed 60 per cent of GDP.[5]

Since the time horizon set by the policy makers/politicians (of the ruling party/coalition) is generally short as they are in need of implementing their manifesto and other promises within the mandated time frame, they may be often seen to be inclined to deviate from what is regarded as optimal fiscal policy. In short, an optimal fiscal policy refers to a policy of choosing taxes and expenditures to maximise social welfare. In order to maximise welfare in a short span of time, the government (the ruling party/coalition) may prefer to increase the level of expenditures which may not be in conformity with tax policy. Thus, government budgets may suffer from deficit bias caused by overspending attached to fulfilment of political ambitions of the politicians. In the Economic and Monetary Union (EMU), fiscal slippage in one of the member states probably has adverse effects on interest rates throughout the union. So, it is even possible that other governments will want to support the offender explicitly or implicitly by undertaking financial transfers or by purchasing the offending government's debt titles [Langenus, 2005, Pp. 65-81]. Despite the presence of an explicit no-bailout clause (Article 125 of the *Consolidated Version of the Treaty on European Union*, 2008), bailouts are now happening in the EU through a country's temporary emergency fund. For example, for Ireland and Portugal, an amount of 48.5 billion euro is to be disbursed over a three year period, i.e., 2011-13. And the European Central Bank (ECB), the only goal of which is to maintain price stability, is, as argued by Buiter [2010, Pp. 12-19], also involved in buying bonds of troubled governments to fulfil the fiscal needs of the latter. In February 2013, the ECB stated that the Italian Government bonds accounted for nearly half of its total holding (the ECB holds bonds of face value of 218 billion euro or 292 billion US dollar). It holds bonds of 44.3 billion euro and 33.9 billion euro for Spain and Greece, respectively.

How did the SGP come about? The rules set in the Maastricht Treaty [1992] in order to achieve the EMU are also seen to be applicable in the euro currency regime that was initiated in 1999. After the euro was launched, fiscal discipline evaporated. Many countries, however, faced difficulty in meeting the SGP rules. In 2003, the two largest economies in the euro-zone -- Germany and France -- broke the rules. They, however, promised to reach the SGP targets as soon as possible. Therefore, no action was taken against them. In general, however, if a country breaks the rules, it has to take harsh measures to reduce its deficit. If it breaks the rules for three consecutive years, an imposition of fine up to 0.5 per cent of GDP may be proposed and institutionalised.

Because the SGP looked weak, the Council of the EU temporarily suspended it.[6] In 2005, the EU agreed on a reformed SGP with much more flexible rules [Gonzalez-Paramo, 2005]. On the surface level, the key rules pertaining to deficits and debt were maintained, but the reformed pact contained a list of exceptions for certain types of spending that would not be counted as part of the debt, e.g., spending on education, research and defence (a political fiscal gimmickry in book-keeping). Therefore, it was almost impossible to break the rules. However, even these much simplified rules were challenged when France, in 2007, tried to revitalise the French economy with Keynesian policies.[7] Of the member states with great budget deficits and accumulated debts, particularly the situation of Greece is critical as it deliberately provided the EC, the executive arm of the Union, with wrong information about its deficit and debt figures.

In 2008, partly because of the global economic crisis, average public debt in the euro-zone began to rise, especially in Ireland, Spain, France, and Greece [Hentschelmann, 2010]. In 2010, to rescue some member states, two temporary emergency funds -- the European Financial Stability Facility (EFSF) and the European Financial Stability Mechanism (EFSM) -- with a combined budget of 500 billion euro have been established. Member states can draw low-interest loans from the funds. In May 2010, Greece took the first loan. In late 2010, Ireland got a bailout too and in 2011 Portugal and again Greece got loans. In 2013, Cyprus has got a loan of 10 billion euro. In October 2012, the permanent European Stability Mechanism (ESM) has entered into force with a budget of 700 billion euros. In the new Fiscal Compact, it is stated that countries cannot get bailouts unless they sign and apply the pact.

Both the versions of the fiscal rules -- the SGP and the new Fiscal Compact -- have received critical reactions from different quarters. The SGP was heavily criticised by the German Central Bank and German Government [Stark, 2001, Pp. 77-105], while the reformed version has been criticised by, *inter alia,* Schuknech, et al. [2011]. While the old SGP has been marked as too rigid, the new version is blamed to be containing so many provisions of exemptions that a country, as often argued and just stated, would find it hard to breach the regulations. Moreover, there have been no effective rules to prevent a breach of the SGP and punish a member state for doing it. Hence, there has been lengthy discussion in the EU to establish a new fiscal pact. Several draft fiscal pacts were proposed and the final version was approved on 2 March 2012.[8]

A major change introduced in the new Fiscal Compact is that the member states are not forced to meet the targets every year; the budget has to be balanced over an economic cycle. The new rule entails, compared to the previous SGP, that the cyclically adjusted budget deficit is to be no more than 0.5 per cent of GDP and a government must run fiscal surplus until its debt level has fallen down to 60 per cent of GDP. As said, a budget needs, in principle, to be in balance. This is a more stringent rule than the previous one which had allowed budget deficit of maximum limit of 3 per cent of GDP. Thus, against the backdrop of much relaxed formulation, the new Fiscal Compact is trying to implement tight policy that is expected to result in greater effectiveness. Also, as has been done in India, the new fiscal rules need to be introduced in the member states' national legal systems at constitutional or equivalent level. We come to this discussion later.

Another change required is that the EU should adopt more stringent principles to effectively penalise the states with excessive deficits or for violating the rules as set in this particular respect. Currently, the Commission has upgraded the theoretical sanctions to real automatic sanctions. The Commission, even without a referral from the Council, would then directly impose sanctions in the event of excessive deficits. Since there is a need for direct intervention in the budgets of member states (as we have experienced SGP violations earlier), there should be a defined mechanism that would assess the degree of violation and ascertain the intervention process. In this respect, as suggestions came from the EC, the post of a European "Stabilisation Commissioner" could be created. The Stabilisation Commissioner would have the right of direct intervention in national budgets in the event of consistent breaches of the Fiscal Compact. Alternatively, the Stabilisation Commissioner could forward its suggestions to the Council for relevant decisions. Some member states (e.g., UK and Czech Republic), however, do question if the Union has the democratic legitimacy to penalise a member state for its budget directly. The European Parliament is still by far no full-blown democratic parliament [Klaus, 2009].

In short, the present discussion is about effective rules on budget deficits and public debt in the euro-zone countries [Buiter, 2003, Pp. 49-58] or, in other words, a new fiscal pact and strengthened economic policy coordination [European Council, 2011]. It is all about the tightening of the EU budget rules to prevent future crises.

3. FISCAL CRISIS AND THE MUCH NEEDED FISCAL RESPONSIBILITY LEGISLATION IN INDIA

Although in sharp contrast to the 1930s, both the credit crunch and the recession have had more impact on the advanced capitalisms of the north than on the global south during the post-2007 global slowdown [Radice, 2011, Pp. 27-31], Indian economy has been exhibiting sluggish growth during the world-wide turmoil [Anonymous, 2011, Pp. 105-143], perhaps partly because of its dependence on foreign private capital and partly due to its internal reasons. There was a time when it was widely held that free trade and unrestricted inflow of foreign private capital would undermine late industrialisation in India and thus protection was seriously taken into consideration at policy levels. Earlier, foreign aid was considered to have an important role to play in development, but presently free trade and foreign private capital are considered essential for development [Ghose, 2011, Pp. 27-31; Govinda Rao and Sen, 2011]. Being a partner of the global trade and a host of the foreign private capital, India could not avert the impact of world-wide slowdown. For example, the immediate response of mobile global capital was rush to the safe havens of the USA and Europe (especially, to gold and to triple-A securities) and consequently the direct impact upon working people in the global south was far more severe [Radice, 2011]. However, apart from the external environment, internal policy and regulatory matters are also responsible for the moderation in growth, particularly for the significant slowdown in investment activity. High inflation has remained the cause of great concern in the recent time. The annual rates of inflation based on average of wholesale price index (WPI) and consumer price index (CPI) have increased from 4.7 per cent and 6.2 per cent in 2007-08 to 7.6 per cent and 10 per cent in 2012-13 (April to January), respectively [Government of India, 2013].[9] The industrial sector has been experiencing a slowdown under the combined impact of high inflation and rising cost of borrowing (caused by rising interest rates). Investment demand and private final consumption expenditure have moderated as a symptom of recession. Besides, the newly elected Government of West Bengal (led by Trinamool Congress Party), instead of raising its revenue level, had been trying to "blackmail" the Centre for a bailout by stalling the latter's every decision of the proposed reforms [Govinda Rao, 2012, p. 12].[10] Failing to achieve the goal, the Party has finally withdrawn its support to the central government on 18 September 2012. However, later (i.e., in 2012-13), the state government has been successful to raise its own revenue level, because, as it seems, that was the only option open to it to combat its current severe financial crunch.

In such a situation, India's growth has shown sluggishness. Although it showed reasonably high growth rates in the early years of global economic crisis (e.g., 8.6 per cent and 9.3 per cent in 2009-10 and 2010-11, respectively), the growth rate fell down drastically in the recent years, to 6.2 per cent and 5 per cent in 2011-12 and 2012-13, respectively [Government of India, 2013]. Nevertheless, it seems that the so called emerging economies, including India, have shown symptoms of greater stability / quicker recovery than the economies in the global north [Radice, 2011]. At the same time, it is very clear from the recent trends that, after reaching certain recovery level at the initial phase, the Indian economy has not further been able to get out of the stagnating growth syndromes. India's goods export to Europe has already moderated. Although Europe is no longer India's biggest export destination, the economy may be indirectly hit via other trading partners.[11] But, India's fiscal deficit is thought to be a real problem. Recently, the finance minister of India had to announce in the parliament that the government would undertake austerity measures to combat the situation. The Reserve Bank of India (RBI) has expressed great concern about India's fiscal deficit position (for fiscal deficit trends, see Table 1). It has remarked that slippage in the fiscal deficit has been adding to inflationary pressures and could potentially crowd out credit to the private sector [RBI, 2012]. Moreover, in India, the liabilities of the public sector banks are "entirely guaranteed by the central government" and "they present a huge potential fiscal risk, one which India does not have the fiscal space to accommodate" [Bery, 2011, Pp. 10-11].

The government is finding it difficult to get out of the expansionary spending policy in the recession time. Had the governments (both the centre and the states) not enacted the FRBM Bill in 2003 by the centre and in the subsequent years by the states, India would have been in much worse fiscal situation during global slowdown. At least partly, it is the FRBM Act that saved India from falling into much deeper crisis. As it is evident from Table 1 that fiscal deficit of the central government alone had crossed the 6 per cent level in 2001-02 and the combined (centre and states) fiscal deficit was found to be close to 10 per cent in the same year. The situation started changing sharply after 2003 (the year of FRBM enactment by the Central Government) until the economy was hit by global economic slowdown. So, it is the FRBM which has partly saved India from a far greater crisis during the world-wide recession.

Table 1. India's Fiscal Deficit as Percentage of GDP

Year	Fiscal deficit as percentage of GDP		
	Centre	States	Combined
(1)	(2)	(3)	(4)
2000-01	5.48	3.80	8.87
2001-02	6.00	3.80	9.36
2002-03	5.73	3.76	9.03
2003-04	4.34	4.14	8.10
2004-05	3.88	3.11	7.05
2005-06	3.96	2.33	6.38
2006-07	3.32	1.82	5.10
2007-08	2.54	1.49	3.97
2008-09	5.99	2.26	8.17
2009-10	6.48	2.94	9.38
2010-11	4.90	2.62(RE)	7.81(RE)
2011-12	5.70*	2.16(BE)	6.75(BE)
2012-13	5.20 (RE)*		
2013-14	4.80 (BE)*		

Source: Government of India [2012], p. 42; *Budget at a Glance 2013-14, Government of India.
Notes: RE = revised estimate; BE = budget estimate.

However, contrary to this view, Govinda Rao and Sen [2011] argue that the improvement in the fiscal situation until 2007-08 was not attributable to the FRBM efforts. They argue that the central government adopted various "creative accounting" procedures to keep deficits outside the budget by issuing, for example, oil and fertiliser bonds. They also find that the improvement in fiscal deficit was mainly due to increase in the receipts from the source of income tax and to some extent revenue from service tax. The former went up, as they argue, mainly due to the introduction of tax information network (TIN) and its effective implementation. However, for a high deficit- and debt-stricken country, achieving the final goal seems to be more important than the means, i.e., the way of achieving goal (of course, the spending on social security for the ultra poor and vulnerable sections and the other important social sector expenditures should not be reduced). However, if other studies precisely suggest that such spending is not reaching out to the targeted poor then wastage of precious public resources needs to be immediately prevented and necessary corrective measures should be undertaken. At the same time, off-budget borrowing (which also accumulates debt burden) by the public sector undertakings should be ceased with immediate effect [Dutta, 2008]. But, as observed in the past, there is not likely to be an easy and short-cut method as far as wiping out of such borrowing is concerned. The Government of Karnataka has made several attempts to eliminate off-budget borrowing primarily by bringing these on the budget and making provisions for the same in the budget for 2008-09 and proposing to avoid all future off-budget borrowing in its Medium Term Fiscal Plan.[12] Earlier, while it has not been possible to stop off-budget borrowing immediately, the Government has made certain decisions: (1) not to allow the list of beneficiaries of off-budget borrowing to expand; (2) to gradually reduce reliance on off-budget borrowing; (3) to stop off-budget borrowing after 2004-05; among others [Khuntia, 2003, Pp. 212-232]. However, another way to reduce such borrowing is to resort to privatisation of the weak or loss-making public sector undertakings. A relatively soft measure is to replace the public management system of the undertaking by efficient private management system with a view to generating profit. In this regard, it is not easy to deal with off-budget borrowing which is associated with the electricity sector in the states. Strong political decision has to be made to fruitfully sort-out this matter. We would briefly touch upon the economic aspects of the electricity sector later in this article. Let us now focus on a brief background of the fact as to why FRBM was necessary for India.

As far as fiscal management is concerned, India had emphasised the management of price stability and balance of payments and thus could maintain a smooth journey during the first 30 years after independence. The balance between revenue (current) expenditure and revenue (current) receipt used to be maintained by the governments. Due to this balance, the governments were not under pressure to finance their revenue expenditures through borrowing. Thus, governments used to borrow resources to finance capital expenditures only. The combined deficit of the centre and the states was seldom seen to go beyond 4 per cent of GDP. The debt/GDP ratio of the country had gone up but remained below 45 per cent of GDP. Things started deteriorating in the 1980s as growth of government expenditures surpassed revenue growth [for further details, see Bagchi, 2006]. As a consequence of growing deficits, the debt/GDP ratio went up. In 1990-91, the combined fiscal deficit of the centre and the states went above 9 per cent of GDP and the debt/GDP ratio reached nearly 62 per cent level. Consequently, interest payment as percentage of GDP shot up from the earlier level of 2 per cent to 4 per cent. However, debt/GDP ratio continued to rise and reached 65 per cent level in 1999-00 [Rangarajan, 2004]. Once it even reached the level of 81 per cent and became a matter of concern and worry [Bagchi, 2005]. According to a study carried out by Hausmann and Purfield [2004], in terms of debt-to-revenue ratio India appears to be the second most indebted country in the world (after Pakistan). Initially, fiscal situation of the states did not raise any concern as the deficits in the state budgets remained at reasonable levels. However, from the second half of the 1990s, the level of deficits in the state budgets also started ringing alarm. The focus then shifted to the states [Bagchi, 2006]. Govinda Rao and Sen [2011] argue that "[e]nsuring a stable macroeconomic environment in a multilevel fiscal system requires coordination in stabilisation policies." In such circumstances, the Government of India [2000: paragraph 1.85] has observed the following:

"More effective management of public finances continues to be the central challenge facing all levels of government of India.... The adverse effects of large fiscal and revenue deficits on virtually every important dimension of macroeconomic performance are well known.... Furthermore, the continuous series of large deficits lead to inexorably mounting interest payments, leaving a declining share of government expenditure available for essential functions such as defence, law and order, social services and public investment in infrastructure".

Rangarajan [2004] argued that fiscal sustainability should ensure that a rise in fiscal deficit is matched by a rise in the capacity to service the increased debt. Considering this, he argued, borrowing for infrastructure or permanent assets may be justified. He found that a little less than 70 per cent of borrowing was not being spent on capital assets (at least of the physical kind) - and even when there was capital expenditure, the return on assets was negligible.

There are several ways to maintain fiscal balance using the provisions available within the fiscal domain -- one, by increasing revenue; two, by reducing expenditures; and three, by both measures together. According to Bagchi [2006], an easy (and also quick) measure is to adopt an expenditure cut policy. "The axe fell mainly on capital expenditure and also on expenditure on social and economic services with consequences that unfolded later and are still unfolding" (p. 4118). Reduced capital expenditure is considered to be adversely impacting on backward rural regions which have been acutely suffering from inadequate infrastructure. As the situation reached very critical stage, the need for adopting fiscal responsibility legislation (FRL) through the intervention of the Finance Commission became inevitable.

Table 2. Aggregate Receipts of State Governments

(amount in Rs. billion)

	1990-1998 (average)	1998-2004 (average)	2004-08 (average)	2008-10 (average)	2010-11	2011-12(RE)	2012-13(BE)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Aggregate receipt (1+2)	1515.20	3666.20	6496.60	9494.60	11735.70	14259.40	16333.00
	(15.00)	(15.90)	(16.10)	(15.70)	(15.30)	(16.10)	(16.10)
1. Revenue receipt (a+b)	1143.50	2400.80	4872.10	7314.00	9353.50	11414.70	13309.80
	(11.30)	(10.50)	(11.90)	(12.10)	(12.20)	(12.90)	(13.10)
a. States' own revenue (i+ii)	696.20	1501.20	2921.10	4279.20	5523.60	6578.50	7649.70
	(6.80)	(6.50)	(7.20)	(7.10)	(7.20)	(7.40)	(7.50)
i. States' own tax	518.00	1187.80	2333.60	3425.00	4607.10	5514.70	6450.70
	(5.10)	(5.20)	(5.70)	(5.70)	(6.00)	(6.20)	(6.30)
ii. States' own non-tax	178.20	313.40	587.50	854.20	916.50	1063.90	1199.00
	(1.70)	(1.40)	(1.40)	(1.40)	(1.20)	(1.20)	(1.20)
b. Current transfer (i+ii)	447.30	899.60	1951.00	3034.84	3829.90	4836.10	5660.10
	(4.50)	(3.90)	(4.70)	(5.00)	(5.00)	(5.50)	(5.60)
i. Shareable taxes	254.30	517.00	1110.70	1630.30	2194.90	2597.30	3021.90
	(2.50)	(2.30)	(2.70)	(2.70)	(2.90)	(2.90)	(3.00)
ii. Grants-in-aid	193.00	382.60	840.40	1404.50	1635.00	2238.90	2638.20
	(2.00)	(1.70)	(2.00)	(2.30)	(2.10)	(2.50)	(2.60)
2. Capital receipts (a+b)	371.80	1265.40	1624.50	2180.70	2382.30	2844.70	3023.33
	(3.70)	(5.40)	(4.20)	(3.60)	(3.10)	(3.20)	(3.00)
a. Loans from Centre	180.80	260.90	117.40	75.60	94.80	159.90	202.10
	(1.80)	(1.20)	(0.30)	(0.10)	(0.10)	(0.20)	(0.20)
b. Other capital receipts	191.00	1004.50	1507.10	2105.10	2287.50	2684.90	2821.10
	(1.90)	(4.20)	(3.90)	(3.50)	(3.00)	(3.00)	(2.80)

Source: RBI (2013), p. 29.

Note: 1. The period averages provided in this table reflect the different fiscal phases of the states;
2. Figures in parentheses are percentages to GDP;
3. Capital receipts include public accounts on a net basis;
4. RE = Revised estimate; BE = Budget estimate.

There is another part, i.e., revenue receipt. During the FRBM regime, how much of the fiscal correction in Indian states has occurred due to the states' own revenue mobilisations? Or, does the credit go to devolutions from the centre only? Fiscal improvement at the state level is attributable to both the central transfers (CT) and states' own tax revenue (OTR). Let us take a look at Table 2 which presents phase-wise data (averages for some phases) on aggregate receipts of the state governments. In the first phase of fiscal consolidation -- i.e., during 2004-08 -- it is not only the CT/GDP ratio that has increased (from 3.9 per cent to 4.7 per cent) against the previous phase of 1998-2004, but OTR/GDP ratio has also increased (from 5.2 per cent to 5.7 per cent) and thus contributed to the consolidation process in the fiscal domain. In the early recession period, (i.e., during 2008-10), the OTR/GDP ratio remained stagnant at 5.7 per cent. But, it has shown increasing trend thereafter (6 per cent in 2010-11, 6.2 per cent in 2011-12 RE, and 6.3 per cent in 2012-13 BE). If the special category states are excluded from these estimations, states' OTR/GDP ratio may perhaps demonstrate greater improvement. The reason is as follows. The typical features of a special category state include hilly terrain, sparsely populated habitation, and high transport costs which lead to high cost of delivering public services. With relatively low level of economic activity in most special category states, their tax base is limited compared to non-special category states. "These States, to a large extent, depend on transfers from the Centre (comprising grants and tax devolutions) for their resource needs" [RBI, 2011: 37].

Loss incurred by the state electric utilities is another major concern as far as improvement in states' fiscal condition is concerned. Electricity is provided to farmers free of charge in some states. In the domestic or residential sector too, electricity is provided at subsidised rates which vary according to different categories of consumers. It has been observed that tariffs are typically higher for those households that consume more electricity [IISD, 2012]. But, such higher tariffs do not fully offset the costs incurred for distribution of power free of charge or at subsidised rates. So, the governments provide subsidy to the distribution utilities. The actual subsidy that is transferred to the utilities is termed as "subsidy released" and is often lower than the amount of "subsidy booked (the state governments announce this amount beforehand, which is to be disbursed to the utilities as compensation)". According to Government of India [2011], the accumulated losses of the distribution utilities during 2005-10 account for Rs. 820 billion after subsidy has been paid. Part of this loss that is supported by the government guarantees is not reflected in the total public debt/GDP ratio since such guarantees belong to the off-budget accounts. However, they have the potential of becoming budgetary liabilities, in case a company is in deep financial trouble. (For a rough idea, let us make a simple calculation. At the end of March 2010, the states' total outstanding liabilities accounted for Rs. 16,486.50 billion. As a proportion of the national GDP of 2009-10, it accounted for 25.45 per cent. If we include the above-mentioned loss amount, i.e., Rs. 820 billion, in the states' total outstanding liabilities, the proportion goes up to 26.72 per cent.) Around 70 per cent of the financial losses of distribution companies during 2005-10 have been financed through loans from public sector banks. Of the total bank loans outstanding at Rs. 585 billion, as much as 42 per cent is backed by government guarantees. Srivastava et al. [2003] argue that subsidies that arise due to such guarantees extended by governments for loans taken by the public enterprises or distribution utilities are regarded as off-budget subsidies. They point out that these have the potential of becoming budgetary liabilities if there are defaults in loans guaranteed by the government. Keeping this in view, the RBI [2013: 1] has cautioned that "[t]here is ... a need to improve the measurement and reporting of implicit obligations of the states to reflect their true fiscal positions, particularly in light of increasing off-budget liabilities on account of guarantees to state power distribution companies (discoms)." If this is not kept in view then the states can show themselves to be on the right track in terms of the FRBM, while they are actually not.

4. MARKET FORCES AND FISCAL STABILITY: A TWO-WAY RELATIONSHIP

The overall goal of the reformed SGP[13] is to impose discipline on member states with potentially massive budget problems. Structural reforms especially to increase the competitiveness of the deficit countries in the Union are necessary. Stability in a fiscal union cannot be established just on the basis of voluntary principles.

To receive greater degree of fiscally responsible behaviour, another approach, next to better regulation, would be to encourage market forces. Weak market may jeopardise government's efforts of maintaining fiscal discipline. For example, low level of economic transactions in a weak country would not be able to generate desired level of revenues to be contributed to public exchequer. Similar examples can be drawn from other specific markets, such as high interest rate in financial/money market. Institutional obstacles, if found responsible for sluggish growth of an economy, need to be removed. Thus, both approaches -- fiscal disciplines and market forces -- can reinforce each other and be applied simultaneously. If member states know that no bailout is possible, they will show greater willingness to follow the fiscal rules. Articles 122 to 125 of the *Consolidated Version of the Treaty, 2008,* highlight the judicial basis for disciplining market forces [Hentschelmann, 2010: 40]. Article 125, the famous bailout Article, states that no member state, or the Union, is responsible for what might result into fiscally unsustainable commitments made by some other member state/s. According to Article 125:

The Union shall not be liable for or assume the commitments of central governments, regional, local or other public authorities, other bodies governed by public law, or public undertakings of any Member State, without prejudice to mutual financial guarantees for the joint execution of a specific project. A Member State shall not be liable for or assume the commitments of central governments, regional, local or other public authorities, other bodies governed by public law, or public undertakings of another Member State, without prejudice to mutual financial guarantees for the joint execution of a specific project.

Let us now explain the relevance of this Article. The large deficit countries may face higher interest rate on the bonds they have issued to finance the government debt. If the financial markets assume, however, as they did till recently, that in the end the Union will pay the debts, the creditworthiness will be misjudged and interest rates will be lower than what it should actually be. The present sovereign debt crisis can also be diagnosed as a situation that since one mechanism, i.e., the fiscal compact, has failed to maintain its disciplined management/behaviour, the other mechanism in the form of market forces has taken over to the extreme. Govinda Rao and Sen [2011] argue that "[a]n important precondition for market promoting federalism is the hard budget constraint because fiscally responsible decision can come only under such an environment and therefore the policies should be calibrated to avoid bailouts and free-riding behaviour." Further, according to them: It is not uncommon that the countries/states which have more developed markets and have been able to create greater market friendly environment will attract capital and skilled labour and grow faster than others. This requires creation of market-friendly policy environment and institutions. India has adopted liberalising policies on various fronts since 1991. In the last decade, India realised that both central and state governments have to respond to the globalising environment from the fiscal perspectives as well. Exorbitant government deficit would result in low demand for goods and services since people would save more than before in order to be prepared for the future hike in tax rate (the government would raise the tax rate in the future to finance the present deficit/debt).

As regards strengthening of market forces, one of the possible prescribed solutions, as discussed in many quarters, for the sovereign debt crisis is the creation of so-called Eurobonds [Springford, 2009]. If Eurobonds are issued they will be issued as a combined mechanism and will not be issued separately by the individual member states. Thus, the interest rate will probably become an average of the interest rates that the several member states will have to pay. As a result, the countries with a low government debt would see that the rate of interest they were earlier charged rises now, while the countries with a high debt would experience the opposite phenomenon. The financial market, however, as is probably the intention of issuing Eurobonds, can no longer effectively, in the extreme, take an individual state as hostage, for example, by asking an exceptionally high interest rate on bonds of the troubled member state. Greece would be facing such tough situation if it needed to finance the present deficit with its own bonds. Conversely, Germany has not approved the idea of floating common Eurobonds since it has to pay higher interest rate. However, some may argue that such an arrangement after Germany has said "yes" might weaken the market discipline.[14] Although such a cosmetic solution can be worked out for temporary relief, the EU has to eventually think of radical remedy to gradually get out of its structural problems of deficits and debts. Thus, imposition of some kinds of strict rules assumes special importance.

5. FISCAL MANAGEMENT: INCENTIVISED LEGISLATION IN INDIA VIS-à-VIS STRICT RULES IN THE EU

The TFC, in its recommendations, linked improvement in revenue deficit status of the states to the debt write-off. Thus, the Finance Commission introduced the incentivisation scheme into the fiscal consolidation process in order to woo the state governments in maintaining fiscal discipline and consequently macroeconomic stabilisation [Herd and Leibfritz, 2008]. The recommendation was like this: The states will be awarded debt write-off, only if they enact appropriate legislations to bring down the revenue deficit in the specified period of time and commit to reducing the fiscal deficit in a phased manner. So, there has been an attempt in India to ensure fiscal discipline by introducing incentive and legislation. Most of the states were keen to grab the incentives as they were heavily indebted. But, for grabbing the incentives, they had to go in for the legislation. Once the legislation was done, the states were put into constitutional binding to follow the FRBM rules. Similarly, the present EU treaty called as Fiscal Compact does also contain obligatory provision of legislative enactment. Let us now present some observations as well as suggestions in view of the proper/effective implementation of the new Fiscal Compact.

- A weak point of the previous fiscal pact was that the sanctions were, in fact, only theoretical. Their implication was low from the implementation point of view. Fines should have been imposed on the offending member states. In the new Fiscal Compact, however, sanctions are no longer theoretical but real and automatic. The EC can directly impose the sanctions without referral from the Council (see Article 126 TFEU), which was earlier subject to qualified majority voting in the Council. There are even ideas in the EC to completely suspend the voting rights of countries in the case of the breach of the agreement.

- Since the rules of the previous SGP have been consistently violated, in the preventive as well as the dissuasive arms, there must be strong provision of taking action on the EC and any individual member state as the case may be. The case/s must be taken before the European Court of Justice (ECJ). At present, this provision is not explicitly included in the Treaties. This provision was made in an earlier draft but has been, though not completely yet, deleted in the final versions. Currently, if a state, which has ratified the Fiscal Compact and is thereby bound by the fiscal provisions of the Compact, fails to enact the required "implementation law" in its own parliament within one year of the treaty's entry into force, it can ultimately be fined up to 0.1 per cent of its GDP by the ECJ. This fine will have to be transferred directly to the ESM. As has been indicated earlier, access to the ESM bailout provision would be conditional on signing the new treaty of fiscal disciplines. Thus, member states cannot be bailed out unless they do sign and apply the pact. A legislation related to implementation of balanced budget should be included in the national constitutions of the member states when there is no major exceptional shock (we discuss this later again). In addition, if failed in maintaining balanced budget, a member state should be taken to ECJ. Due to the present financial turmoil and the consequent political tension, many people are highly apprehensive about the future existence of the EU. However, a chance has now opened up before the EU to find new routes of establishing fiscal discipline through the fiscal treaty and building solidarity through the ESM.

- A post of European Stabilisation Commissioner needs to be created to monitor the national budgets. If a country does not comply with its commitments under the Fiscal Compact, the so-called European Structural and Cohesion Funds could be denied to the member state.

- If a member state has accepted or needs support from the funds of the ESM, the budgetary sovereignty of the member state gets automatically restricted. This is because then a national government has to present its draft budget in the EU (or EC) for approval before it presents the same in its own parliament. And the EU, if necessary, can temporarily reject or refuse it, suggesting some specific spending cuts or the establishments of new revenue streams or the both. In this endeavour, both the ESM and the Stabilisation Commissioner can play the necessary roles.

- Chronic deficits (and debt) of a certain country may adversely affect banks located in other countries. This is because of the fact that those banks have purchased bonds of the defaulting countries. To save those banks, some arrangements should be made, otherwise taxpayers' burden in those countries will unnecessarily increase.

- Good rules should be simple and easily verifiable. For Buiter [2003: 4], the earlier SGP rules were "both simple and simply wrong much of the time. It is better to be approximately right than precisely wrong". Some people are strongly arguing to eradicate structural deficit problem,[15] whereas a rule in the new Compact asserts that the budget deficit is normally not to exceed the 0.5 per cent of GDP, which could be further cyclically adjusted. This means that flexibility in the form of cyclical adjustment has been allowed in the Compact. The EU believed that splitting budget deficits into their cyclical and structural components -- although analytical process of such splitting is critical -- determines how much of the deficit is cyclical and will be slowly tackled when the economy recovers and how much is structural and must be eliminated by discretionary fiscal measures such as tax increases and spending cuts [McArdle, 2012]. To calculate the cyclical component, one would need (a) current and historic growth rates, (b) potential growth rates, and (c) output gaps expressed in terms of difference between these two growth rates, that is (b) - (a). Then, estimating the impact of the output gap (the extent to which the economy is under- or overheating) on the budget through a regression, one would get the cyclical component of the deficit. Finally, the structural component is the residual when temporary or one-off factors (expenditures and revenues) are excluded from the cyclical component. This mathematically/statistically derived cyclical adjustment notion has some shortfall due to non-incorporation of a subjective variable such as political factor and thus may lead to structural deficit crisis if the process of budget, sometimes politically inflated, is not properly monitored. This might happen due to populist political agenda (greater spending programmes) of the ruling party/coalition, which may be seen to have outweighed the need for maintaining fiscal disciplines. However, it is imperative to allow for cyclical adjustment to tackle unfavourable circumstances. The current treaty states that the countries may temporarily incur deficits only to take into account the budgetary impact of the economic cycle or severe economic downturn, and exceptional economic circumstances such as unusual event (which has a major impact on the financial position) beyond the control of the contracting party provided that this does not endanger budgetary sustainability in medium term. More specifically, in the treaty, the medium-term budgetary objectives (MTOs) allow the structural budget balances to be country-specific, taking into account differences across countries according to their economic fundamentals and risks to public-finance sustainability. Thus, the member states were requested to declare their specific MTOs in view of the following considerations:

* a balanced or surplus structural budgetary position (for high debt/low potential growth countries);

* a general limit of a structural deficit of 0.5 per cent of GDP, while the limit can be increased to up to 1 per cent only for countries with a government debt-to-GDP ratio significantly below 60 per cent and with low risks to long-term fiscal sustainability;

* the above-mentioned tight limits have been designed so that the member states can try to maintain the earlier budget deficit limit of 3 per cent in times of economic downturn (if the deficit is already very close to 3 per cent level, it would shoot up to much higher level during recession).

Hence, there are flexibilities in the Fiscal Compact to make necessary adjustments taking into account different situations.

6. TWELFTH FINANCE COMMISSION AND THE FRBM IN INDIA

It is imperative that in order to keep the fiscal issues of the member states on the right track the EU might need to think of a mechanism of surveillance that would include, among others, formulation of a set of rules, creation of a responsible post, etc. India has already initiated its own mechanism. Considering the alarming fiscal situation (especially the deficit and debt levels) in India, the TFC had recommended a set of fiscal rules (for both the centre and the states). As indicated earlier, it also recommended incentives (to be offered by the centre) for the states which would enact the rules in the state assemblies. Let us now discuss this in a little detail.

Finance Commission is a constitutional body formed after every five years "to undertake a quinquennial review of the resources of the Union and the States, ... and make recommendations on the manner in which the proceeds of Union taxes and duties have to be shared between the Central Government and the States, and further on the manner in which the share of the states is to be distributed among all the states" [Ramji et al., 2001: 28]. The Eleventh Finance Commission [2000-2005] had recommended the centre and the states to restore fiscal balance and asked the centre to create an incentive fund for the states that would follow the fiscal restructuring plan. However, the plan did not materialise. The focus of the TFC’s

[2005-2010] report was on fiscal consolidation and enactment of the FRBM Rules. The centre had already enacted the FRBM rules [in 2003] before the TFC came up with its report [in 2004], hence, enhanced emphasis was given in relation to the states in its report. Some of the recommendations are as follows [Government of India, 2004]:

* Revenue deficit to be eliminated.
* Fiscal deficit to be brought down to 3 per cent of GDP (for states, 3 per cent of gross state domestic product) and, at a maximum, to be contained at this level.
* The combined (centre and states) debt-GDP ratio with external debt measured at historical exchange rates should, at a minimum, be initially brought down to 75 per cent (at the time of recommendation it was 81 per cent).
* The long term goal for the centre and the states for the debt-GDP ratio should be 28 per cent each.
* The centre's interest payment relative to revenue receipts should be about 28 per cent. In the case of the states, the level of interest payments relative to revenue receipts should be 15 per cent.
* States should follow a policy of recruitment and wage, in a manner such that the total salary bill relative to revenue (recurring) expenditure net of interest payments and pensions does not exceed 35 per cent.

Rangarajan and Srivastava [2008] observed that, after the enactment of FRBM, the fiscal situation in terms of both fiscal deficit and debt/GDP ratio for both the centre and the states has improved. This improvement continued until the economy was hit by the world-wide recession. However, it was evident that India's strong federal system, with the centre occupying greater financial power, has facilitated by and large smooth enactment and implementation of fiscal responsibility legislations. Let us now briefly discuss this issue in the following section.

7. HAS INDIAN CONSTITUTION'S CENTRIPETAL BIAS PLAYED ANY ROLE?

Under the British regime, an Act was passed in 1919 which specified that the provinces should make initial contributions to the Federal Government to cover its deficits for a period of seven years and thereafter make a standard annual contribution. However, the 1935 Act commanded a financially strong Centre, and for Federal Grants-in-aid, conditional or discretionary, to be given to the provinces to meet public purposes. India became independent in 1947. The economic and social conditions prevalent in the wake of the Second World War and the Partition of the country appeared to provide logical support to the emergence of a strong Centre, with the Indian Constitution of 1950, not conferring more powers on the states than was considered under the 1935 Act [Ramji, et al. 2001]. Leftists in India are in favour of transferring more powers to the states. The Left Front has ruled the state of West Bengal for last 34 years (until it was out of power in 2011 assembly election) and largely accused the centre for occupying greater financial power and fostering a condition of underdevelopment in different states.

West Bengal and Sikkim are only two states which had earlier declined to enact the FRBM. West Bengal did not want to lose its borrowing power at greater scale and opposed the centre's policies of fiscal restructuring from different perspectives. Some arguments that were provided by the earlier Left Front-ruled Government are as follows [Government of India, 2010]:

* While, on the one hand, in the Constitution the major responsibilities in the sphere of development expenditure (for example, on irrigation, roads, power, education, health, etc.) and administrative expenditure (for example, on law and order, general administration, etc.) have been given to the states, the important revenue-raising powers (such as income tax, corporate tax, union excise duties, customs, service tax, etc.) have remained concentrated in the hands of the centre, on the other.

* While the states are endowed with less power of resource mobilisation and greater responsibility of development expenditure, the gap is not adequately met through fund transfers from the centre to the states in terms of devolution of central taxes and grants.

* It may also be noted that the share of total market borrowing to which the states may be entitled is also fixed by the centre. While in 1950s the share of market borrowing of the states and the centre in the total government market borrowings were approximately in the proportion of 50:50, this share of market borrowing of the states has now fallen sharply to about 20 per cent, with more than 80 per cent of the market borrowing being garnered by the centre.

In addition, as some allege, the central government takes the opportunity of raising funds by imposing surcharge rather than altering the rates and thus they can avoid sharing the receipts with the states [Amiya K Bagchi, 2004]. Even though all these are considered as counter arguments, it becomes once again evident that Indian Constitution has a centripetal bias, which has facilitated the FRBM to come into effect. And it has further been evident that the FRBM has helped the centre and the states to bring the fiscal condition in order. Adoption of incentivisation policy was instrumental. Finally, West Bengal had to bow down and enact the FRBM (little before the Left Front lost power), since such enactment was linked to some incentive schemes awarded by the centre. Incentives facilitated legislation and legislation facilitated fiscal restructuring process. This has been partly, if not largely, possible for the centre's possession of greater financial power, something which is missing in the EU federal structure.

Let us conclude this section by referring to another important issue relevant as an appendage. The Planning Commission is responsible for earmarking the plan size for each state for a Five-Year plan period. Indian state-level politicians, especially the chief ministers and finance ministers, often raise their voice for greater plan size. Approval of a large plan size provides a chief minister with arguments in favour of her/his successful efforts for further development of the state. The ruling party takes the opportunity to publicise the approval of a large plan size and wants to earn political competitiveness. Such approval from the Planning Commission was possible in case the same political party was in power both at centre and in a particular state [Biswas, et al. 2008].

Let us now try to understand about how an approved plan is financed. The expenditure on state plans consists of (1) the balance from current revenues from the state budgets, (2) plan assistance in the form of grants and loans by the central government (the grant-loan ratio is fixed at 30:70),[16] and (3) borrowing from other sources that include the market and different small saving schemes [Government of India, 2004]. Here, the important point to note is that if the balance from current revenues, (i.e., money from the first source) appears to be negative, something which the states have experienced for a long period of time before the FRBM regime, "the financing of the plan, apart from a small contribution of the plan grants from the centre, depends entirely on borrowing by the states" [Government of India, 2004: 20]. Although the main observation is important, part of the explanation seems to be flawed. According to the Thirteenth Finance

Commission report, plan grants were 35.80 per cent of the total transfers from the centre to the states during the award period of the Eighth Finance Commission [1984-89]. The share has come down to 28.55 per cent during the Twelfth Finance Commission award period [2005-10]. Although the share has decreased over time, the latest proportion/figure cannot be considered as a "small contribution" compared to the total size of the state plan. (as it has been termed by the Government of India) [Government of India, 2004]. However, larger plan size has led the states to greater debt trap. How? The states often considered a larger plan size as a positive reflection on their economic performances [Government of India, 2002, p. 3]. The states, which wanted to increase the 'grant' part, had to necessarily increase the 'loan' part as well in order to maintain the grant-loan ratio to be 30:70. This means that a larger plan size effectively leads to larger borrowing. This has provoked the TFC to suggest the plan size of every state be linked to the sustainable level of debt. A relatively large plan size is affordable with the less borrowing pressure if revenue surplus goes up. Such linkage needs to be incorporated in the EU fiscal consolidation processes.

8. SOME VIEWS, NOT JUST CONCLUSION OR SUMMARY

Does a rule-based system work in controlling and/or reducing deficit and debt? For the Indian states, the favourable effects of FRBM on deficit reduction were observed until the process was interrupted by the global slowdown [Dutta, 2012a]. FRBM has temporarily been relaxed to combat effects of the slowdown. There are signs that the states will be able to reduce deficits within dates newly fixed by the Kelkar Panel, if not by the earlier ones fixed by the Thirteenth Finance Commission (for the latest state-wise trends of revenue deficit and fiscal deficit, see Dutta [2012b]). But, turmoil is going on in the EU, especially in countries like Greece, Portugal, Ireland and Spain. Unlike the EU member states, a state government in India is not a sovereign body; rather it is partly but significantly dependent on the central government for resources, since the central government has adequate tax collecting powers. Thus, it has been possible for the central government to make the states enact the FRBM through introducing incentives, e.g., debt write-off scheme, swap of the high cost debt, etc. The EU federal system is very different from that of India. Attempts to bring in changes in the two systems may hint at a trade-off between decentralisation and the requirements of the fiscal union. Can the Indian states prefer greater autonomy at the cost of strong federal system? Can the EU member states prefer stronger federal bond at the cost of their sovereignty or autonomy? May be, extreme surrenders are neither feasible nor desirable from the perspectives of the concerned stakeholders, but some amount of compromise may result in more favourable outcomes. For example, the Indian centripetal bias may get somewhat loosened and thus a more decentralised fiscal union is produced (through, among others, transfer of some tax collecting powers from the centre to the states). Conversely, the EU member states may compromise their moderate fiscal sovereignty in the interest of stronger federal-fiscal Union.

Currently, if a state, which has ratified the Fiscal Compact and is thereby bound by the fiscal provisions of the Compact, fails to enact the required "implementation law" in its own parliament within one year of the treaty's entry into force, can ultimately be fined up to 0.1 per cent of its GDP by the ECJ. Questions have already been raised as to whether a sovereign member state can be punished by the EC. Amidst this, there is a proposal from the EC to introduce the "European Union financial transaction tax" (EUFTT) within some of the member states of the EU by 1 January 2014.[17] Somewhat greater financial power of the EC might create a relatively strong central body in the EU which might be useful in generating stronger federal system in the region.

India’s FRBM is a legislation which has been enacted in national parliament and state assemblies, whereas EU’s Fiscal Compact is a set of rules that have not been legislated. The EU member states are expected to enact the implementation law of the Compact in their national parliaments within one year after they have ratified the Compact. Violation of SGP rules has been observed earlier. Once the present rules are enacted, violation of the legislation by the government is extremely difficult unless duly amended. Possibility of amendment in the future, without taking any consent from the EC, cannot be totally overruled, since each member state is an independent sovereign country. So, a central mechanism at the EU level is required to be created to discuss whenever any uncomfortable circumstances associated with exercising the Compact arises in any member state, in order to prevent undesirable changes in the law. In India, to respond to cyclical fluctuations in the economy and exogenous shocks, temporary relaxations of FRBM rules -- as has been experienced during the recent recession -- may be necessary from time to time. This is being considered by the Fourteenth Finance Commission as one of the Terms of Reference asks the Commission to address this issue. However, in our opinion, states should not be allowed much autonomy in this regard, because that may be misused under political pressure; rather a permanent post of FRBM Commissioner can be created under the office of the Central Finance Commission to recommend state-specific relaxations from time to time, as necessary, and such provision, (i.e., FRBM Commissioner’s role) should be included in the FRBM Acts.

Another important issue also needs to be touched upon in this regard. Spending cuts have led to citizens’ agitations and demonstrations in some troubled EU countries. In India, it is true that although the states have benefited from the FRBM with respect to deficit reduction. They have, however, experienced a harsh situation as well -- i.e., a fall in their recurring (revenue) expenditures [Dutta, 2012b]. Similarly, as Polychroniou [2012] argues, Greece has been passing through tough time due to its harsh austerity measures, resulting in reduction in social sector expenditures like education, unemployment allowances, etc. While Polychroniou blamed the tough fiscal rules for the Greek social unrest, he did not forget at the same time to tell us that "there are definite specific domestic factors at work which led to the build-up of the crisis both within and outside the context of the financial crisis" (p. 35). Especially, when he states that "under the long and ignominious reign of the socialists, the looting of public wealth became an art form and covering up corruption a science" (p. 38) then we cannot just target the tight fiscal rules for all the odds that have been occurring. Something should have been done to correct the governance deficit as well. Moreover, in the process of fiscal restructuring, it is not always obligatory to reduce expenditures; one can also think of imposing taxes as well. Reducing expenditure, as some argue, could adversely impact on the standard of living of the poor if there is any cut in spending on social security and other social sectors such as health and education. Creating a fiscal union to supplement its monetary union is only one of the EU’s problems. Part of the problem is also to bring about structural reform and adjustment in many member states in order to improve their competitive position. If the EU, as indicated above, can create greater funds at the exchequer of the EC through tax collecting powers and/or other mechanisms, the member states can receive supplementary funds from the Fiscal Compact on the lines of India’s Finance Commission’s devolutions, including grants, to tackle adverse situations when they are in trouble. This would, however, require a degree of cohesiveness and a sense of oneness as a nation, which may be more missing in the EU than in India.

From the perspective of Indian situation, Chandrasekhar [2011, Pp. 21-37] argues that India's tax/GDP ratio (11.3 per cent as per 2006 accounts) is extremely low by international standards, including those of many developing countries. He stated:

"In the 1950s and the 1960s, economists concerned with development had concluded that national savings and government revenues in most developing countries were as low as they were not because these countries were poor, but because their governments had failed to adequately tax the rich in their countries. This meant that tax revenues of the government were lower than warranted" (p. 23).

But, when it comes to fiscal restructuring plan, many politicians as well as policy makers talk about austerity (the price of which is mostly borne by the poor), not about a mixed strategy that could offer a scope for maintaining a balance between both austerity and new revenue generation. In addition, fiscal restructuring also engages certain kind of policy shift from unreasonable, huge, recurrent (revenue) expenditure (that often engenders wastage through unproductive as well as unnecessary administrative expenses) to specific number of infrastructure projects through capital outlay.[18] The difference between the two is that the former has a much smaller multiplier effect in generating further income and revenue compared to the latter which is expected to induce new economic activities and thus new avenues for earning revenues. This is what had happened in the USA while the government had been tackling the Great Depression in the 1930s. Beyond the common notion of demand-generating, expansionary, expenditure policy, the US government sought to resort to structural shift from petty local expenditures to large federal projects:

"Before 1932 relative shares for each level were roughly 50% local, 20% state, and 30% federal government. After 1940, 30% of relative shares were local, 24% state, and 46% federal. A major part of increasing government expenditures, 75%, came in programs administered at the federal level but in cooperation with state and local governments" [Bordo et al. 2011: 9].

This clearly indicates a shift of focus from small projects to large projects. Large-scale expenditure in big infrastructure projects not only provided employment and thus helped generate demand through increased purchasing power, but also encouraged new entrepreneurship by linking remote areas with markets and growth centres, something which was also crucially important to get rid of recession first and prosper further.

NOTES

1. For an analysis from a legal point of view of the first draft of a new EU fiscal pact, see Peers [2011]; and Vasconcelos [2012] for an analysis of the third draft.

2. See "Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions" published by the EC on 3 October 2012, which is available at http://ec.europa.eu/internal_market/smact/docs/single-market-act2_en.pdf.

3. To come into effect, at least 12 of the 17 euro-zone member states have to ratify this intergovernmental fiscal treaty.

4. Violation of an Act is not permitted without necessary amendment in the national parliament or in a state assembly in question.

5. In the first quarter of 2012, the overall government deficit of the euro-zone countries was 3.2 per cent of GDP. The primary budget deficit of the euro-zone member states, net lending or borrowing excluding interest, as a percentage of GDP was about zero. Government debt as a percentage of GDP was on an average 87.3 per cent. The unemployment rate was about 11 per cent and consumer-price inflation was 2.6 percent. In the first quarter of 2012, there was no growth in the euro-zone. It is to be noted that, for all these figures/parameters, the differences between the individual member states vary significantly. For example, the government deficit for Finland is 0.7 per cent, whereas for Ireland 8.3 per cent.

6. The European Council defines the general political direction and priorities of the Union. The Council consists of the heads of governments of the EU member states, together with the President of the European Commission and the President of the European Council.

7. The budget of the EU is too small to play any role, in general, in stimulating the economy or, in particular, in solving the present sovereign debt crisis. The total budget (e.g. 147 billion euro in 2012) is about one per cent of the total GNP of the Union and the revenue and expenditure shown in the budget have to be in balance (Article 310, Consolidated Versions of the Treaty, 2008).

8. For the final version, see http://www.european-council.europa.eu/ media/639235/ st00tscg26_en12.pdf; for the fourth draft, see http://openeuropeblog.blogspot.com/ 2012/01/ draft-euro-fiscal -pact-episode-iv.html; and see http://www.telegraph.co.uk/ finance/financialcrisis/ 9026142/ The-EU-fiscal- draft-treaty-in-full.html for the first draft.

9. The annual rates of inflation based on averages of WPI and CPI were found to be 9.6 per cent and 10.4 per cent in 2010-11 and 8.9 per cent and 8.4 per cent in 2011-12, respectively, which appeared to be very high as compared to the 2007-08 levels [Government of India, 2013].

10. For many years, tax receipt of West Bengal, relative to its gross state domestic product (GSDP), has remained the lowest in the country. The tax-GSDP ratio in the state was 4.5 per cent in 2011-12, compared to the all-state average of 5.7 per cent [Govinda Rao, 2012]. The earlier Left Front government was largely responsible for such a situation and the present Trinamool Congress government does not also seem to have adopted corrective mode. The state's debt-burden is huge and so is their burden of annual interest payment.

11. *The Times of India,* 11 June, 2012.

12. See (1) Business Line, *The Hindu,* 19 July 2003, Saturday, http://www.thehindubusinessline.in/2003/07/19/stories/2003071901291700.htm; and (2) *The Hindu,* 23 July 2008, Wednesday, http://www.hindu.com/2008/07/23/stories/2008072354240400.htm.

13. Recently, the EC has produced four drafts. For the first draft, see Peers (2011); for the second draft, see http://www.openeurope.org.uk/research/ 06012012draftfiscalpact.pdf; for the third, see Vasconselos (2012); and see http://www.europolitics.info/ penalties-for-botching-debt-brake-fifth-draft-possible- art323899-32.html, for the fourth draft.

14. Germany has to understand that if the present turmoil keeps growing in the EU then the size of its export in EU countries may go down.

15. In general term, a structural deficit differs from a cyclical deficit in that it exists irrespective of the point in the business cycle due to an underlying imbalance in government revenues and expenditures. Thus, even at a relatively high point in the business cycle (when revenue level should be high) the country may still be in deficit and thereby resort to borrowing. We would now conceptually see how its technicalities are supposed to be dealt with in the European Fiscal Compact.

16. For the special category states (which are located in hilly terrain and have relatively very low level of economic activity as well as limited tax base), the ratio is 90:10.

17. For further details, see http://en.wikipedia.org/wiki/European_Union_financial_transaction_tax.

18. "Liberal policies did not and do not stipulate retreat of the state from its basic duties of building up social and economic infrastructure" [Chelliah, 2010, p. 12].

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INDIA'S AGRICULTURAL TRADE - POLICIES AND PATTERNS: AN ANALYSIS OF SELECTED FOOD COMMODITIES

Ashutosh Kumar Tripathi*

The policy environment for Indian agriculture since the early-1990s has witnessed considerable changes from broad-based economic reforms launched in 1991, to the signing of the Uruguay Round Agreement on Agriculture in 1994, leading to a series of reforms in agricultural trade policies. These changes were accompanied by first a sharp decline in international prices of several agricultural commodities, particularly after 1997, which reached almost 25-year low levels around year 2000, and then reversal in trend afterwards with rapid increase from 2004 onwards. As the period represents the two different scenarios in world prices/agriculture, the paper seeks to analyse how India has maintained a balance in its twin objectives of food policy, i.e., to maintain the domestic supply in order and keep the price at reasonable level in respect of four commodities, namely, wheat, rice, edible oils and sugar, following the progressive liberalisation of trade.

Key words: agriculture trade, trade policy, agriculture prices, agriculture supply, agriculture demand

JEL classification: Q11, Q17, Q18

Background

India, like many other developing countries, has been conservative player for long in agricultural trade. Trade policies were designed to regulate the volume of trade flows in order to impart stability to domestic prices and for improving the performance of the marketing system by influencing the average level of prices, inter-crop price ratios and the price-spreads in the domestic market. India's external trade policy, which was heavily controlled by government until the early-90s through a web of quantitative restrictions; licensing; and the canalisation of exports and imports, has undergone considerable change since then. The move towards agricultural trade liberalisation was triggered both by internal policy assessments as well as the external developments such as India becoming signatory to World Trade Organisation (WTO) in 1995 and committed to incorporating an open and liberal policy framework for her agricultural sector.

The move towards liberal trade policy framework for agriculture sector has generated intense debate among Indian academicians and policy makers on its likely implications for domestic agriculture and, in turn, on national and household food security; the levels of poverty and so on. The literature on liberalisation and agricultural performance is marred with controversies, as the arguments are equally divided in favour as well as against agricultural growth.[1] Some scholars feel that there are tremendous opportunities for Indian agriculture to benefit from increased openness and benefit from trade by reallocation of resources based on principle of comparative advantage [Gulati and Sharma, 1994; Gulati and Kohli, 1996; Gulati and Sharma, 1997, Pp. A154-A164; Pursell and Gulati, 1995; Parikh et al., 1995, 1997; Bhagwati and Srinivasan, 1993]. They viewed the process of liberalisation as a major opportunity for raising the overall rate of economic growth by exploiting India's comparative advantage in agriculture,[2] for improving the efficiency of resource use and for

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This paper is part of author's PhD thesis submitted to Jawaharlal Nehru University, New-Delhi. The draft of the paper was prepared while author was based at Yale University, New Haven, USA, as Fox International Fellow. The author would like to thank anonymous referee of the paper and editor of the journal Professor Vikas Chitre whose comments have greatly helped in improving the presentation of the argument.

technological up-gradation. Therefore, this school of thought emphasises closer integration of Indian agriculture with world agriculture and favours openness. The other group of scholars are sceptical about the gains from international trade in agriculture especially for two reasons [Storm, 1997, 2001; Bhalla, 2004; Nayyar and Sen, 1994a and 1994b; Chand, 1999, Pp. A153-A159; Chand and Jha, 2001; Chand, 2002a and 2002b]; first, international prices are highly distorted and do not represent true opportunity cost of resources and second, world prices suffer from serious year-to-year fluctuations, and free trade will transmit volatility to domestic market prices. Taken together, these considerations, the follower of this school of thoughts believes that some trade policy intervention in agriculture is both necessary and desirable. And argued for strategic openness[3] rather than general or indiscriminate openness in agriculture.

The issue of self-sufficiency in food production in India has also received considerable attention in the debate. On the one hand, it has been argued that a country like India can not rely on world market to meet its domestic requirements as international supply in case of agricultural commodity is limited, and India's import or export decision would have huge impact on global prices. On the other hand, merits of self-reliance as against self-sufficiency have also been highlighted [Gulati and Kohli, 1996]. There have been concerns about implication of liberalization on food security and livelihood as large segment of population depends on agriculture. The implication of trade liberalisation is different for consumers and producers. For instance, export liberalization, which increases the domestic prices, is favourable to producers but at the same time it hurts the domestic consumer adversely not only directly because of increase in prices but also because aggregate demand goes down with increase in domestic prices and consumer expenditure on essential commodities. Conversely, import liberalisation, which results in lower domestic prices is favourable to consumers but adversely affects the domestic producers who get lower price for their produce.

It has now been almost two decades since India has embraced economic openness and also one and half decade since it became signatory to WTO agreement on agriculture. The post-WTO period of last one and a half decade also accompanied by first a sharp decline in international prices of several agricultural commodities particularly after 1997 which reached almost 25-year low levels around year 2000 and then reversal in trend afterwards with rapid increase from 2004 onwards - representing two different scenarios in world prices and/or agriculture. These patterns of world prices for agricultural commodities, particularly food commodities, also pose serious challenge to government and policy makers in India in maintaining a balance between twin objectives of Indian food policy, i.e., to maintain the domestic supply of food in order and keep food prices at reasonable levels following the progressive liberalisation of trade. The present paper is an attempt in this direction.

In this paper, to deal with the aforesaid issues, we consider the broader question of maintaining the twin objectives of India's agricultural trade policy of maintaining domestic supply of agricultural commodities and keeping their prices at reasonable levels. The paper first critically analyses how trade policy instruments were used during post-liberalisation period to maintain domestic supplies of agricultural commodities in order and keep their prices at reasonable levels. It then juxtaposes the trade flow in agricultural commodities against domestic demand and supply situation. We begin with evolution of agriculture trade policy in section I. This is followed in section II, by commodity specific developments in the external trade policies with reference to four food commodities, namely, wheat, rice, edible oils and sugar. Since, the actual trade outcome is dependent on many factors and trade policy at best gives an idea about government intentions, therefore, an attempt is made to analyse the export and import pattern of selected the above mentioned food commodities in section III, in the light of the domestic demand and supply situation along with changes in global prices of these commodities. Section IV draws together some conclusions that emerge from the analysis.

I. EVOLUTION OF AGRICULTURAL TRADE POLICY

India's foreign trade policy in the sphere of agriculture which regulated the volume of both exports and imports till the reform initiated in 1991 was primarily dictated by two important considerations, a quest for import substitution and a concern for food self-sufficiency. In most of the commodities,[4] foreign trade flows have been perceived as a residual whether we consider exportables or importables. For exportables, the difference between actual domestic production and estimated domestic consumption has determined the surplus available for export. For importables, the difference between estimated domestic production and desired domestic consumption has determined the volume of imports [Nayyar and Sen, 1994b]. The major instruments used to implement these policy goals comprise quantitative restrictions (either in the form of licences or quotas), canalisation or a combination of both. The role of the State Trading Corporation (STC) and the co-operative federations was emphasised as canalising agencies for agricultural trade. There was little emphasis on export oriented production, and the production pattern of all major commodities was strictly guided by the requirements of domestic consumers and self-sufficiency. Allocation of resources according to comparative advantage in trade hardly got any emphasis.

This scenario has witnessed significant changes after 1991 when India started a process of stabilisation and adjustment, associated with sweeping reform of the industrial licensing, pricing, and tax policies and the dismantling of the restrictions on the foreign trade in industrial goods. The economic reforms involved the devaluation of the rupee by 18 per cent against the dollar and the exchange rate was left to be determined by the market forces. The changes in the industrial and the trade policy were introduced to expose the industry to competition by reducing the protection hitherto enjoyed by the industrial sector. However, no direct references were made to the agricultural sector in the reform package, though it was argued that new macroeconomic policy framework would have profound implications for Indian agriculture for more reasons than one. First, it was expected that changes in exchange rate and trade policy, devaluation of the currency, gradual dismantling of the industrial licensing system and reduction in industrial protection would benefit tradable agriculture by ending discrimination against it and by turning the terms of trade in its favour.[5] And second, these policies together with globalisation would bring domestic farm prices in line with world market prices. This, in turn, would provide a justification to increase support prices,[6] which will also turn the terms of trade in favour of agriculture. These implications of reform policies for Indian agriculture would, by altering relative prices in favour of agriculture, encourage private investment and technical change with consequent better agricultural growth [Singh, 1995, Pp. 1-6; Ahluwalia, 1996; Mishra, 1998; Gulati and Sharma, 1991].

Following the broad based macro-economic reform in 1991, new initiatives in trade policy were undertaken in subsequent export-import policies at different stages to provide stimulus to exports while at the same time reducing the degree of regulation and licensing control on foreign trade. The scope of canalization for both exports and imports was narrowed over the period of time. These policy changes aimed to strengthen export incentives, eliminate import licensing and optimise import compression.

Agricultural exports and imports were strictly regulated until 1992 through quantitative restrictions such as quotas and licenses or channelled through some trading organisation or some combination of both. With the new export-import (EXIM) policy initiated in 1992, three major changes were made in agricultural export-import. One, channelling of trade was abandoned and government stopped determining the value or nature of the import or exports, except for exports of onion and import of cereals, pulses and edible oils. Two, most of the quantitative restrictions on agricultural trade flows were dismantled. Three, there was some reduction in the tariff rates. These broad changes occurred at different phases starting from 1994 by liberalising import licensing on sugar and cotton; opening up of exports of rice and further allowing private traders in wheat export in 1995. The benefits available under the scheme of 100 per cent export oriented unit and export processing zones were also extended to agriculture and allied sector under this policy.

However, by and large, liberalisation in agriculture trade has been much in response to external stimulus particularly signing of Uruguay Round Agriculture Agreement (URAA) in 1994. Given the limited change that the URAA implied initially,[7] agricultural trade liberalisation did not cause a major problem during the early years of implementation.[8]

In the Uruguay round, India has agreed to make adjustment in tariff rates for 3,375 commodities/commodity groups (i.e., 65% of all tariff lines) at 6 digit level of HSTC (harmonized system of trade classification). Out of these 3,375 commodity groups, 692 tariff lines at 6 digits of HS classification belong to agriculture sector [Sharma, 2002].[9] Like many other developing countries, except for a few commodities, India submitted very high ceiling bindings of 100 per cent for primary products, 150 per cent for processed products and 300 per cent for edible oils. But for certain items (comprising about 119 tariff lines), which were historically bound at lower level in the earlier negotiations, the binding levels were very low, in some cases, even zero (including for commodities such as rice, coarse grain, and dairy products). But these zero or low tariffs had no relevance because India was allowed to use Quantitative Restrictions (QRs).

Beginning in 1996, strong pressure was put on India by several developed countries to remove all kinds of QRs on imports as it was found that India was not suffering from a balance-of-payments problem and this required a WTO member country to remove QRs. Thus, in order to make its policy consistent with WTO obligations, India removed the QRs on 714 items including 142 commodities belonging to the category of agricultural commodities during 1999-00. On April 1st, 2001, India eliminated the last QRs on 715 six-digit tariff lines including 142 tariff lines pertaining to agriculture. The modifications to EXIM policy for the period 1st April 1997 to 31st March 2002 in April 1999, 2000 and 2001 were very much in tune with meeting the requirements of the WTO panel’s ruling about QRs as discussed.

When the QRs were finally abolished in 2001, it was feared that there would be a surge in imports. Primarily to allay these fears, the modification to EXIM policy in 2001-02 has taken a number of measures. Import of agricultural products like rice, wheat, maize, other coarse cereals, copra and coconut oil were placed in the category of State Trading.[10] The government also started monitoring imports of 300 sensitive items, as many as two-thirds of which are agricultural products, including milk products, fruit and nuts, coffee, tea, spices, cereals, and edible oils. The government also started exploring options, which would permit the imposition of temporary quantitative restrictions to combat adverse flow of cheap imports into the country. As a result, certain agricultural products that were previously subject to quantitative restrictions are now considered sensitive products and bear above-average tariffs.[11] Others, such as sugar (HS 1701) and some cereals,[12] are considered sensitive because of employment and food security concerns and also bear high average applied tariff rates.

To understand the implementation experience with respect to tariffication, the bound rate should be compared with the level of applied tariff rates. The most striking feature of India's post Uruguay Round tariff structure is the wide gap between the bound and applied levels. Against the simple average bound tariff rate of 117.2 per cent the average applied rate of basic custom duty for 2006-07 was 40.8 per cent. Applied tariff rates range from 0 per cent to 182 per cent. The highest rates are in HS Chapters 22 (beverages, spirits and vinegar); 21 (miscellaneous edible preparations); 9 (coffee and tea); 15 (animal or vegetable fats); and 10 (cereals). Some of these rates, notably for cereals, are currently at their bound rates. However, for the majority of tariffs, there remains a considerable gap between the applied and bound rates, ranging from 10 per cent to 300 per cent (Appendix Chart 1).

India's agricultural exports policies began to change in 1994. They have been progressively liberalised since then, barring the occasional reversal in order to ensure adequate domestic supply of essential commodities at reasonable prices. The policy reforms leading to the liberalisation of exports include reductions in products subject to state trading, relaxation of export quotas, the abolition of minimum export prices (MEPs), and increased credit availability for exports. The amendments of EXIM policy 1997-2002 during April 2001 gave importance to agricultural sector through creation of Agricultural Export Zones wherein the state governments could identify product specific zones. The EXIM Policy 2004-09 has given more importance to agriculture, especially for exports. With sluggish growth in exports and rising imports, liberalisation of agricultural exports was an inevitable outcome. Export restrictions like registration and packaging requirements were removed on butter, pulses, wheat and wheat products, groundnut oil, cashew and coarse grains. Restrictions on export of all cultivated varieties of seed, except jute, and onion were also removed. The creation of agricultural export zones which was initiated earlier was modulated and 20 agricultural export zones were notified covering many exportable items. Nonetheless, the policy keeps changing from year to year, and sometimes even within a year. Export licenses are generally required for goods such as cattle, milk, cereals, edible oils, and pulses.

In sum, all the three EXIM policies launched since 1992 are based on the premise that India has vast potential for export, and emphasise the need to harness this potential. And to further this, various restrictions and controls on export of various agricultural items have been gradually removed, institutional and infrastructural support has been strengthened and some indirect incentives have been put in place. However, imports continued to be considered as undesirable. Though the QRs on imports of agricultural products were phased out by April 2001, there exist wide gaps between the bound and applied levels of tariffs, which provide India with the discretionary ability to adjust tariffs to support its overall goals of food self-sufficiency and price stability. The only agricultural item for which real liberalisation of import has taken place is vegetable oil. In all other cases, imports are encouraged only when domestic supply can not match with domestic demand or when there are some temporary supply shocks. The section below provides in-depth analysis of how the trade policy instruments were used over the period of time in case of four food commodities namely, wheat, rice, edible oils and sugar.

II. COMMODITY SPECIFIC EXTERNAL TRADE POLICIES

Wheat

From the 1980s to the early 1990s, India protected its wheat sector with quantitative restrictions on both imports and exports. Wheat trade has been under government control, and the import and export quantities reflect government decisions made during each year as well as across the years in managing supply, demand, stocks and food prices to strengthen domestic food security. Quantitative controls on exports were administered through the Food Corporation of India (FCI). According to the trade policy followed from 1988 to 1991, the export of wheat was restricted through licensing. During 1992-97, wheat was kept under the negative list[13] but the export was allowed freely, as long as it did not exceed the ceiling limit stipulated from time to time, at a price above MEP. This policy was followed till 1997, except for the period between 1995 and 1996 when the government attempted to boost wheat exports. In 1995, government placed wheat export in the open category and notified an export ceiling of 2.5 million tonnes for export of non-Durum wheat from the open market without any MEP during the year 1995-96. But as exports picked up, domestic prices of wheat rose and the government, fearing unrest, put a ban on wheat export. Therefore, till 1997, export of wheat from India was restricted and subjected to minimum export price. Since then, the export restrictions were removed in a phased manner, first, by abolishing the condition of MEP in 1998 and second, by removing the ceiling limit on export of wheat and its products in April 2002, subject to the condition that stocks in the central pool are not lower than 14.3 million tonnes at any point of time. Government started providing budgetary subsidies since 2000 to support exports of surplus wheat when the combination of declining world prices and higher domestic prices made Indian wheat uncompetitive in world markets [Tripathi, 2013].

Table 1 shows that from 2001 to 2005 substantial amount of export subsidies were paid to make it worthwhile for private traders to help dispose of large excess wheat stocks.

Table 1. Wheat export quantities and amount of subsidy provided by Food Corporation of India; 2000-01 to 2004-05

	Quantity lakh tonnes	Rate of subsidy Rs/qtl	Amount of subsidy Rs lakh
(1)	(2)	(3)	(4)
2000-01	21.53	468.40	100850.53
2001-02	37.95	430.15	163242.56
2002-03	73.91	445.27	329098.71
2003-04	71.75	379.15	272003.54
2004-05	8.45	353.19	29844.62

Source: Annual reports of Food Corporation of India, various issues

In 2005, the Government halted export subsidies because of tightening domestic supplies and increased Indian competitiveness in international markets, although private traders remain free to export wheat. Following a sharp fall in government's annual food grain procurement because of good open market prices and lower production, India banned exports of wheat and wheat products in 2007.

In the case of import, trade policies were changed when quantitative restrictions on imports were lifted and replaced by tariffs in the mid-1990s. There was zero customs duty on import of wheat until 1999 and a check on imports was kept through quantitative restrictions and canalisation. Removal of quantitative restrictions and freeing of imports in mid-1999 led to sudden importation of wheat. This forced the country to impose varying rate of tariff to regulate wheat importation. As a result, the wheat tariff which was initially set at zero was raised to 50 per cent on December 1st, 1999, to curb imports into southern India at a time when surpluses were growing in the north,[14] which continued till January 2006. In view of inadequate stocks with public agencies it was decided in February 2006, that government run agencies can import wheat at zero duty. Later on during the year, the previous major role of State Trading Enterprises (STEs) in import was eliminated in June 2006 by announcing that wheat imports would no longer be a monopoly of the Food Corporation of India (FCI). Reacting to the surge in wheat prices, initially, the government on June 28th, 2006, decided to reduce the customs duty from 50 per cent to 5 per cent for private agencies along with the standards of quality applicable only to the imports made by the public sector and after that in September 2006 the government allowed private traders to import wheat at zero duty.[15] Therefore, there appears to be a tendency in food policy to use trade policy instruments more frequently since 2000 compared to earlier decades.

Rice

Before liberalisation, a restrictive trade policy was followed in the case of rice. There was zero customs duty until 1999 and imports had been subject to QRs and canalisation. Imports were restored only when domestic production dropped significantly. However, since 1998-99, trade policy witnessed a major shift when quantitative restrictions on imports were lifted and replaced by tariffs to meet WTO commitments. This resulted in import of 35 thousand tonnes of rice in 1999-2000 and 13 thousand tonnes during 2000-01. With the decline in international prices of rice between 1999-2000 and 2000-01, imports of low grade rice became attractive, mostly to some of the eastern states of the country [Tripathi, 2013]. To keep a check on such undesirable imports, in 2002-03, India levied a 70 per cent duty on milled rice import and 80 per cent on paddy, brown rice and broken rice. This import tariff structure was maintained till September 2009, except for the period between March 20th, 2008, and March 31st, 2009, when government allowed duty-free import in order to control inflation. In a subsequent move, as the twin-impact of drought and floods deepened fears of a dip in output, on October 26th, 2009, the government scrapped import duty on "semi-milled or wholly milled rice, whether or not polished or glazed" till September 2010 to augment domestic supply [*The Hindu Business Line*, October 27th, 2009].

Export restrictions on rice, historically imposed through State trading, quotas, and minimum export prices, have been progressively liberalised. A different policy has been followed for common rice and basmati rice. While, there was no restriction on export of basmati rice, export of common rice was restricted through canalisation, minimum export prices and export quotas till 1991 (according to trade policy 1988 to 1991). There were restrictions on stocking rice beyond a limit unless there was an export order in hand [Datta, 1996]. The devaluation of the Indian rupee in 1991 along with relaxation in export controls on common rice during 1992 changed the situation dramatically. As per the trade policy for 1992-97, though rice was kept in the negative list, its export was freely allowed subject to MEP and registration of contracts with Agricultural and Processed Food Export Development Authority (APEDA). Export controls on all varieties of rice were abolished in October 1994, which further improved possibility of rice export [Bhasin, 1996].

In order to liquidate excess stocks, a scheme for export of food grains from the central pool was adopted in the year 2000. As part of that, a decision was taken to offer food grain for export[16] at a price "equal to the economic cost minus two year carrying cost but not lower than the central issue price for BPL". The scheme which was extended to rice as well in the subsequent year led to a record growth in India's rice export. The quantities of rice exported and subsidy provided by the government during the years 2000 to 2004 are presented in the table 2.

Table 2. Rice quantities exported and subsidy provided by Food Corporation of India; 2000-01 to 2004-05

Financial years	Quantity lakh tonnes	Rate of subsidy Rs/qtl	Amount of subsidy Rs lakh
(1)	(2)	(3)	(4)
2000-01	0.47	466.04	2202.40
2001-02	24.69	513.69	126820.19
2002-03	77.69	570.20	442989.43
2003-04	27.75	555.70	154188.72
2004-05	0.65	492.29	3199.92

Source: Annual report of Food Corporation of India, various issues

On a review, it was decided to stop fresh allocation for export from 11th August 2003. After meeting the pending commitments of exports, sale of food grains for commercial exports under the scheme to liquidate the excess stocks with the provision of export subsidy have been totally stopped w.e.f. 1st October 2004. In October 2007, government put a ban on non-basmati rice exports to manage rising inflation. However, the government allowed the shipping abroad of about two million tonnes only via diplomatic channels (meant for humanitarian aid). The government's decision to ban non-basmati exports has brought India down to fourth position, whereas Pakistan has moved up by one place to third rank in the list of top rice exporters in the world in 2008-09 [Commodity online, July 16th, 2009].

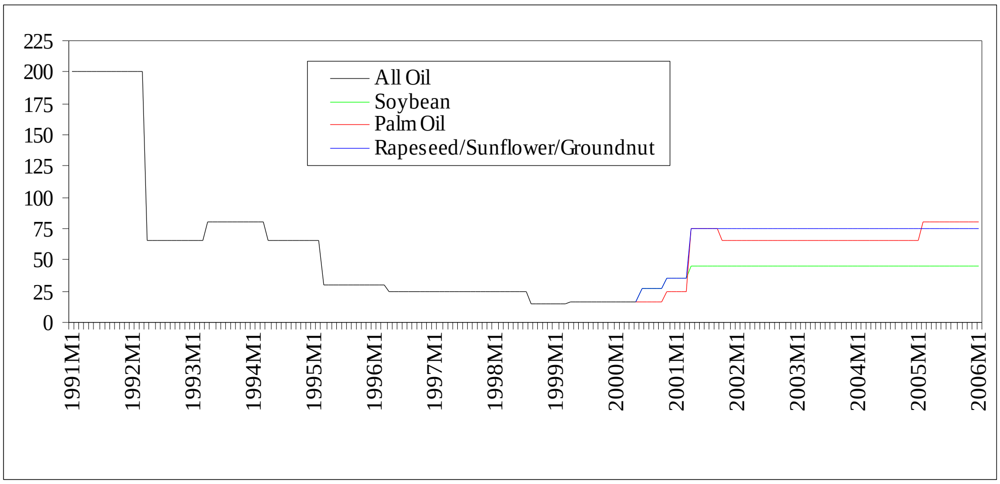
Edible oils

From the 1970s until 1994, India protected its oilseed sector with quantitative restrictions on both imports and exports and annual import and export quantities were determined by an inter-ministerial committee based on domestic market condition, (i.e., demand and supply), producer versus consumer interests, international prices, and foreign exchange availability. Although the government did at times permit relatively high imports, averaging as much as 1.3 million tonnes annually between 1976-77 and 1987-88, imports were sharply curtailed in 1989-94, when the government promoted domestic oilseeds production under its Technology Mission on Oilseeds (TMO) programme.[17] Nonetheless, up to 1994, imports were canalised through the State Trading Corporation (STC) and the Hindustan Vegetable Oils Corporation (HVOC) and subject to state-imposed import quotas.

Since 1994, when India began conforming to WTO rules and replacing quantitative trade restrictions with tariffs, oil imports have been placed under open general license (OGL) allowing imports by private traders subject to applied tariffs. In March 1994, import of palmolein oil was permitted under OGL with a duty rate of 65 per cent for private traders and at a concessional duty of 20 per cent for the state agencies such as NDDB and STC. This was followed by a measure to enlarge the basket of oil under OGL imports on March 1st 1995, when all vegetable oils except coconut, RBD palm oil and palm stearin[18] were placed under OGL with an import tariff of 30 per cent; STC and NDDB continued to benefit from the 20 per cent concessional tariff rate.

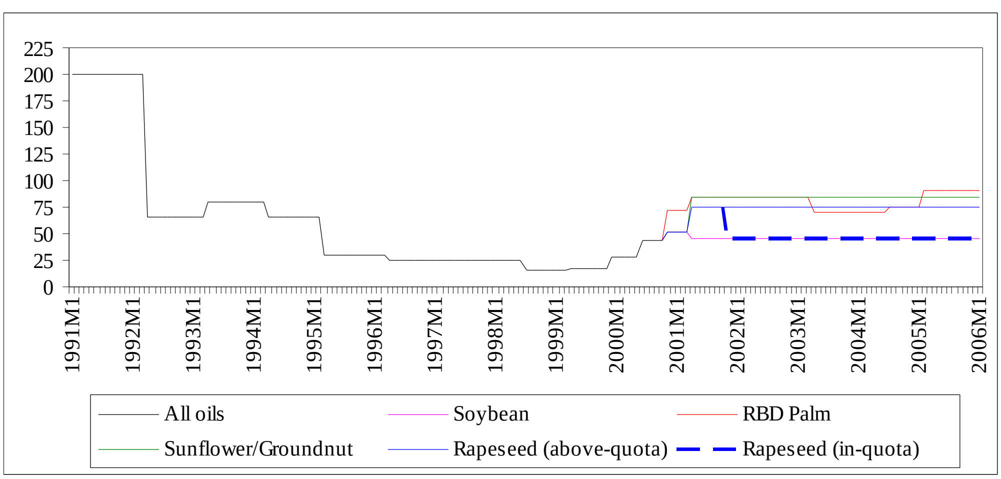
During 1995-98, India started moving towards liberal and relatively simple tariff structure with a common applied *ad valorem* (percentage) tariff for all oils, progressively lowered to a uniform rate of 16.5 per cent by the middle of 1998.[19] Importers responded to the lower tariffs and declining international prices[20] by importing 2.6 million tonnes of edible oil in 1998-99, up sharply from earlier levels, and more than double the level of imports in 1997-98. Since 1998, the government began making frequent tariff adjustments in case of edible oils to protect domestic oilseed producers and processors from imports and to smooth the effect of fluctuating world prices on domestic consumers (Figure 1 & 2). Although, applied tariffs fell in 1999 after an initial hike in June 1998, the trend after April 2000 was incremental increases to applied rates for all oils, with adjustments being made to the relative rates on different types of oil, creating a more complicated tariff structure.[21] The main effect of these changes was to slow the growth of imports.

Figure 1. India's import tariff on crude (vegetable) oil: 1991 to 2005



Source: Government of India

Figure 2. India's import tariff on refined (vegetable) oil: 1991 to 2005



Source: Government of India

Appendix table 1 gives the detailed chronology of trade policy changes in the Indian edible oil sector since 1994. As can be seen, in December 1999, government introduced higher tariffs for refined versus crude oils in order to shift imports from refined soft oils to crude oils and improve capacity utilisation in the refining sector. Again, in November 2000, tariffs on all oil imports were raised. The differential duties on crude and refined oils did shift in demand from refined oils toward crude oils, improving capacity utilisation of domestic refiners. The change in March 2001 was aimed at reducing the differentials between crude and refined oil tariffs, and providing limited concessions to vanaspati manufacturers. The tariff hikes also made the tariff on soybean oil increasingly preferential, since tariffs on palm, rapeseed, and sunflower oils could be raised well above the 45 per cent tariff binding on soybean oil, although recent adjustments to the palm oil tariff have reduced this preference (see appendix table 1).

In addition to adjusting tariffs, the government established a tariff rate value (TRV) system for palm oil in August 2001 and for soybean oil in September 2002 to prevent under-invoicing, i.e., reporting low import prices to evade tariffs by importers, and establish a government reference price for tariff calculation. Although the tariff values were amended several times to reflect changing market conditions, the system created new potential distortions when actual market prices diverged from the tariff values used by the government [Dohlman et al, 2003].

Sugar

Sugar is included under the Essential Commodities Act (ECA) of 1965 and hence all the aspects of the industry including marketing and distribution are highly regulated. Until July 2000, ECA was applied to regulate the stocks and turnover of sugar traders, but these controls were lifted in July 2000 and August 2001. However, in June 2003, ECA was invoked as a *de facto* import restriction by obliging importers to obtain permission to resell imported sugar, on the grounds that they compete with Indian mills and therefore should be subject to the same "release order" restrictions.[22]

Until the 1980s, sugar imports were canalised and government was having monopoly in sugar import, but subsequently private firms were allowed subject to import licensing. In March 1994, when world sugar prices were high [Tripathi, 2013], import licensing was dropped and tariffs were cut to zero. This policy remained in place for the next four years. Again, in 1998, when world sugar prices started declining,[23] government reversed these policies and between April 1998 and February 2000 tariffs were increased, in steps, from 0 to 40 per cent. In January 1999, government again imposed the ECA on sugar imports along with making it mandatory in September 1998 to register all sugar import contracts with APEDA, which monitors them to evaluate their impact on the domestic industry. Along with import duties sugar imports are also subject to countervailing duty (CVD), as is the case with domestically produced sugar (Table 3).

Table 3. Indian Sugar Tariffs and QRs Status; 1991-2008

	Tariffs (Raw Sugar) %	Tariffs (Refined) %	Domestic taxes Rs/Qtl	QR status
(1)	(2)	(3)	(4)	(5)
1991	40	60	64	Restricted
1992	40	60	85	Restricted
1993	40	60	85	Restricted
1994	0	0	85	Restricted
1995	0	0	85	Free
1996	0	0	85	Free
1997	0	0	85	Free
1998	0	0	85	Free
Apl 98-Jan 99	5	5	85	Free
Jan 99-Apl 99	20	20	85	ECA
Apl 99-Dec 99	35	35	85	ECA
Dec 99-Feb 00	40	40	85	ECA
Feb 00-Mch 00	60	40	85	ECA
2001	40	40	85	ECA
2002	60	60	85	ECA
2003	60	60	85	ECA
2004	60	60	85	ECA
2005	60	60	85	ECA
2006	60	60	85	ECA
2007	60	60	85	ECA
2008	60	60	85	ECA

Source: Adopted from Pursell, 2007.

Before 1991, sugar exports were canalised, i.e., they were a legal monopoly of the government trading company, STC. During the period of state export monopoly, whenever government found excess supply in the market, sugar was exported, if necessary at a loss, in order to maintain a presence in quota markets (see Pursell and Gupta, 1998, for details) and the sugar export quotas and losses were allocated between the sugar mills through the Sugar Export Promotion Act of 1958.[24] The 1991/92 trade policy reform de-canalised sugar export by allowing sugar to be exported by Indian Sugar and General Export Import Corporation (ISGIEIC), now known as Indian Sugar Exim Corporation (ISEC), a private association of Indian sugar mills. But, as previously, the quantities exported were controlled by the Ministry of Food and Civil Supplies. Accordingly, export quotas were allocated to sugar mills. In January 1997, individual sugar mills and private traders were allowed to export sugar, but the overall level of export was still controlled by the government, and export quotas were allocated by APEDA. In 1999 and 2000, export policy was reversed to actively encourage sugar export as a way to reduce excess accumulated stock and assisting sugar mills facing severe financial difficulties. This was done in April 2001 by first removing the APEDA's control over export, and then by introducing and gradually increasing export subsidies for sugar [Pursell, 2007].

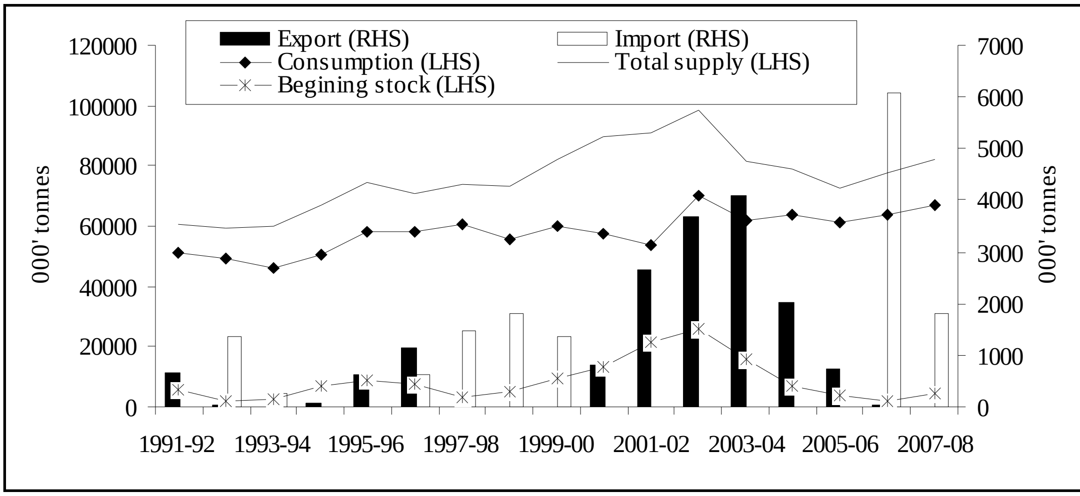
In summary, it is evident from the discussion that external trade in agricultural commodities has been liberalised and most of the alterations took place only from mid-1990s when India opened her markets to world trade. However, in the past and even in most recent periods also, there have been significant departures from the stated policy depending on developments in global and domestic economies. For instance, emphasis on export liberalisation and import duty underwent significant change after 2006, when global prices started increasing with the onset of global food crisis. Following the crisis, India almost reversed some aspects of trade policy to insulate domestic market from global food prices. It banned export of main staples - rice and wheat in 2007 to augment domestic supplies and manage rising inflation. There was also steep reduction in import duty on import of wheat and rice. For example, reacting to the surge in wheat and rice prices, government allowed import of wheat and rice at zero duty since 2006 and 2008, respectively. Agricultural trade was strictly regulated by various notifications issued by Directorate General of Foreign Trade. The section below analyses the trade pattern for these commodities in the light of domestic demand and supply situation, trade policy environment and international prices.

III. COMMODITY SPECIFIC TRADE PATTERN

Wheat

India was often an importer of wheat prior to the 1990s. During the 1990s, however, India has been a marginal exporter on occasion as well as an importer (Appendix table 2). However, since India is a large market, these marginal quantities can be often significant for the world market. India's wheat trade shows violent year to year fluctuation. One or two years of good harvest resulted in the pilling up of wheat stock, which encouraged the country to opt for large exports. This was immediately followed by huge imports. For instance, India exported 2.75 lakh tonnes of wheat during 1987-88, and in the following year imported as much as 18 lakh tonnes. Again, India exported 6.60 lakh tonnes of wheat during 1991/92 which was followed by import of 13.64 lakh tonnes in 1992-93 (Appendix table 2). Wheat export which was restricted until 1995 was placed in the open category afterwards. Consequently, exports started picking up and for two consecutive years India exported 6.32 lakh tonnes of wheat during 1995-96 and 11.46 lakh tonnes of wheat during 1996-97, at a time when world prices were at a peak.[25] As exports started to pick up there was upward pressure on domestic wheat prices; due to shortfall in supply and meagre addition to wheat stock with public agencies[26] government hastily banned exports of wheat in 1996/97 (Figure 3; Appendix table 2). Simultaneously, it opened up imports of wheat at zero import duty. Initially, very low levels of import followed but from 1997-98 the world prices of wheat started coming down,[27] encouraging the country to go in for large imports and India imported 15, 18 and 14 lakh tonnes of wheat during 1997/98, 1998/99 and 1999/2000, respectively (Figure 3; Appendix table 2). A very low level of world prices in 1999/2000, forced the country to impose tariff - varying from time to time - to regulate wheat importation. The major imports to India were from the countries like Australia, France, Belgium, Turkey, Ukraine, etc.

Figure 3. Demand, supply and trade pattern of wheat in India; 1991-92 to 2007-08

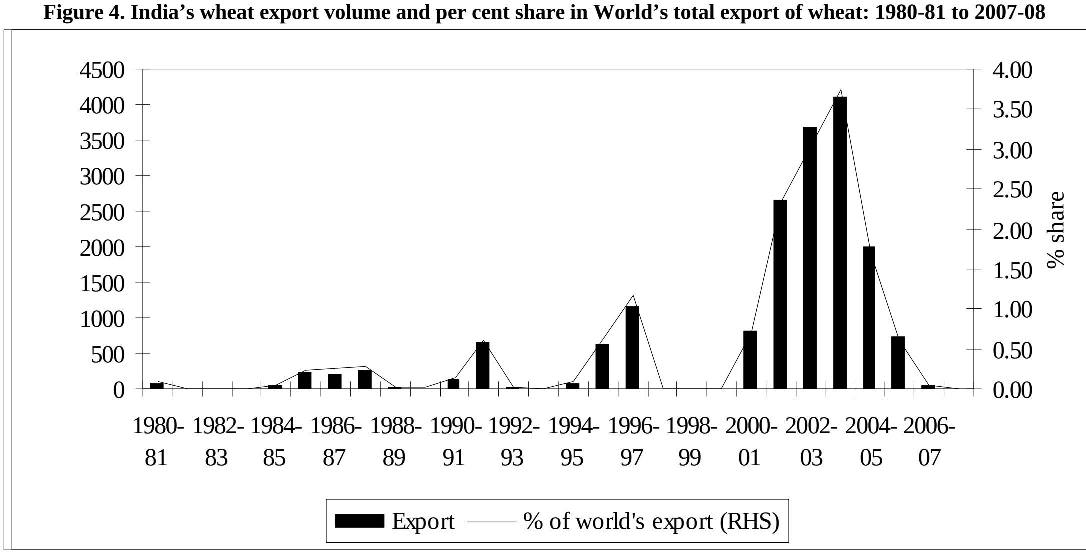


Source: Appendix table 2

There was a huge build up of wheat stock with public agencies in India after 1997-98, and reached a peak of 26 million tonnes in 2002-03. This level of stock was equal to 36 per cent of total wheat produced in the country in 2002-03. The huge build up of wheat stock with public agencies resulted from a combination of demand and supply side factors. On the demand side, demand for wheat[28] started declining since 1997-98 and reached the level of 53 million tonnes in 2001-02. The food demand fell more than 6 million tonnes during the period. This was the period when an excessive rise given to MSP and a resulting increase in PDS and open market prices forced consumers to cut down consumption, which led to an adverse impact on nutrition [Chand, 2005, Pp. 1055-62; Chand and Kumar, 2006, Pp. 329-64]. On the supply side, excessive rise given to procurement price (MSP) resulted into an increase in wheat supply.[29] This happened despite stagnant wheat production during the period. Wheat production during the period, (i.e., 1997-98 to 2001-02) stagnated at the level of 69 to 70 million tonnes, but the procurement by public agencies increased from 9.30 million tonnes to 20.63 million tonnes, mainly on account of huge increase of 60 per cent in wheat procurement price between 1996-97 to 2001-02. Government faced serious difficulty in disposing of these large stocks as domestic demand fell short of supply at ruling prices, which were largely governed by government actions related to the minimum support price (MSP), open market sales, and public distribution system (PDS) prices. Consequently, India used the export option to liquidate these stocks at a highly subsidised price[30] through its agencies such as STC (State Trading Corporation), MMTC (Minerals and Metals Trading Corporation) and PEC (Project Equipment Corporation). India exported 2.65 million tonnes during 2001-02 and 3.67 million tonnes during 2002-03. Despite a fall in production to the tune of 7 million tonnes in 2003-04 relative to the previous year (Appendix table 2), India exported more than 4 million tonnes of wheat during 2003-04, as impact of fall in production could not be felt because a large stock of wheat was available with public agencies to augment domestic supply. Buffer stock of wheat declined by more than 10 million tonnes between 2002 and 2003, so excluding (net) export (3.67 million tonnes), there was a net addition of

6.72 million tonnes in the domestic supply of wheat from stock (Appendix table 2). Because of supplementing of production by drawing on the stock, shortage of wheat could not be felt for a couple of years. And large scale export continued during 2004-05 and India continued to export wheat till 2005-06. During the period between 2001-02 and 2005-06, India's total wheat export was 13.17 million tonnes constituting around two and half per cent of world's total wheat export during the period. India's contribution to the world's total wheat export was highest (around 4 per cent) during 2003-04 (Figure 4).

Figure 4. India's wheat export volume and per cent share in World's total export of wheat: 1980-81 to 2007-08



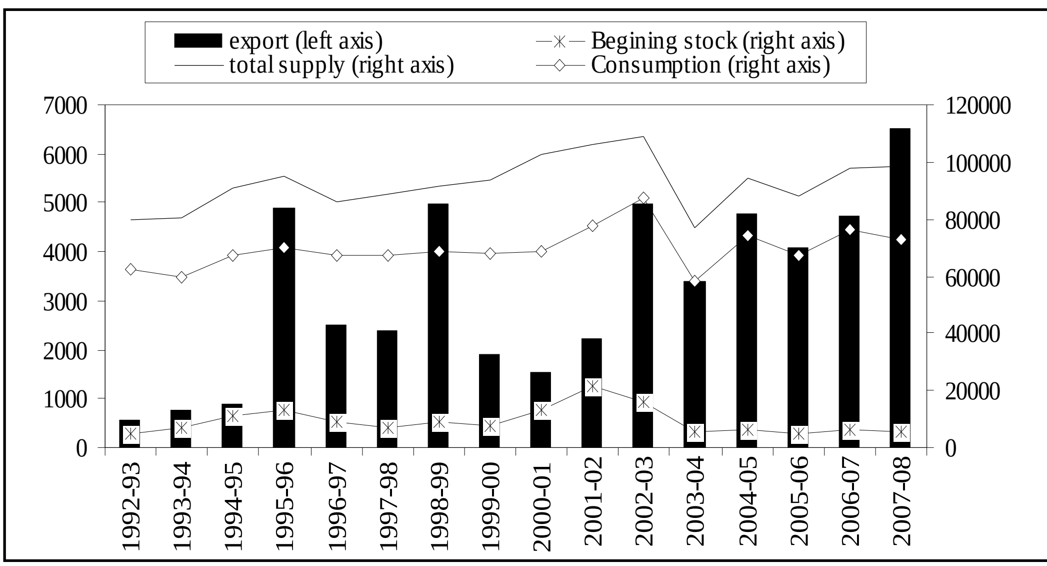
Sources: DGCI&S, Calcutta, Ministry of Commerce and FAO STAT

The level of the buffer stock reached a very low level of 2.1 million tonnes on April, 2006. As there was no abrupt increase in price of wheat between 2003-04 and 2007-08, total wheat consumption in these years, (i.e., production adjusted for net trade and change in stock) can be treated as normal demand. This comes to 70.39, 73.02, 69.95, 72.69 and 76.49 million tonnes during these years (Appendix table 2). The level of buffer stock had reached a dangerously low level on April 1, 2006, and only about 2.01 million tonnes wheat was added to the stock by April 1, 2007, which forced the government not only to put a ban on wheat export in April 2007 but also allowed duty free import of 6.10 million tonnes in 2006-07 to meet the increase in demand of 2.74 million tonnes in 2006-07 over the previous year. After meeting the excess (2.03 million tonnes) of increased demand over increased production, there was a net addition of 4 million tonnes to the government stock from imported wheat. As a result, the ending stock amounted to about 4.70 million tonnes of wheat on April 1, 2008.

Rice

India had never been among the major rice exporting countries until it attained self-sufficiency in rice production in the early 1980s. The growing demand for basmati rice in the international market enabled India to increase its export gradually to a level of over four lakh tonnes by 1989-90, constituting around 2.8 per cent of world's total rice export. In the early 1990s, total rice export increased somewhat more to reach more than 7 lakh tonnes in 1993-94. Until 1994, India had been exporting comparatively small quantities of fine (basmati) rice, as export only of this variety was permitted, subject to a minimum export price stipulation. Successive good harvest and increase in rice procurement by public agencies[31] coupled with reduction in off-take due to increase in sales prices resulted in rise in rice stock from the level of 5.07 million tonnes on October 1st, 1992 to 13 million tonnes on October 1st, 1995 (Figure 5; Appendix table 4). As discussed earlier in the paper, in order to dispose of rice stocks, export of basmati rice was further liberalised in January 1994, by the elimination of minimum export price and, a little later, the ban on exports of common rice was removed. These steps led to a dramatic increase in export volumes. In the following year, 1995-96, India's exports of rice went up from less than 1 million tonnes to about 5 million tonnes, making India the second largest exporter of rice in the world in that year. India continued to be a major exporter in the next three years, averaging 3.29 million tonnes per year from 1996-97 to 1998-99 (Figure 5; Appendix table 4).

Figure 5. Demand, supply and trade pattern of rice in India; 1992-93 to 2007-08

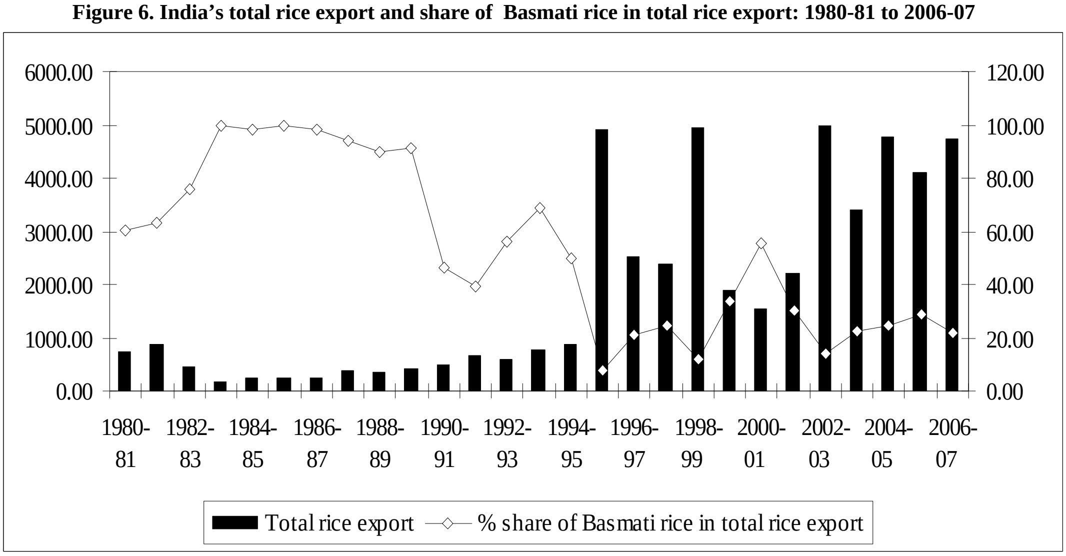


Source: Appendix table 4

Since mid-1990s rice consumption hovered around 67-68 million tonnes during 1996-97 to 2000-01, whereas, on the supply side, excessive rise given to procurement price (MSP) resulted in an increase in supply[32] from 86 million tonnes to 103 million tonnes (Figure 5; Appendix table 4). Increase in supply mainly came through increase in rice production. The rice production during the period increased from 77 million tonnes in 1996-97 to 90 million tonnes in 2000-01, on account of an increase of 40 per cent in procurement price during the period. As a result, the rice stock held with public agencies reached an all time high level of 21.45 million tonnes by October 1st, 2001, which was more than three times the required norm[33] for such stock. This level of stock was equal to 25 per cent of total rice produced in the country in 2001-02. Along with domestic demand and supply dynamics, a big setback to rice export between 1999-2000 and 2000-01 was also responsible for piling up of rice stocks with the government agencies. Rice exports experienced a big setback between 1999-2000 and 2000-01 because of two reasons. One, international prices of rice dropped sharply after 1998-99.[34] Two, domestic prices had been moving up mainly under the pressure of increasing support prices. This reduced the competitiveness and profitability of rice exporters. India's exports picked up again after November 2000 when it began to subsidise internal and international freight and other costs of marketing exports (Table 2) in an attempt to neutralise the high subsidisation by OECD countries like the US and as FCI started selling rice to traders for export at much lower prices compared to open market prices since 2001-02. This attracted a positive response as private traders found it more profitable and resulted in an increase in India's rice exports. Between 2002-03 and 2006-07, India exported on an average around 4.3 million tonnes of rice every year constituting around 15% of world's total rice export.

India's rice trade during the period also witnessed tremendous changes in its composition, particularly after the year 1994-95. Until 1989-90, 90-95 per cent of the rice exported from India was of the basmati variety. But its share and volume started dwindling after that due to a spurt in the export of non-basmati rice (Figure 6). The share of basmati rice in total rice exports from India decreased from 94 per cent in 1989-90 to 46 per cent in 1990-91 and further to 39 per cent and 8 per cent in 1991-92 and 1995-96, respectively. After 1995-96, exports of non-basmati rice have dominated India's rice trade, constituting around 75 per cent of the total quantity of rice exports during T.E. 2006-07 (Appendix table 3). This sharp decline in basmati rice could be attributed to two factors: First, availability of sufficient stocks with the major buying countries and also to large shipments of superior variety long grain non-basmati rice, and second, stiff competition from cheaper basmati rice produced in Pakistan. In terms of the major markets for India, Saudi Arabia accounted for 39% of the total export value in 2001-02, followed by Nigeria at 8.7%, South Africa at 7.5% and Kuwait at 6.8%. In terms of quantity of exports also, Saudi Arabia was the largest importing country with 26.4% in 2001-02, followed by South Africa at 14.4%, Nigeria at 13.7%, and then Indonesia at 6.4%.

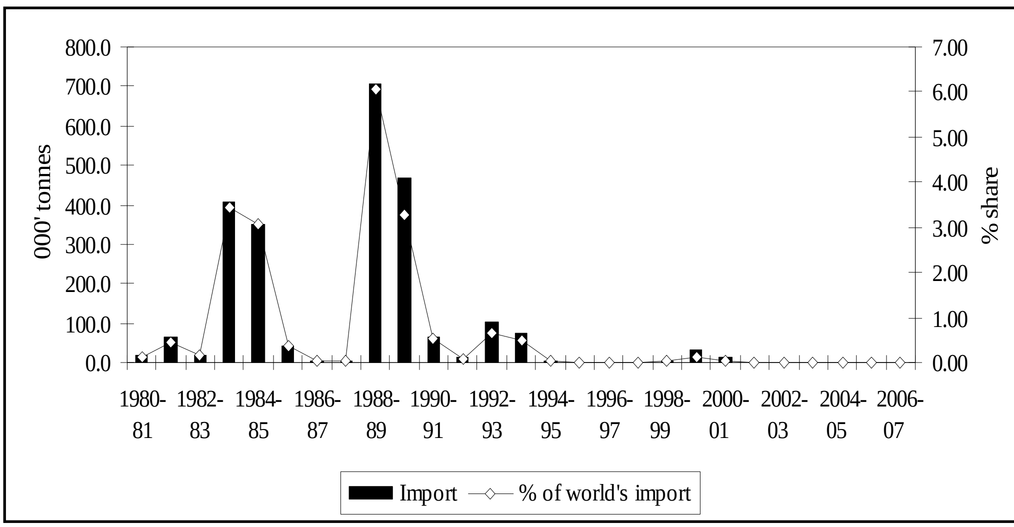
Figure 6. India's total rice export and share of Basmati rice in total rice export: 1980-81 to 2006-07



Source: Appendix table 3

India was a marginal importer of rice on occasion, particularly when world prices were on their downward trend. A big drop in world rice prices during the 1980s resulted in import of rice in small quantities in four years, 1983-84, 1984-85, 1988-89 and 1989-90. Again, during the 1990s, with a decline in international prices of rice between 1999-2000 and 2000-01, imports of low grade rice became attractive, particularly to some of the eastern states of the country. This resulted in import of 35 thousand tonnes and 13 thousand tonnes of rice in 1999-2000 and 2000-01, respectively (Figure 7).

Figure 7. India's rice import volume and its share in World's total rice import: 1980-81 to 2006-07



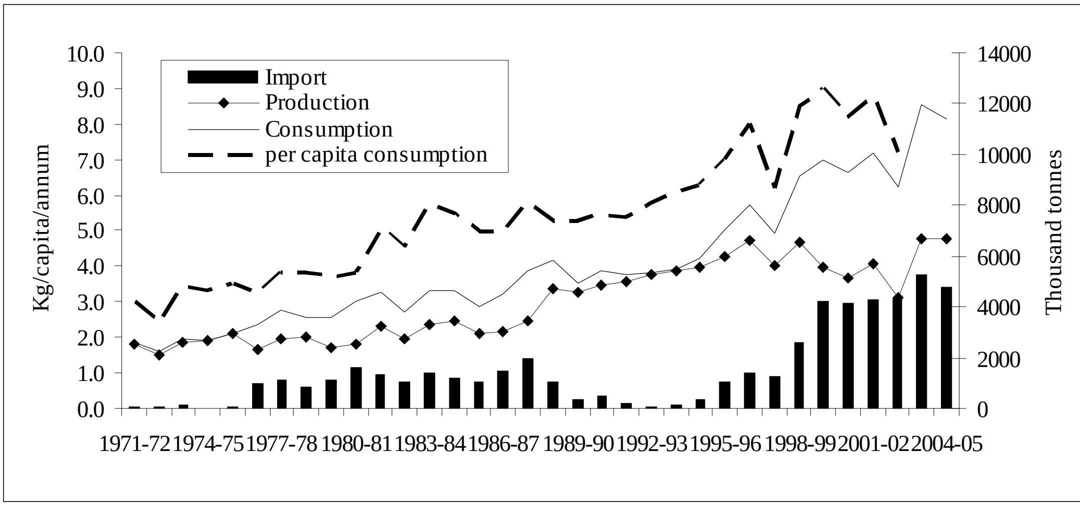
Source: Appendix table 3

Edible oils

Trade policy has played an important role in determining the overall level and type of India's edible oil imports for decades. India's recent large imports of edible oils have been the result of reduced border protection beginning in 1994. The government made frequent adjustments in its trade policy, depending on the domestic demand and supply situation, to protect the interest of oilseed producers and processors, and also to smooth the effect of fluctuating world prices on domestic consumers. The section below discusses the trade pattern in edible oils in the context of domestic demand and supply situation along with the trade policy regime.

A careful look at the production and consumption levels of edible oils shows that beginning with a level of 3.8 kg/capita/annum in 1977-78, consumption of edible oils started rising and reached the level of 5.8 kg/capita/annum by 1987-88. The slow growth in vegetable oil production compared to growing demand for oils has created a gap between domestic supply and demand and necessitated massive imports. As a result, India imported an average of 1.4 million tonnes of vegetable oil every year, constituting around 10 per cent of the world's total vegetable oil import and about 36 per cent of India's total availability or supply by 1987-88 (Figure 8; Appendix table 5). The gap between domestic consumption and production had narrowed considerably in the early 1990s, and self-sufficiency had been virtually achieved. The achievement of self-sufficiency in edible oils during this period can be attributed to two main factors; a large increase in production,[35] and a virtual stop in the growth of per-capita consumption. The per capita consumption varied slightly between 5.3 kg/annum to 6.3 kg/annum during the period between 1988-89 and 1994-95.

Figure 8. Production, Consumption and Imports of Edible Oil in India, 1971 to 2004-05



Source: Appendix table 5

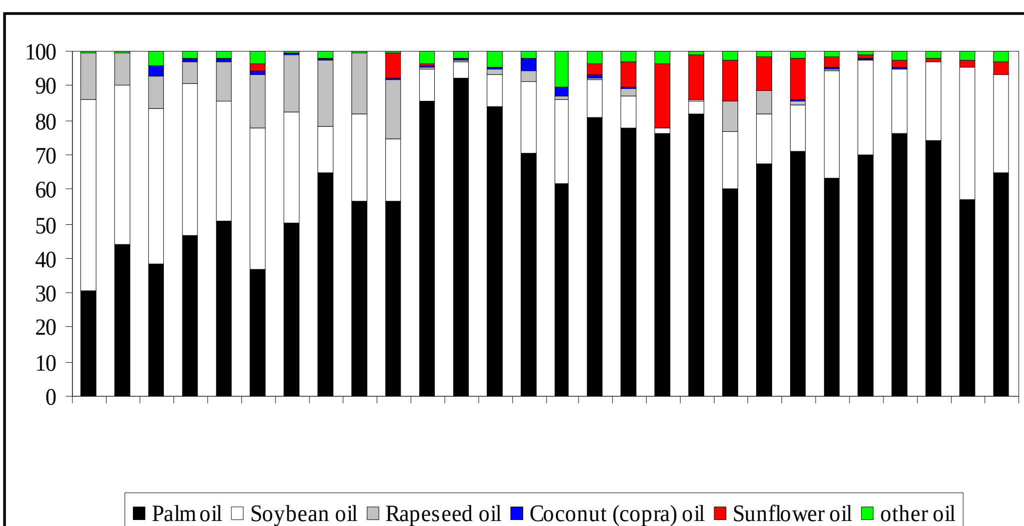
However, domestic production of edible oil started falling from 1997-98 due to a steep decline in domestic prices on account of emergence of liberal edible oil import policy[36] along with India's domestic price support programme which has often favoured production of crops that compete for area with oilseeds. And at the same time, consumption started rising due to a consistent increase in per capita income along with low prices of vegetable oils (Figure 8). To elaborate, on the supply side, domestic production of edible oil started falling since 1997-98, mainly on account of decline in area under oilseeds by 3.84 million hectare between TE 1997-98 and TE 2002-03,[37] in response to depressed domestic prices due to cheap imports of vegetable oils under liberal trade policy regime along with domestic price support programme which has often favoured production of crops that compete for area with oilseeds.[38] Real prices of oilseeds (deflated by WPI price index with base 1993-94=100) started falling after 1995-96 from the level of Rs. 106 per quintal and reached to the level of Rs. 83 per quintal in 2000-01. On the demand side, increase in per capita income along with low prices of edible oils pushed up the demand for edible oils significantly (the income elasticity of demand is close to 0.7) as a result per capita consumption of edible oils has risen significantly.[39] The annual consumption of edible oils which was around 5.5 kg per person in the early 1990s has increased to the level of 8.8 kg in recent years, therefore, pushing the demand for edible oils at a high rate. In fact, imports of edible oils were much more than the reduction in production of edible oil. This is evident from the per capita availability of edible oil in the country which remained between 5 to 5.8 kg for a decade till 1992-93 and then steadily increased to more than 9 kg by 2002-03. Thus, edible oil imports have been quite favourable for consumers as they could increase consumption due to low prices.[40]

This demand-supply gap has necessitated import of edible oil. Imports of vegetable oils increased rapidly and reached 5 million tonnes, or about 44 per cent of domestic supply during 2003-05. In 2006-07, India was the third-largest importer of vegetable oil (5.4 million tonnes) after the European Union (10 million tonnes) and China (8.6 million tonnes), according to *Oil World*. Import growth was most rapid during 1996-2000, when tariffs were relatively low (varied between 25 to 27.5 per cent), and were slowed down by higher tariffs, ranging from 45 per cent to 80 per cent for different oils, during 2001-05.[41]

The sensitivity of Indian importers to price was also reflected in the composition of imported oils. Palm oil, generally the lowest priced oil, has dominated Indian imports since the mid-1990s, accounting for about 65 per cent of vegetable oil imports during 2000-06. Soybean oil, generally the second cheapest oil in the market, accounted for about 28 per cent of imports during 2000-06 (Figure 9). Higher priced oils like sunflower oil and oils traditional to the Indian diet, such as groundnut and rapeseed oil, were imported in only small amounts. On the consumption front, together, these non-traditional imported oils now account for more than half of the oil consumed in India, replacing the higher priced, domestically produced oils such as groundnut and rapeseed oil.[42] Market share gains for palm and soybean oils are largely due to increased access to imports, as well as increased domestic soybean production. Palm oil, which is generally the lowest priced oil on world markets, has experienced the most rapid import growth followed by soybean oil.

The Indian import of palm and soybean oil accounted for 15 per cent and 13 per cent of the world's total import of palm and soybean oil. With the shift of U.S. exports from concessional shipments to commercial sales after the mid-1990s, the U.S. share in the Indian soybean oil market declined sharply. The Indian soybean oil market is dominated by Argentina and Brazil, which countries offer consistently lower prices than U.S. suppliers (Dohlman et al., 2003).

Figure 9. Composition of India's Vegetable Oil Imports: 1979-2006



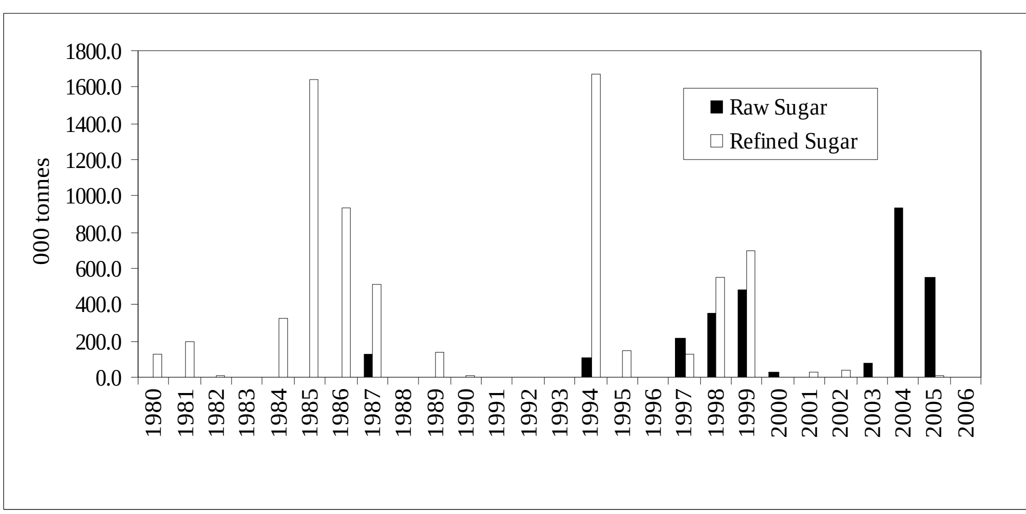
Source: FAO STAT

Sugar

India's share in world's sugar trade has always been very small, both in relation to Indian production and world trade. A broader pattern which emerges from Indian sugar trade clearly shows that, when sugar production exceeds demand, stocks build up, and the government has typically removed controls preventing exports, and if needed has provided export subsidies to boost exports and help diminish excess sugar stocks. On the other hand, at some point during the downturns in the production cycle when consumption is running ahead of production, it has typically relaxed import controls or reduced tariffs in order to facilitate sugar imports and in this way taken some of the pressure off domestic sugar prices.

In the case of imports (Figure 10), except for a few years, there have been no imports of raw sugar till 1996. And since then India started importing raw sugar every year in very small quantities for processing into white refined sugar. But there have been sporadic imports of refined sugar mostly in very small quantities, with the exception of a period of very low world prices during the mid-1980s when large quantities were imported. In 1985, India imported 1.6 million tonnes of refined sugar which was equivalent to 27 per cent of domestic white sugar production and 19 per cent of world's trade in refined sugar. Similarly, in 1994, India again imported 1.7 million tonnes of refined sugar to meet the domestic demand because of shortfall in sugar production (Appendix table 6). As the world prices were at a peak during this time, (i.e., 1994), government typically reduced the applied tariff rate to zero along with withdrawal of import licensing requirements on imports of refined sugar.

Figure 10. India's Import Volume of Raw and Refined Sugar; 1980-2006

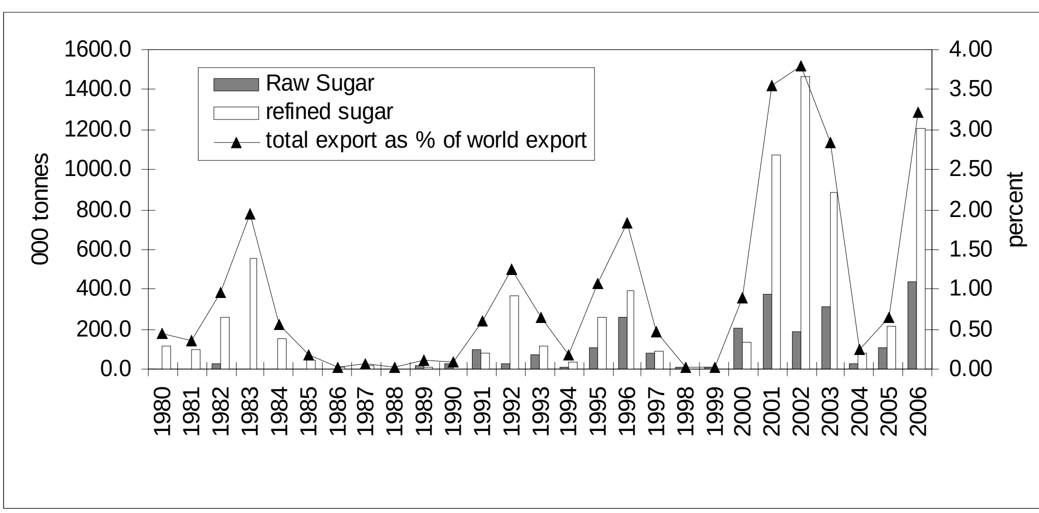


Source; FAO STAT

More recently, in response to a large fall in sugar production during 2004 and 2005 (mainly because of a decline in sugarcane production due to bad weather) the government (in September 2004) imported Brazilian raw sugar at zero (instead of the normal 60 per cent) import duty (under the *advance licensing* scheme, which permits duty free imports of inputs used to produce exported products), and allocated it to mills for processing it into white refined sugar [Pursell, 2007].

India remained a net exporter of raw sugar till 1993 except for the year 1987. India has also consistently exported some of its plantation white sugar (refined sugar) almost every year. The share of plantation white sugar was always higher compared to raw sugar in India's total sugar export, and combining these together accounted for more than 3.4 per cent of world's total sugar export during 2001 to 2003 (Figure 11). India's total export witnessed an increase by 13 per cent from 1.3 million tonnes to 1.6 million tonnes from 2001 to 2006. But unlike few other countries, which produce sugar for exports on a regular basis, Indian exports were mainly to liquidate partly its surplus stocks (see discussion below for further details). This is because India has a large and growing domestic market. As it can be seen from its export's share in total production, which varied between 6 to 9 per cent during 2001 to 2003.

Figure 11. Trends in India's Export of Raw and Refined Sugar and its Share in World's Total Sugar Export: 1980-2006

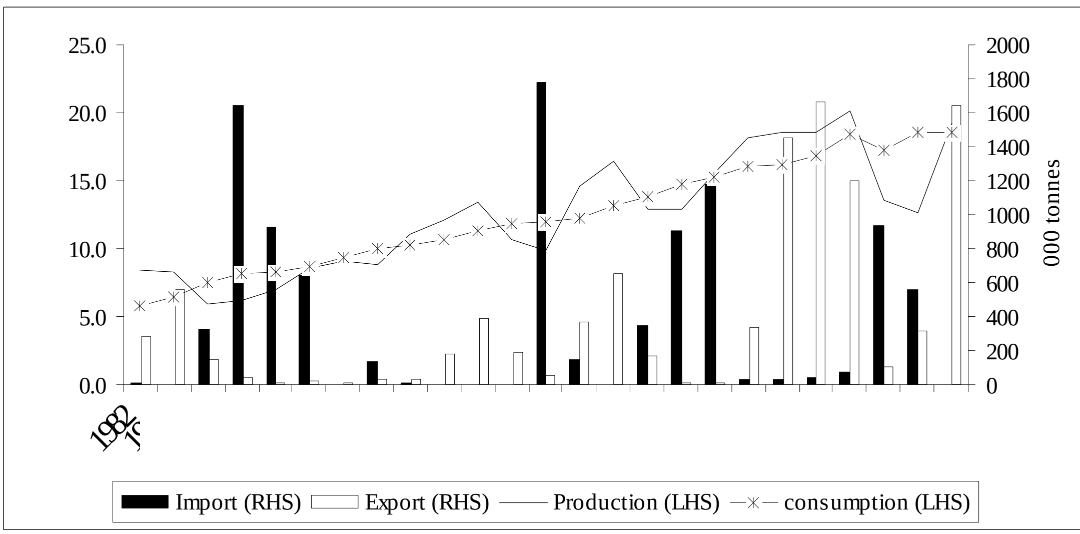


Source; FAO STAT

As mentioned, India's sugar import and export is highly regulated and mainly resorted to when there was mismatch in domestic sugar production and consumption. Whenever sugar production exceeded domestic consumption requirement and stocks built up, the government has typically allowed exports by removing export controls, and if needed has provided export subsidies to boost exports and help diminish excess sugar stocks. On the other hand, when consumption has exceeded production, it has typically relaxed import controls or reduced tariffs in order to facilitate sugar imports to reduce the pressure from domestic sugar prices. These patterns are apparent from figure 12.

As it can be seen, consumption exceeded production during 1984 to 1989, 1993 to 1994, 1997 to 1998 and 2004 to 2005, and these were the periods of imports with some lag. More recently, in response to large cut in sugar production during 2004 and 2005 the government in September 2004, imported Brazilian raw sugar at zero import duties and allocated to mills for processing into white refined sugar. Similarly, in case of export, starting in 1999 production consistently exceeded consumption for five years in a row, leading with a lag to substantial exports beginning in 2001, the cumulative amount of which reached 4.4 million tonnes by March 2004. Exports during this episode were stimulated by export subsidies that were increased to keep exports profitable as world prices declined.

Figure 12. Production, Consumption and Trade Pattern in Sugar: 1982-2006



Source: Appendix table 6

In sum, the analysis of commodity specific trade patterns shows that in majority of the cases, trade flows reflected the difference between domestic production and consumption and trade policy instruments were used to manage the trade flow in order to maintain domestic supplies and stability in domestic prices. For instance, during the post-WTO period when international prices faced severe downward pressure and stocks at home piled up as in the case of rice, wheat and sugar; the government typically removed controls preventing exports, and began to provide export subsidies to boost exports and liquidate excess stocks with the public agencies. Among imports, edible oils have shown very high growth in the post-WTO period. With the introduction of liberal policies for edible oil imports, low world prices resulted in a steep decline in domestic prices. As a result, domestic production of edible oil started falling. At the same time consumption started rising due to a consistent increase in per capita income along with low prices of vegetable oils, which has created huge gap between domestic demand and supply. Therefore, in order to meet growing domestic demand, imports of vegetable oils increased rapidly, constituting about 44 per cent of domestic supply during 2003-05. Growth in edible oil import which was most rapid during 1996-2000 has been slowed down by imposing higher tariffs, during 2001-05. Whereas, in the case of sugar, during 1994-97 when consumption exceeded domestic production coupled with high world sugar prices, government has typically relaxed import controls and reduced tariffs in order to facilitate sugar imports. Again, when world sugar prices started declining (after 1998), government has increased tariffs in order to check sugar imports.

Therefore the analysis clearly highlights the fact that, despite significant liberalisation, trade in agricultural commodities continues to be regulated as India has preferred strategic opening up rather than complete free trade, where government adjusted its trade policy instruments depending on domestic production and price situation and global situation. At the time when world prices were low, say during 2000-01 and stocks at home piled up, India did not put any restriction on export of most of the agricultural commodities but imposed very high duty on imports to prevent cheap imports. Similarly, the increase in MSP during this period was low (Table 4). However, when global prices started increasing, after 2006 and reached to peak during 2008-09 coupled with depletion of food stock with public agencies, government reversed its policy, i.e., imports were freely allowed but exports were banned or restricted. Similarly, MSP on the other hand was given steep hike during these periods, compared to the period of low world prices in order to minimize the gap between domestic and world prices.

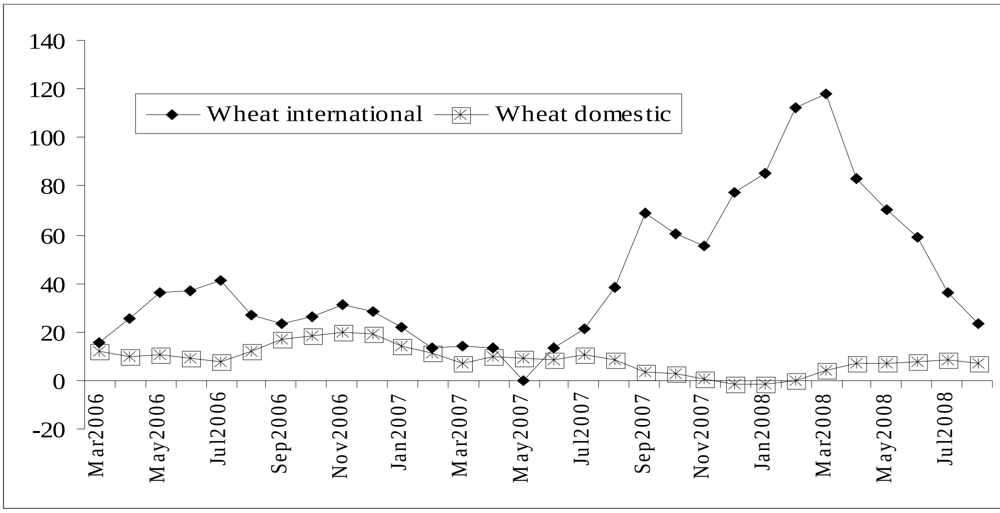
Table 4. Trade and Price Policy During Different Phases of World Prices

Policy instruments	Year	Wheat	Rice	Groundnut oil	Sugar
(1)	(2)	(3)	(4)	(5)	(6)
International Price	2001	127	173	680	190
	2009	224	555	1184	400
Import duty	2001	50	70-80	75-85	60
	2009	Duty free	Duty free	Duty free	Duty free
Export policy	2001	Free	Free	Free	Free
	2009	Banned	Non-Basmati: Banned Basmati: MEP	Banned or Restricted	Banned
Increase in MSP	2001	5	4	6	6
	2009	18	11	36	60

Note: International price in case of wheat refers to FOB US GULF for HRW; Rice to Thai 5%; Groundnut oil to c.i.f. Rotterdam and Sugar to f.o.b. Caribbean ports. MSP refers to minimum support price and MEP refers to minimum export price
Sources: Commodity price data, pink sheet, World Bank; Agricultural statistics at a Glance, Ministry of Agriculture, GOI, New-Delhi

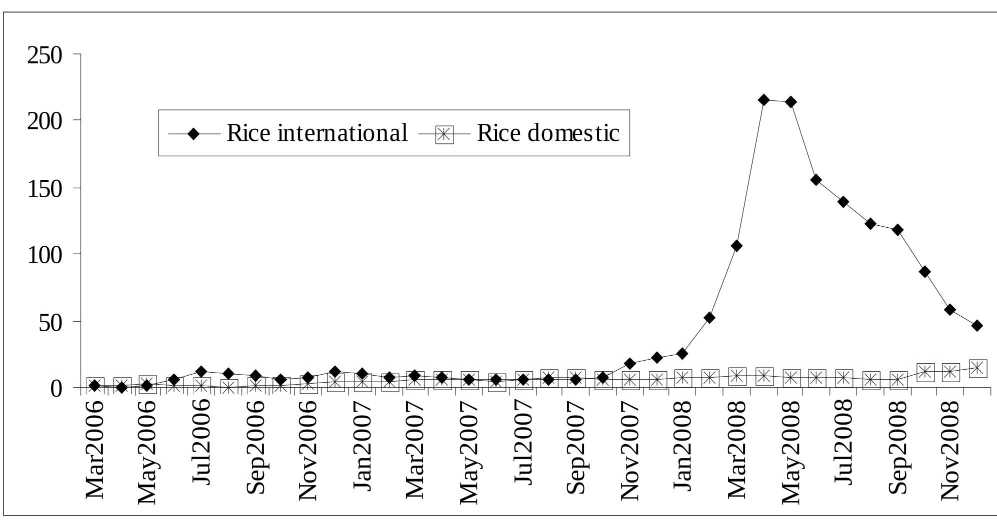
The guiding principle behind this was to allow domestic prices to move in tandem with the trend in world prices but insulate against sharp troughs and spikes. This has helped India in maintaining the lower level of instability in domestic market prices compared to international prices. For instance, year on year inflation in India in any month during 2007-08 in wheat and rice remained below 11 per cent, whereas, global prices showed more than 100 per cent inflation in wheat and more than 200 per cent annual rate of inflation in rice during early months of 2008 (Figure 13 & 14). Similarly, food price inflation in India did not exceed 11 per cent, whereas, global food inflation exceeded 40 per cent in early months of 2008.

Figure 13. Annual Rate of Inflation in Wheat Prices (percentage)



Source: UNCTAD commodity price data set; office of the economic adviser, govt of India

Figure 14. Annual Rate of Inflation in Rice Prices (percentage)



Source: UNCTAD commodity price data set; office of the economic adviser, govt of India

However, the government intervention in the food grain market in terms of buffer stock operation and price support programmes for ensuring greater stability in domestic market prices has come under serious criticism in recent years mainly on account of fiscal unsustainability as it involves heavy cost in terms of procurement, handling, carrying, storage, etc. As an alternative, it has been suggested that trade liberalisation is a better measure than buffer stock operations for stabilisation of domestic food prices [Jha and Srinivasan, 1999, Pp. 93-108]. Jha and Srinivasan compared public buffer stocks with the alternatives of import and export of foodgrains by government agencies, variable levies on private external trade and subsidy to private storage in case of wheat and rice. For each of these alternative scenarios they worked out the impacts on government costs and producer and consumer welfare by using a multi-market equilibrium framework where private storage, consumption, supply and prices of rice and wheat are determined simultaneously.

They argued that, stabilisation of prices through public buffer stocks is the least preferred option. The options of canalised trade and variable levies appear better compared to buffer stocks and lead to similar welfare outcomes and a choice between them can be made based on administrative considerations. However, these arguments were refuted by Chand [2003], who contended that owing to high volatility in international prices, any comparison of trade option with stock option could result in a different conclusion depending on the level of international price in that year. Chand [2003] compared export parity price during a year of above-normal production and import parity price during a year of below-normal production with economic cost of grain to FCI by selecting a fairly long period of 26 years (1975 to 2000). The comparison of trade option with policy of buffer stock in case of wheat shows that out of the 15 years during which domestic supply fell short of the trend, in 10 years the cost of meeting the supply deficit from domestic sources (economic cost to FCI) was lower than the import parity price. In remaining 5 years, meeting the shortfall in supply through imports was cheaper for maintaining stability in domestic supply. In the second scenario, wheat production was above normal in 11 out of 26 years. Out of these 11 years, the price realised from export was lower in 10 years. Selling in international market would have fetched better price than that available under government intervention in only 1 year (Table 5).

Table 5. Frequency Distribution of Superiority of Trade v/s Buffer Stock as Stabilisation Measures (1974-2000)

PARTICULARS	PRODUCTION SCENE: WHEAT		PRODUCTION SCENE: RICE	
	Above normal	Below normal	Above normal	Below normal
	Frequency		Frequency	
Target of stabilisation	Producer	Consumer	Producer	Consumer
Trade better option than buffer stock	1	5	5	2
Buffer stock better option than trade	10	10	9	170

Source: Chand, 2003.

In case of rice, during the 12 years since, 1975 when output was short of the trend, import was more cost effective option than domestic stabilisation in only 2 out of 12 years. In the second scenario, when the actual output exceeded the trend, domestic producers could earn better from export only in 5 out of 14 years. In the remaining 9 years, the government determined domestic wholesale price was higher than the export parity price. Therefore, the analysis clearly shows that among the two options - stabilisation through buffer stock and trade - the latter was costlier than the former mostly though this also depends on fluctuation in international prices.[43] Because of this experience, even after liberalisation of trade, buffer stock continues to be an important instrument for price stabilisation in India.

However, since a relatively small proportion of world output enters world trade in several agricultural commodities. Therefore, compared to the total usage of these commodities, the exportable surplus is very low. For instance, FAO statistics shows that, just 0.34 per cent of world's total rice production goes to the international market while in case of wheat it is only 2 per cent (averages for 2000 to 2005). To put these figures into perspective, the world's total rice exports are only about 2 per cent of India's rice production, while in the case of wheat it is only 16 per cent. In the case of cereals, this is around 50 per cent of India's production; in pulses, the world's total exports are only 10 per cent of India's production. In this context, how much India buys or sells in the world market can be often significant for the world prices. The most recent evidence of this is in the case of sugar. World sugar prices ruled around $290 per tonne during the first quarter of 2009. When the market realised that there would be a sugar shortage in India, prices increased up to around $470 per tonne in the third quarter of 2009. By the end of the year, world sugar prices had doubled [Chand, 2010, Pp. 10-13]. However, this is the area which requires an in-depth analysis and not many of scholars have attempted to analyse the extent by which world prices gets affected by India's export and import decisions. And also, the small country assumption, so often the basis of simulation exercises with computable general equilibrium models as applied to Indian agriculture are not valid because world prices will not remain unchanged when India enters into the world market. This is partly because India's share in world output for many agricultural commodities is high, and partly because a relatively small proportion of world output enters world trade in several agricultural commodities. Thus, how much India buys or sells in the world market would affect world prices.

IV. CONCLUSION

The analysis in the paper dealt with the issue as to how India has maintained a balance between its twin objectives of food policy - maintaining the domestic supply in order and keeping the price at reasonable level - following the progressive liberalisation of trade in agricultural commodities in which process the country has followed a cautious approach. The major findings which emanate from our analysis can be summed up as follows:

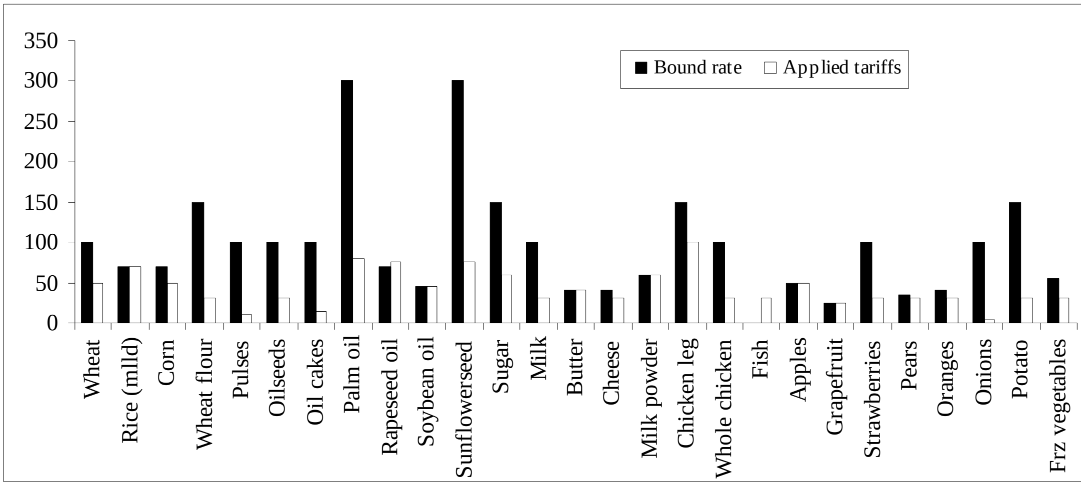
First, in general, the evaluation of agricultural trade policy since early-1990s suggests that the country has witnessed significant departure from its earlier policy regime. For instance, in case of agricultural exports, various measures were taken by the government over the period of time to provide stimulus to export of agricultural commodities and includes, reduction in products list subject to state trading; relaxation of export quotas; the abolition of minimum export prices (MEPs); increased credit availability; strengthening institutional and infrastructural support by creation of agricultural export zones and also putting in place some indirect incentives for agricultural export. Similarly, in case of imports it includes - removal of QRs; replacing non-tariff barriers by tariffs; narrowing the scope of canalisations; elimination of import licensing and optimisation of import compression. Though the QRs on imports of agricultural commodities were phased out by April 2001, there exist a wide gaps between the bound and applied levels, which provide India with the discretionary ability to adjust tariffs to support its overall goals of food self-sufficiency and price stability.

Second, the commodity specific analysis of trade policy in the context of four food commodities, namely, wheat, rice, edible oils and sugar, also suggests that the external trade in these agricultural commodities has been liberalised and most of the alterations took place from mid-1990s when India opened her markets to world trade. Nonetheless, there have been significant departures from the stated policy on various occasions depending on developments in global and domestic economies. For instance, emphasis on export liberalisation and import duties underwent significant changes after 2006, when global prices started increasing with the onset of global food crisis. Following the crisis, India almost reversed some aspects of trade policy to insulate domestic market from global food prices. It banned export of main staples - rice and wheat - in 2007 to augment domestic supply and manage rising inflation. There was also steep reduction in import duties on imports of wheat and rice. For example, reacting to the surge in wheat and rice prices, government allowed import of wheat and rice at zero duty since 2006 and 2008, respectively. Agricultural trade was strictly regulated by various notifications issued by Directorate General of Foreign Trade (DGFT) from time to time.

Third, looking at the changes in trade policy instruments in the light of domestic demand and supply situation further reveals that, trade flows reflected the difference between domestic production and consumption and trade policy instruments were used to manage the trade flows in order to maintain domestic supplies and stability in domestic prices. For instance, during the late-1990s and early-2000s, when international prices faced severe downward pressure and stocks at home piled up as in the case of rice, wheat and sugar; the government typically removed controls preventing exports, allowed private traders to participate and also began to provide export subsidies to boost exports and liquidate excess stocks with the public agencies. The period also witnessed a very high duty on imports to prevent cheap imports from depressing domestic prices. Similarly, in the recent past also, when stocks with public agencies reached to very low levels in response to decline in production, coupled with high world prices, the government not only imposed ban or restrictions on exports but also allowed imports freely.

Therefore, the analysis highlights the fact that, despite significant liberalisation, trade in agricultural commodities, particularly food commodities continues to be regulated as India has preferred strategic opening up rather than complete free trade, where government adjusted its trade policy instruments depending on domestic production and price situation and global situation. This has helped India in maintaining lower level of instability in domestic market prices compared to international prices. For instance, year on year inflation in India in any month during 2007-08 in wheat and rice remained below 11 per cent, whereas, global prices showed more than 100 per cent inflation in wheat and more than 200 per cent annual rate of inflation in rice during early months of 2008. However, since a relatively small proportion of world's output enters world trade in several agricultural commodities and India's share in world output for many agricultural commodities is high, therefore, how much India buys or sells in the world market can be often significant for the world prices. The small country assumption, so often the basis of simulation exercise with computable general equilibrium models as applied to Indian agriculture is not valid because world prices will not remain unchanged when India enters into the world market. This is the area which requires an in-depth analysis and not many scholars have attempted to analyse the extent by which world prices gets affected by India's export and import decisions. Nonetheless, in respect of the claims made by the proponents of trade liberalisation about the gains that would arise by using trade liberalisation as a measure for stabilisation of domestic food prices than buffer stock operations, the empirical evidence provided by the stylised models fails to provide clinching proof that the latter was costlier than the former.

Appendix chart 1. A Comparison Between Bound and Applied Tariff Rate for Selected Agricultural Commodities: 2006



Source: Government of India, Ministry of Agriculture, Agriculture statistics at glance

Appendix Table 1. Summary of Import policy for Edible oil: 1994-2007

April, 1994	Import of RBD Palmolein placed on OGL with 65% import duty.
March, 1995	Import of all edible oils (except coconut oil, palm kernel oil, RBD palm oil, RBD palm stearin) placed on OGL with 30% import duty.
1996-97 (in regular Budget)	Further reduction in import duty to 20% + 2% (special duty of customs) bringing total import duty to 22%. Another special duty of custom @ 3% was later imposed bringing the total import duty to 25%.
July, 1998	Import duty further reduced to 15%.
1999-2000 (Budget)	Import duty raised to 15% (basic) + 10% (surcharge) =16.5%.
December, 1999	Import duty on refined oils raised to 25% (basic) + 10% (surcharge) = 27.5%. In addition, 4% SAD levied on refined oils.
June, 2000	Import duty on crude oils raised to 25% (basic) + 10% (surcharge) = 27.5% Import duty on refined oils raised to 35% (basic) + 10% (surcharge) + 4% (SAD) = 44.04%. Import duty on Crude Palm Oil (CPO) for manufacture of vanaspati retained at 15% (basic) + 10% (surcharge) =16.5%.
November, 2000	Import duty on CPO for manufacture of vanaspati raised to 25% and on crude vegetable oils raised to 35%. Import duty on CPO for other than vanaspati manufacture raised to 55%. Import duty on refined vegetable oils raised to 45% (basic) + 4% (SAD) = 50.8%. Import duty on refined palm oil and RBD palmolein raised to 65% (basic) + 4% (SAD) = 71.6%.

(Contd.)

Appendix Table 1. ***(Concld.)***

March, 2001 (As amended on 26.4.2001)	Import duty on crude oils for manufacture of vanaspati/refined oils by the importers registered with Directorate of VVO&F raised to 75% (for others import duty levied at 85%) except soybean oil, rapeseed oil and CPO at 45%, 75% and 75% respectively. The duty on refined oils including RBD Palmolein raised to 85% (basic) except in the cases of Soybean Oil and Mustard oil where the duty is placed at 45% (basic) and 75% (basic) respectively due to WTO binding. In addition, 4% SAD levied on refined oils.
October, 2001	Import duty on Crude Palm Oil and its fractions, of edible grade, in loose or bulk form reduced from 75% to 65%.
November, 2001	Import duty on crude sunflower oil or safflower oil reduced to 50% up to an aggregate of 1,50,000 MTs (Tariff Rate Quota) of total imports of such goods in a financial year subject to certain condition. Import duty on refined rape, colza or mustard oil reduced to 45% up to an aggregate of 1,50,000 MTs (Tariff Rate Quota) of total imports of such goods in a financial year subject to certain condition.
March, 2002	Status quo on import duty structure of vegetable oils/edible oils maintained. Import of vanaspati from Nepal be levied SAD @ 4%.
August, 2002	SAD is not applicable on vanaspati imported from Nepal under TRQ.
March, 2003	Status quo on import duty structure of vegetable oils/edible oils maintained.
April, 2003	Import duty on Refined Palm Oil and RBD Palmolein reduced from 85% to 70% and SAD not applicable on edible oils.
July, 2004	Import duty on Refined Palm Oil and RBD Palmolein raised from 70% to 75%
February, 2005	Import duty on Crude Palm Oil / Crude Palmolein raised from 65% to 80% and Import duty on Refined Palm Oil / RBD Palmolein raised from 75% to 90%
2006-2007 (Budget)	With effect from March 1st 2006, edible oils attract a special additional duty of Customs @ 4% and Import Duty on Vanaspati and similar products raised from 30% to 80%.
August, 2006	With effect from August 8th 2006, special additional duty of customs not applicable on vanaspati imported from Nepal w.e.f. August 11th 2006 Import duty on Crude Palm oil/Crude Palmolein reduced from 80% to 70% and Import duty on refined Palm Oil/RBD Palmolein reduced from 90% to 80%.
January, 2007	From January 24th 2007, import duty on Crude Palm Oil /Crude Palmolein reduced from 70% to 60%, Import duty on refined Palm Oil/RBD Palmolein reduced from 80 % to 67.5%, import duty on Crude Sunflower oil reduced from 75% to 65% and Import duty on refined Sunflower oil reduced from 85%to75%.

Source: Ministry of Food, Consumer Affairs and Public Distribution, Government of India

Appendix Table 2. Total Production, Stocks, International Trade and Consumption of Wheat in India (quantity in 000' tonnes): 1984-85 to 2007-08

	Production	Beginning stock	Import	Export	Consumption			Ending stock
					Total	Food	Feed/Seed/ Waste	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1984-85	45480	9620	564.37	39.51	43155	37470	5685	12470
1985-86	44070	12470	183.14	229.61	46284	40775	5509	10210
1986-87	47050	10210	119.25	221.78	47717	41836	5881	9440
1987-88	44320	9440	21.48	274.97	50167	44627	5540	3340
1988-89	46170	3340	1792.40	15.80	48977	43205	5771	2310
1989-90	54110	2310	32.63	11.79	52981	46217	6764	3460
1990-91	49850	3460	63.61	139.54	47634	41403	6231	5600
1991-92	55140	5600	0.00	660.43	57870	50977	6893	2210
1992-93	55690	2210	1363.70	36.75	56487	49526	6961	2740
1993-94	57210	2740	241.70	0.39	53191	46040	7151	7000
1994-95	59840	7000	0.57	86.63	58034	50554	7480	8720
1995-96	65770	8720	8.69	632.47	66106	57885	8221	7760
1996-97	62100	7760	616.17	1145.90	66090	58328	7763	3240
1997-98	69350	3240	1485.78	1.52	68994	60326	8669	5080
1998-99	66350	5080	1803.70	1.76	63572	55278	8294	9660
1999-00	71290	9660	1365.97	0.00	69126	60215	8911	13190
2000-01	76370	13190	4.22	813.49	67251	57704	9546	21500
2001-02	69680	21500	1.35	2649.38	62492	53782	8710	26040
2002-03	72770	26040	0.00	3671.25	79489	70393	9096	15650
2003-04	65760	15650	0.46	4093.08	70387	62167	8220	6930
2004-05	72160	6930	0.00	2009.35	73015	63995	9020	4066
2005-06	68640	4066	0.00	746.18	69951	61371	8580	2009
2006-07	69350	2009	6079.56	46.64	72689	64020	8669	4703
2007-08	75800	4703	1793.21	0.23	76493	67018	9475	5803

Basic data sources: Ministry of Food, Consumer Affairs and Public Distribution; DGCI&S, Calcutta, Ministry of Commerce; Agriculture statistics at glance, Directorate of economics and statistics, Ministry of agriculture, Government of India

Appendix Table 3. India and World Rice Trade: 1982-83 to 2006-07

Marketing years	Import Quantity (000' tonnes)			Export Quantity (000' tonnes)					Share of Basmati in total rice export
	India	World +	% share	Basmati	Non-basmati	Total	World +	% Share	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1982-83	19.33	11438.80	0.17	343.50	110	453.50	12065.80	3.76	75.74
1983-84	408.74	11885.25	3.44	175.60	0	175.60	11540.72	1.52	100.00
1984-85	348.60	11398.46	3.06	243.50	4.1	247.60	12768.19	1.94	98.34
1985-86	43.83	12460.55	0.35	244.80	0.7	245.50	11546.42	2.13	99.71
1986-87	6.89	12695.69	0.05	244.30	3.9	248.20	13325.30	1.86	98.43
1987-88	5.38	12217.99	0.04	366.10	22.8	388.90	13012.57	2.99	94.14
1988-89	705.94	11620.91	6.07	314.05	35.52	349.57	12234.95	2.86	89.84
1989-90	468.63	14317.25	3.27	384.12	37.64	421.76	15203.24	2.77	91.08
1990-91	66.04	12274.94	0.54	232.30	272.69	504.99	12458.42	4.05	46.00
1991-92	12.12	12938.88	0.09	266.53	411.94	678.47	13141.99	5.16	39.28
1992-93	102.38	15576.01	0.66	324.79	255.62	580.41	16074.03	3.61	55.96
1993-94	75.52	15940.70	0.47	527.23	240.44	767.67	16830.37	4.56	68.68
1994-95	6.99	17734.64	0.04	442.13	448.5	890.63	17974.19	4.96	49.64
1995-96	0.08	21604.98	0.00	373.31	4540.7	4914.01	22494.41	21.85	7.60
1996-97	0.00	21665.58	0.00	523.16	1989.04	2512.20	19737.39	12.73	20.82
1997-98	0.05	19132.15	0.00	593.32	1795.74	2389.06	21017.98	11.37	24.83
1998-99	6.63	24571.18	0.03	597.79	4365.89	4963.68	28842.78	17.21	12.04
1999-00	34.99	27300.57	0.13	638.38	1257.79	1896.17	25277.46	7.50	33.67
2000-01	13.20	22821.08	0.06	849.02	682.27	1531.29	23545.81	6.50	55.44
2001-02	0.06	23444.49	0.00	667.07	1541.49	2208.56	26685.41	8.28	30.20
2002-03	0.87	26812.05	0.00	708.79	4259.08	4967.87	27350.20	18.16	14.27
2003-04	0.54	27358.03	0.00	771.49	2640.57	3412.06	27858.67	12.25	22.61
2004-05	0.00	27385.21	0.00	1163.00	3615.1	4778.10	29051.40	16.45	24.34
2005-06	0.26	26428.46	0.00	1166.57	2921.6	4088.17	29492.44	13.86	28.54
2006-07	0.16	28557.16	0.00	1045.73	3702.22	4747.95	30553.68	15.54	22.02

Data sources: DGCI&S, Calcutta, Ministry of Commerce; Agriculture statistics at glance, Ministry of Agriculture, Government of India; FAO trade statistics

Appendix Table 4. Total Production, Stocks, International Trade and Consumption of Rice in India (quantity in 000' tonnes): 1992-93 to 2007-08

Marketing years	Production	Beginning stock as on 1st Oct	Import	Export	Consumption			Ending stock as on 30th Sep	total supply
					Total	Food	Feed/Seed /Waste		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1992-93	74680	5070	102.38	580.40	72052	62717	9335	7220	79852
1993-94	72860	7220	75.52	767.67	68518	59410	9108	10870	80156
1994-95	80300	10870	6.99	890.57	77286	67249	10038	13000	91177
1995-96	81810	13000	0.08	4914.01	80556	70330	10226	9340	94810
1996-97	76980	9340	0.00	2511.98	76768	67146	9623	7040	86320
1997-98	81740	7040	0.05	2389.86	77430	67213	10218	8960	88780
1998-99	82530	8960	6.63	4963.59	78793	68477	10316	7740	91497
1999-00	86080	7740	34.99	1896.12	78749	67989	10760	13210	93855
2000-01	89680	13210	13.20	1534.48	79919	68709	11210	21450	102903
2001-02	84980	21450	0.06	2208.56	88452	77829	10623	15770	106430
2002-03	93340	15770	0.87	4967.87	98903	87236	11668	5240	109111
2003-04	71820	5240	0.54	3412.06	67558	58581	8978	6090	77061
2004-05	88530	6090	0.00	4778.10	84993	73927	11066	4849	94620
2005-06	83130	4849	0.26	4088.17	77921	67530	10391	5970	87979
2006-07	91790	5970	0.16	4747.95	87523	76049	11474	5489	97760
2007-08	93350	5489	0.15	6495.84	84480	72812	11669	7863	98839

Basic data sources: Ministry of Food, Consumer Affairs and Public Distribution; DGCI&S, Calcutta, Ministry of Commerce; Agriculture statistics at glance, Directorate of economics and statistics, Ministry of agriculture, Government of India.

Appendix Table 5. Availability of Edible Oil for Human Consumption: 1971-72 to 2004-05

Years	Domestic Production of		Import of edible oil	Total availability	Import as % of total availability
	Oilseeds*	edible oil**			
(1)	(2)	(3)	(4)	(5)	(6)
			Thousand tonnes		
1971-72	9080	2543	86	2629	3.27
1972-73	7140	2126	104	2230	4.66
1973-74	9390	2634	126	2760	4.57
1974-75	9150	2648	26	2674	0.97
1975-76	10610	2922	67	2989	2.24
1976-77	8430	2340	959	3299	29.07
1977-78	9660	2732	1123	3855	29.13
1978-79	10100	2799	821	3620	22.68
1979-80	8740	2411	1149	3560	32.28
1980-81	9370	2560	1633	4193	38.95
1981-82	12080	3219	1350	4569	29.55
1982-83	10000	2728	1090	3818	28.55
1983-84	12690	3282	1383	4665	29.65
1984-85	12950	3446	1227	4673	26.26
1985-86	10830	2964	1036	4000	25.90
1986-87	11270	3049	1474	4523	32.59
1987-88	12650	3463	1945	5408	35.97
1988-89	18030	4735	1083	5818	18.61
1989-90	16920	4567	324	4891	6.62
1990-91	18610	4877	526	5403	9.74
1991-92	18600	5022	226	5248	4.31
1992-93	20110	5247	103	5350	1.93
1993-94	21500	5397	114	5511	2.07
1994-95	21340	5531	347	5878	5.90
1995-96	22110	5989	1062	7051	15.06
1996-97	24380	6634	1417	8051	17.60
1997-98	21320	5605	1266	6871	18.43
1998-99	24750	6525	2622	9147	28.67
1999-00	20720	5586	4196	9782	42.90
2000-01	18440	5107	4177	9284	44.99
2001-02	20660	5711	4322	10033	43.08
2002-03	14840	4381	4365	8746	49.91
2003-04	25190	6672	5290	11962	44.22
2004-05	24350	6679	4751	11430	41.57

**Domestic edible oil includes: Groundnut, Rapeseed/Mustard, Seasum, Safflower, Nigerseed, Soybean, Sunflower, Cotton seed, and Coconut oil.

Sources: Ministry of Food, Consumer Affairs and Public Distribution; Agriculture statistics at glance, Directorate of economics and statistics, Ministry of agriculture, Government of India.

Appendix Table 6. Production, Consumption and International Trade of Sugar in India (quantity in 000' tonnes): 1982 to 2006

Sugar Year	Production Thousand tonnes	Export	Import	consumption	Surplus over production	Export as % of production	Import as % of production
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1982	8437	287.87	12.00	5743	2694	3.41	0.14
1983	8229	556.32	0.00	6488	1741	6.76	0.00
1984	5917	152.32	321.68	7565	-1648	2.57	5.44
1985	6144	47.10	1638.70	8093	-1949	0.77	26.67
1986	7016	7.60	930.69	8272	-1256	0.11	13.27
1987	8502	18.69	638.42	8687	-185	0.22	7.51
1988	9110	6.65	0.32	9385	-275	0.07	0.00
1989	8752	31.36	134.32	9936	-1184	0.36	1.53
1990	10990	26.63	12.00	10215	775	0.24	0.11
1991	12047	176.50	2.59	10714	1333	1.47	0.02
1992	13405	393.78	1.34	11270	2135	2.94	0.01
1993	10609	187.11	0.45	11875	-1266	1.76	0.00
1994	9833	49.48	1780.78	11960	-2127	0.50	18.11
1995	14643	365.85	150.63	12270	2373	2.50	1.03
1996	16453	653.13	2.13	13121	3332	3.97	0.01
1997	12905	171.71	346.89	13792	-887	1.33	2.69
1998	12852	12.21	901.17	14717	-1865	0.10	7.01
1999	15539	11.91	1180.95	15224	315	0.08	7.60
2000	18200	337.78	30.96	16101	2099	1.86	0.17
2001	18519	1447.83	26.58	16201	2318	7.82	0.14
2002	18527	1661.62	41.43	16781	1746	8.97	0.22
2003	20140	1198.31	74.40	18384	1756	5.95	0.37
2004	13560	105.96	932.44	17285	-3725	0.78	6.88
2005	12691	320.61	558.77	18500	-5809	2.53	4.40
2006	19267	1642.26	1.05	18500	767	8.52	0.01

Sources: DGCI&S, Calcutta, Ministry of Commerce; Agriculture statistics at glance, Directorate of economics and statistics, Ministry of agriculture, GoI.

NOTES

1. For a comprehensive commentary see Bhalla, G.S. [2002, Pp. 21-44]

2. Argued that India has strong comparative advantage in agriculture over most of the developed countries and trade liberalisation has made agricultural exports more attractive and remunerative. It is said to be more true in case of high value crops such as fruits, floriculture products and vegetables, Basmati rice and cotton.

3. Strategic openness refers to partial openness up to the point that it is in country's interest to do depending on domestic production, price situation and global situation, and includes tariffs on imports, taxes on exports and retention of buffer stock policy.

4. Traditional exports which originate in the agricultural sector, both plantation crops such as tea or coffee and cash crops such as tobacco or spices, that have always been an important source of foreign exchange earnings for the economy since the colonial era, constitute the exception to the rule.

5. See Little, Scitovsky and Scott [1970] for the original statement and Singh [1995] for an exposition.

6. As the world prices for many of the agricultural commodities were ruling high at that time compared to domestic prices of agricultural commodities.

7. Along with many other developing countries, India was permitted to offer ceiling bindings instead of tariffication. In addition, there was no obligation to reduce these ceiling bindings during the implementation period. India was also allowed to maintain quantitative restrictions (QRs) on account of balance of payment problem.

8. Under market access commitments in the AoA, member countries were required to replace all types of non-tariff barriers with tariffs, and to reduce tariff levels under a time-bound programme starting from 1995. The implementation period was 6 years and 10 years in case of developed and developing countries respectively with overall reduction by 36% in case of developed countries and 24% in case of developing countries.

9. Of these, there are only two items (almonds in shell and shelled) whose bound rates are committed in the form of specific amount in Rs/Kg.

10. Use of import monopolies is consistent with Article XVII of GATT 1994 as long as the agencies that have been granted these monopolies have a free hand in importing the canalised products. Since import tariffs for the canalised products remained high in general, imports had not been taking place until the end of 2002.

11. Milk and milk products, fruits and vegetables, poultry, tea and coffee, spices, and some food grains.

12. Durum wheat of seed quality (HS 1001.10.10): 50%; jawar, ragi, and bajra (HS 1008.20): 70%; and broken rice (HS 1006.40): 80%.

13. Importation/exportation under the category is subject to restriction on total quantity or on price, such as Minimum Export Price (MEP) issued as public notice by the competent authority from time to time. It also includes the items kept under canalised list, where goods can be exported/ imported only by a Government-designated agency.

14. Milling industries in south found landed cost of imported wheat from US Gulf and Australia lower than transporting domestically from north, say Punjab.

15. Information regarding chronology of wheat trade policy was collected from various media sources along with custom notification of DGFT.

16. The Cabinet has allowed Public Distribution Department to enter into counter trade/or extend commodity assistance in the form of food grains to the poor or needy countries on terms decided on a case to case basis. The humanitarian assistance in the form of food grains has been extended to Cambodia, Afghanistan, Zambia, Tajikistan, Myanmar, Tanzania, Lesotho, Chad, Iraq, etc. on the recommendations of Ministry of External Affairs (*Annual Report: Department of Food and Public Distribution, 2005-06*).

17. During the TMO programme, oil imports averaged only 325,000 tonnes per year, leading to increased domestic oilseed prices and a temporary surge in domestic production.

18. Coconut oil, RBD palm oil and palm stearin were remained canalised.

19. In 1997, a tariff surcharge and a special additional duty were added to the basic duty, but these were applied uniformly across all products and did not affect relative tariffs.

20. International prices for oilseed and edible oils were subject to strong downward pressure during the years from 1997 to 2002. Until the end of 2001, the international markets for oilseeds and oils were over-supplied relative to demand, which resulted in above average stocks and downward pressure on prices. The period was characterised by increased direct support to domestic producers and increased export promotion efforts by major exporting countries. During the period, prices for oilseeds declined by 34 per cent, 36 per cent and 34 per cent in the case of groundnut, rape/mustard seed and soybean, respectively, reaching their lowest level since 1992-93. Whereas, decline in oil prices has been caused by unusually sharp, but temporary, increases in palm oil production, as oil palm plantations in Asia recovered from the 1998 weather anomalies. In the case of three major edible oils, namely, groundnut, rape/mustard and soybean, prices declined by 32 per cent, 42 per cent and 48 per cent, respectively, during the period and touched their lowest level since 1987-88.

21. With respect to palm versus soybean oil and crude versus refined oil.

22. The purpose of these 'release order' controls is to

stabilise the free market price in periods when production exceeds demand

23. World sugar prices were on downward trend since 1996 and crashed in 1999 to levels not seen for more than a decade. World sugar production grew between 1994-95 and 2000-01 by 16 per cent, whereas consumption increased by only 11 per cent, leading to a substantial build-up in stocks and continued downward price pressure. By August 2000, surplus stocks had risen to 18 million tonnes, an all time high. High average world sugar prices during the mid-1990s drew the biggest response from Latin America and Brazil in particular. In fact, Latin America's export increased by 51 per cent during the 1994-95-2000-01 period to reach 17.6 million tonnes, whereas Brazil's export alone grew by 6.8 million tonnes during the period. The price crash of 1999 in hindsight occurred because the Asian financial crisis curtailed demand in several large sugar importers while Brazil continued to export record amounts, aided by the devaluation of the country's currency.

24. Sugar Promotion Act, 1958, gave the power to STC to administer the losses and were shared by the sugar mills in proportion to their production.

25. The price of wheat peaked in May 1996 at around $ 260 per tonne, about 65 per cent higher than the price a year earlier and more than double the price in May 1994. This steep rise in prices resulted from a combination of demand and supply side factors. On the supply side, between 1994-95 and 1995-96, global cereal production declined by 3.0 per cent (accounting to 1728 million tonnes), driven by a 9.6 per cent reduction in production in developed countries, due to poor weather in some major cereal-producing countries such as Australia, Canada, and the United States; policy-induced reductions in price subsidies in Western Europe and North America that diminished production and stock-holding incentives; and significant declines in food production in the former Soviet Union. At the same time, on the demand side, global consumption of cereals outstripped production for the third year in a row, considerably depleting stocks and contributing to a rapid increase in prices (Andersen et al 1997). By 1995-96, there was a substantial reduction in global cereal stocks, which reached a 20 year low of 258 million tonnes. This constituted only 14 per cent of global cereal consumption, well below the 17 per cent considered by the Food and Agricultural Organisation (FAO) to provide the necessary margin of safety for world food security. Much of the drawdowns occurred in the traditional exporting or stock-holding countries like Canada, US and Australia.

26. Only about 3.24 million tonnes of wheat was added to the stock by April 1, 1997.

27. Wheat prices, which rose by about 70 per cent between April 1995 and May 1996, dropped to less than half of its 1996 level by July 1999. In this context, it must be noted that policies of major exporting economies also exacerbated the fall in the international price by generating artificial export surpluses. For example, the United States increased its support payments from US$ 15 in 1996 to US$ 55 per MT in 1999. In the European Union too, while substantial direct payments were maintained at the rate of 54 Euro per MT during the period, there was an increase in export refunds also. As a result of increased farm support in major exporting countries along with high world prices of 1995-96, worldwide, wheat area cultivated increased by 5 per cent between 1995-96 and 1996-97. The world grain stocks were rebuilt and reached 337 million tonnes by 1999, corresponding to 17.9 per cent of annual world cereal consumption and consequently the grain prices fell [Sekhar, 2008, Pp. 12-14].

28. Food demand for a year was computed by gross production minus seed, feed & wastage minus net trade *minus* change in stock. Thus the demand for a year is demand during the year.

29. Total supply for a year was computed by gross production+ beginning stock + Import. *Ex- post* demand and supply are always equal and the two cannot be measured separately, therefore, in our analysis ex-post demand for wheat (or any other commodity in question) was computed, as stated in the previous footnote, which is nothing but net availability of wheat or amount of wheat consumed during the year as food. Supply, on the other hand, refers here to ex-post gross availability (during the year) and was computed by gross production plus stock held with public agencies at the beginning of the year plus imports. The same methodology is also used by US Department of Agriculture while releasing the data on production, supply and distribution (PSD) for agricultural commodities not only for US but for rest of the world also. With this explanation, we use the expressions (gross) availability and supply inter-changeably in this paper.

30. Because of the decline in international prices and rise in domestic prices it became difficult to dispose of the large stock of wheat at a price matching the cost of these food grains to the Government. Thus, the Government was forced to release wheat for export at a price much lower than acquisition cost.

31. During the period from 1988-99 to 1994-95, an increase in rice procurement price, of more than two times, resulted in an increase of 77 per cent in rice procurement.

32. Total supply for a year was computed by gross production + beginning stock + Import.

33. According to the norms laid down for rice buffer stock, it was necessary to maintain a buffer stock of 6.00 million tonnes at the beginning of October during 1992 to 1998. However, this quantum was raised to 6.50 million tonnes in 1999 but was reduced to 5.20 million tonnes in 2005.

34. Beginning with the year 1996-97, international rice prices again faced a severe downward pressure and touched

in 2000-01 the lowest level since the 1960s of US$ 176 per metric tonne. On the supply side, this was the time when major exporting countries had bumper harvests. Rice production in Asia increased continuously, breaking records every year through 1999, and reaching 371 million tonnes. Total world production, reflecting the situation in Asia, reached a new record at slightly over 400 million tonnes in 1999, which was the first time in history for rice production to reach the 400 million tonnes level. The increased exports from countries like India, China and Pakistan have ensured low world prices. On the demand side, following the East Asian crisis, demand from Asian importers got weakened. The crisis affected Latin America too, and reduced global agricultural commodity prices, consumption, and trade in general and those of rice in particular. Domestic policies in the developed countries exacerbated the situation arising from the decline in prices. During the period when international rice price was declining, a massive dose of counter-cyclical subsidies were provided to the US rice farmers. The United States increased its support payments from US$ 53.99 in 1997 to US$ 172.70 per MT in 2000. As a result, US rice producers were insulated from the price shock and they managed to maintain their high trading volumes. As USA is a major rice exporting country, this resulted in over-supply of rice in the international market and exacerbated the decline in international rice prices [Hoda and Gulati, 2008]. Despite a decline of 8 million tonnes in global production in 2000 over the previous year, international rice prices continued on the downward path in 2000. The reason underlying such a slide in price is fundamentally the same as in the previous year, as import demand continued to shrink in most of the traditional importing countries such as Bangladesh, Indonesia, the Philippines and Sri Lanka [FAO, 2002].

35. The launch of Technology Mission on Oilseeds in 1986 marked the beginning of a new phase in the history of Indian oilseeds. The main goal of the mission was to achieve self-sufficiency in edible oils through price incentives and improved technology, processing and supporting services such as seeds and credit (Shenoy, 1989). These moves paid dividends and production of oilseeds increased by 93 per cent, i.e., from 11.68 million tonnes to 22.61 million tonnes between TE 1986-87 and TE 1996-97. Import of edible oils came down from one-third of the total supply during mid 1980s to about 2 per cent in 1992-93.

36. A comparison of domestic prices with international prices in case of major edible oils like groundnut, mustard/rapeseed and soybean during the period 1980-81 and 2004-05 shows that domestic prices ruled at higher levels than the international prices during the entire period, making import an attractive proposition. However, when edible oil imports into the country were not freely allowed, during the late 1980s and early 1990s for example, the ratio of domestic to international prices for majority of edible oils was more than three but with the liberalisation of edible oil import since mid-1990s when edible oil imports were placed under the OGL and private traders were permitted to import any quantity of vegetable oils, subject only to a tariff, the gap between domestic and world reference prices almost evaporated, as both the prices started moving jointly. This was mainly on account of decline in domestic prices of edible oils due to import of cheap edible oils [Tripathi, 2013]. As mentioned in previous section of the paper, world prices of edible oils were subject to strong downward pressure during the years 1997 to 2002 as the international market for oils were over-supplied relative to demand.

37. As a result, the oilseeds production declined by 20 per cent during the period.

38. MSP levels for grains have also been raised more than for oilseeds since the mid-1990s. In addition, although the government had regularly supported wheat and rice MSPs - mainly in several important cereal-producing states - price support operations for oilseeds have usually not been funded. As a result, increasingly favourable returns to wheat and rice have drawn area away from oilseeds, lowering oilseed production from an average of 23 million tonnes in TE 1997-98 to 18 million tonnes in TE 2002-03.

39. With the population growing from about 550 million in 1970 to over 1 billion in 2001, and per capita income growth rising throughout the 1970s (1.4 per cent annually), 1980s (3.1 per cent), and 1990s (3.7 per cent), consumption growth in India has been almost uninterrupted. The most rapid growth occurred when government trade policy changes allowed increased access to imports, such as in the early to mid-1970s, when the monopoly State Trading Corporation was allowed to import substantial amounts of oil, and after 1994, when private traders were first allowed to import vegetable oils.

40. Despite high tariffs, prices for edible oils have tended to decline compared with other foods since the early 1990s, stimulating increased per capita oil consumption.

41. In the case of groundnut oil, the period 1997 to 2002 witnessed a decline of 29 per cent in world reference prices, whereas in case of rapeseed and soybean oil, the world reference price witnessed a decline of 36 per cent and 41 per cent, respectively, between 1998 and 2001. These periods also witnessed a sharp increase in Indian import tariff rates, in response to low world prices. For instance, the applied tariff duty rates on imported rapeseed oil were increased from 25% to 85% between 1997 and 2002, whereas, in case of rapeseed and soybean oil, it increased from 25% to 44% and from 23% to 47%, respectively [Tripathi, 2013].

42. Indian consumers spend a large share of their income (about 55 per cent) on food and are generally highly responsive to prices. Middle and lower income consumers, in particular, substitute items in and out of the diet based on relative prices. The strong growth of palm and soybean oil imports and their

rising share in consumption largely reflects the sensitivity of Indian consumers to price changes.

43. Editor's Note: A question may be raised as to whether counting of the years with profitable outcomes is adequate for resolving the issue. Should we not consider the present value of the alternative income streams resulting from the trade option and the stocking policies over the entire period of analysis? Should one not, for example, examine, using Tables 5.3 and 5.4 of Chand's paper, (or preferably using updated data similar to those, if possible) whether (a) *the present value* of the sum of the difference between IPP and the economic cost of wheat and rice multiplied by the shortfall of output from trend for the corresponding years will be positive (implying the domestic stocking option was better than the trade option in bad years of grain output over the period as a whole) and (b) *the present value of the sum of* the difference between EPP and domestic price of wheat and rice multiplied by the excess of output from trend for the corresponding years will be negative (implying the domestic stocking option was better than the trade option in good years of grain output over the period as a whole), at a reasonable social rate of discount? The author has refrained from making such calculation claiming that the biggest disadvantage of the calculation of present value is its sensitivity to discount rate and it is highly sensitive to the assumption made in this regard. However, when we did this calculation at various assumed social discount rates, we found that for wheat, even present value criterion does not alter Chand's conclusion for any social discount rates as high as even 100 per cent or even a little higher but for rice, while the same conclusion is valid for the import option, the export option becomes preferable to the stocking option in the event of excess outputs, when the social discount rate is considered to be a little higher than 9 per cent (9.4 per cent or more, to be precise). The point is that a simple counting of years with profitable outcomes does not take into account the size of gain or loss. Figures 13 and 14 of the present paper suggest that if the above calculations were to be extended to cover the period up to 2008, Chand's conclusion about the export option is likely to be further weakened because of the extremely high international prices of wheat and rice in 2008. Also, how these stop-go policies in regard to foreign trade in some of these agricultural commodities may affect the incentives for production of these commodities is a question which requires a serious consideration.

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PARTY POLITICS AND OUTSOURCING POLICIES IN US: IMPLICATIONS FOR INDIA'S IT-BPO INDUSTRY

Siddhartha Mukerji

The global integration of digital technologies has led to a radical restructuring of business strategies whereby the private companies located in the Western hemisphere particularly US and West Europe have started taking advantage of the rapidly-growing service sector in the East. In this context, a certain level of mutual dependence has emerged between US and India in the economic realm. Taking full advantages of the rapid growth of internet and long-distance communication links, India's IT-BPO industry has assumed a leadership role in the outsourcing business.

However, after reaching its pinnacle of growth, the Indian companies that provide outsourcing services have started facing new challenges on the political front from US. The increasing social pressures against outsourcing which has been viewed as the chief cause of unemployment in the category of high-skilled, research-based IT and software services in the recent past, has manifested in strong political dissensions and disagreements between the two major political parties in US. Outsourcing emerged as a critical issue of political campaigning in the last US Presidential elections where Republicans were being held responsible for appeasing external forces at the cost of the economic interest of local employees in the IT and software industry. This research paper is an attempt to explore the political context and the consequent policy developments in US for determining the extent of business collaborations in the outsourcing segment.

India has emerged as a popular destination for service outsourcing from US and West European countries. The IT services industry in India accredits its comparative advantage to a technically-skilled, English speaking manpower coupled with its cost-effectiveness - unique qualities that have enabled US and West European companies to hire professionals from India or to operate through a firm based in India. India being the provider of a variety of IT and back-office services has been a host to several private companies located in United States. Today, these companies are clients not only to the large software giants like TCS and Infosys but a whole range of SMEs, BPOs and KPOs in India.

The IT and BPO industry in India has become a base for intensifying business engagement between India and United States. The growing service trade between two economic giants has required state intervention in providing the required support for the business ventures. In view of this, the government of India has provided institutional support to export-oriented companies through software technology parks (STPs). On the other side, the government in United States offered benefits in the form of tax exemptions to companies that take services from India. However, the flip side of this mutually-beneficial trade became apparent in the form of social reaction in United States against outsourcing in view of job cuts of local employees in the service sector. Due to intensification of the social opposition the issue of outsourcing in United States has taken political overtones in the recent past. It has also appeared as a major subject of party competition.

The central argument here is that growing business engagements between nations through outsourcing are impeded by policy uncertainties or instability in the client country (the US), resulting from social disturbances growing out of increasing unemployment. The policy uncertainties arise out of fundamental disagreements between the political parties over issues in international trade and the extent of business

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engagements with emerging Asian economic giants like India and China. The political reactions and counter reactions against global integration may be triggered by the increasing social rejection of the 'external' forces in 'internal' business in the client country. I attempt to explore the growing nature of politicisation of the outsourcing business in the US and how it has determined, and will determine, the future prospects of India's growing IT-BPO industry. The discussion follows a brief section on the emergence of the Indian outsourcing industry and its growing popularity in US with the growth and expansion of information and communication technology at a global scale.

Emergence of the outsourcing industry

The Indian IT-BPO industry has acquired a centre stage in the international market for software and support services today. Its achievements could be gauged from the increasing growth rates achieved particularly after the year 2000, a year that witnessed the 'Y2K software bug' issue. Recent reports from the Department of Information Technology (DIT), the ministry of information and communication technology and National Association of Software and Service Companies (NASSCOM) have clearly indicated the unprecedented expansion of the Indian IT-BPO industry in the world market, particularly US and Europe. As per the estimates, the aggregate revenue generated by the IT-BPO industry (combined)[1] in the FY 2012-13 was $108 billion in which the software and service segment alone contributed $95 billion. The industry also contributed 8% of national GDP in the same year. The export revenues generated by the industry were $75.8 billion within which the software and services segment revenues amounted to $43.9 billion. [Annual Report 2012-13, p. 1] The three major components of IT services are: custom application development, application management and support and training. Other services include IT consulting, system integration, infrastructure services outsourcing, network consulting and integration and software testing. Vertically the BPO and KPO segments mainly provide their services to banking, finance, insurance, telecom, and retail sectors.[2]

Till very recently, most of the software services had to be performed onsite whereby the companies were required to send their professionals at the client site to execute the required task. This process has been termed as 'bodyshopping'. Bodyshopping placed the Indian software industry at a disadvantage as against competitors like Israel, Philippines and China that could develop strong long-distance data communication links and provide outsourced services to the US. Second, it established the monopoly of the big players in the industry who were able to meet the high expenditures involved in onsite servicing. Also, a large part of onsite servicing was confined to low-value added tasks like coding, debugging, testing of technical specifications, and so on. Unfortunately, the specific data giving an estimate of the proportion of low-value added tasks to total value added of the IT industry or the IT-BPO sector is not readily available.

With the advancements in telecommunication technology, long-distance data links requirements were met and it became possible to provide the service from the host site. This saved the unnecessary time and cost incurred in sending the professionals to client countries. This shift from onsite services to offshore/outsourced services for US companies by the Indian IT-BPO industry has led to rapid expansion. A gradual shift in the direction of outsourcing is also visible particularly after 1997 with the rise of IT-BPO (combined) industry. It is shown that in the year 2011, India assumed a share of 58% of the global outsourcing market generating net revenue of $59 billion. United States that registers almost 70% of the overall global outsourcing gets 80% of its business from India.

Outsourcing is the contracting out of a business process. The US and West European countries outsource several kinds of services to the IT industry in India. The most popular amongst them is customised applications that cover a large part of the outsourced services provided from India. This is followed by the pre-eminent position of the application outsourcing segment that primarily includes database management systems and IT-enabled services like business process outsourcing (BPO), knowledge process outsourcing (KPO), geographical information systems (GIS) and other forms of engineering services.

One of the outsourcing segments for which India is seen as popular destination is the BPO industry. The BPO industry emerged as a result of the internationalisation of the service industry coupled with the integration and dissemination of advanced digital and communication technologies globally. The sector grew by almost 12% reaching a mark of $16 billion in 2012.[3] The increasing popularity of the Indian BPO industry is accredited to its talented, technically-skilled, English-speaking pool of young energetic professionals. These professionals work through dispersed computer networks and provide the required customer service and back office business and technical information. Due to the zonal time difference between India and US, the call centres operate during night hours in India. Over a period of time, the BPO services have got upgraded to KPO, representing a shift from low-end services to higher-end research and analytical services to the clients. [Rastogi, 2005, p. 202] This phenomenon started sometimes around mid-2000s with an increasing requirement for up-gradation of skill and technological innovation. KPOs are still at a nascent stage of development and its future prospects will primarily depend on demand-supply equations for high-end services in the US.

Politicisation of Outsourcing

While the growth trajectory of the outsourcing industry has primarily been understood from an economic standpoint, the growing significance of this industry in the areas of governance, international relations and cultural convergence has drawn the attention of policy makers and agenda setters at both national and international levels. The external drivers of growth have captured some attention in the contemporary literature. This primarily includes the political conditions in both client and host nations and the way political perceptions are manifested in the state policies on international trade. The market mechanisms and the prospects of private investment have remained susceptible to social predicaments, electoral politics and political decisions in the client country.

Country/region-wise data shows that in the year 2011-12 the US attained the highest market share in the IT-BPO industry of 62%. Continental Europe and UK combined assumed a market share of 28% in the previous year while APAC (Asia-pacific) region was expected grow by 8%.[4] Due to high level of dependence on the US market, the prospects of the industry in India have remained susceptible to political developments in the US. Outsourcing to low-cost countries like India and Philippines has aroused opposition from the software and IT professionals in the US in recent years as it was viewed as the chief source of job losses and unemployment in that country. Before the Y2K software issue came up, the issue remained insignificant as the transfer of responsibilities were confined mainly to low-value added tasks like coding, debugging, technical specifications testing and so on. Later, the private companies in the US, particularly the banking and the finance sectors, started looking for low-cost solutions even for high value added tasks in countries like India, China and Philippines. Even amongst these countries India having additional advantages of technically-skilled, English speaking youth was seen as the most favoured destination.

Since 2000, the unemployment rates remained high particularly in both manufacturing and service sectors in the US. The outsourcing of high-valued assignments that included several turn key management projects deprived the local service sector of business and employment opportunities. The scepticism towards outsourcing emerged from job losses in both skilled and semi-skilled segments. Once the private companies began outsourcing a great deal of other services like software development, debt collection, equity and bond analysis, accounting, filing income tax returns, legal services, drug and medicinal research, and so on, the issue became a matter of social and political concern.

Forrester Research Inc. shows that a total of 3.4 million jobs may move outside the US during 2003-2015. Around 1.7 million of these are being relocated during the first seven years of the 12-year period. According the Bureau of Labour Statistics Report cited in Levine [2012], 'In 2007, there were some 30 million jobs in around 160 offshorable- service providing occupations that accounted for nearly 1/5th of the total employment in that year. More than half of these occupations were in professional and technical categories'. [Levine, 2012] Another Report of BLS that accounted for employment gain and loss sector-wise found that in the period between January and July 2009 there was an average loss of 104 thousand jobs in professional and business services. However, there have been job gains since 2010 particularly in management and technical consulting services. Similarly, it observed that between March 2011 and mid-2011 information services industry lost 1 million jobs or 1/3rd of the total employment.[5]

Concurrently, the addition of ITES-BPO jobs in India since 2000 clearly indicates the transfer of jobs from the US to India. The Annual Report 2004-05 of the Department of Information Technology observes that the IT services added around 109,000 jobs while the ITES-BPO generated an addition of 94,500 jobs in 2004. In the following financial year a total of 345, 000 jobs and 348,000 jobs were created in the previously mentioned categories, respectively. The FY 2004-05 has been taken for the assessment as the pace of outsourcing increased after 2000 and started showing the desired impact on employment in a period of 3-4 years. [Annual Report, 2004-05]

The IT outsourcing that offered lower-end services like software testing and debugging at the initial stages of its development has today assumed global significance in high-end services like total IT outsourcing, R&D and business transformative services. Similarly, the BPO-segment that took off with voice-based call centres has now entered multiple domains of knowledge, offering high-end services like research and analytic services. When the nature of outsourcing business shifted from low to high-value added projects it became a matter of concern for the IT and software professionals within the US. As the new avenues offered by India for back-office services motivated the private companies to harness the opportunities available abroad, the job insecurities of the engineers and professionals in that country became apparent. As a result outsourcing to Indian IT-BPO/KPO industry was seen as a major driver of unemployment in US.

Outsourcing as an Issue in Electoral Politics

Subsequently, the social pressures against outsourcing started building up and provided a platform especially to the Democratic Party to challenge the insouciant attitude of the Republicans towards rising unemployment in the IT service sector. The demand primarily came from the Communication Workers of America with a membership of nearly 7 lakh workers. The Democrats who were in opposition strongly resisted the immigration-friendly and outsourcing-encouraging programmes of the Republican government between 2000 and 2008.

Bush's administration accorded prior attention to outsourcing to keep with party's ideological commitment for free trade regime. The CEA (Council of Economic Advisors) with N. Gregory Mankiw as its chairman spoke strongly about tax breaks and other non-monetary incentives for US companies that planned to outsource. CEA is a three-member body of eminent economists within the President's executive office whose task is to advise the president on important domestic and international economic policy matters. The President's CEA in the US is politically the strongest economic and financial advisory body. Mankiw in one of his statements to the media said that, 'Outsourcing is just a new way of doing international trade...More things are tradable than were tradable in the past. And that's a good thing'.[6] The Republican government thus attempted to make the service trade free of import tariffs. Making a powerful advocacy for a freer trade in services, the sector was kept completely out of the ambit of domestic regulation. Furthermore, common concerns over internal security and means to check global terrorism after the terrorist attacks necessitated a closer cooperation between India and the US. Also, the ideological similarities of a liberal trade regime in both countries provided better avenues for a strong impetus for outsourcing from the governments.

The issue of outsourcing acquired centre stage in the presidential elections of 2004 where promises were made by Democrats to open new avenues for employment by restricting outsourcing. The political debates that preceded the elections reflected serious dissensions between the Democrats and the Republicans at the ideological level. The disagreements between the two political parties on the subject of offshoring services to low-cost destinations like India raised larger questions on the sustainability of the economy with IT globalisation. The release of the Economic Report of the President by the then Republican President George Bush on 9 February 2004 that highlighted the necessity to promote free trade in the service sector through outsourcing set the ball rolling for future political campaigns leading up to the elections of November 2004. The Economic Report of the President in 2004 underscored the vitality of free trade in the service sector. In this regard it observes that,

> "The benefits from new forms of trade, such as services, are no different from the benefits from traditional trade in goods. Outsourcing of professional services is a prominent example of a new type of trade. The gains from trade that take place over the internet and telephone lines are no different than the gains from trade in physical goods...when a good or service is produced at a lower cost in another country, it makes sense to import it rather than to produce it domestically". [Economic Report, 2004]

The policy direction given by the Report made the possibilities of governmental support for outsourcing absolutely transparent. However, as a matter of fact it led to a mismatch between the expectation of the domestic labour and government position on service trading. The Democrats who were already preparing themselves for the upcoming presidential elections sharply reacted to the government's position on this subject. The timing was politically ripe for adopting populist measures to draw public attention towards the government's appeasement of the foreign service industry at the cost of the interests and aspirations of the domestic labour. The presidential election was only about 9 months ahead of the release. The outsourcing issue thus provided a launch pad to the Democrats. As a result, the Democrat presidential candidate from Massachusetts John Kerry along with his team of close political associates including John Edwards, who were at the helm of affairs in the party, launched a campaign against government's encouragement for outsourcing. They advanced a parallel policy proposal, often referred to as the 'Kerry-Edward Plan', on March 2004, that sought to restructure US tax laws in order to discourage offshoring of jobs. It directly charged the foreign service companies for increasing unemployment in US.

The proposal clearly stated that, 'it (Democratic Party) seeks to repeal every tax break and loophole that rewards any Benedict Arnold CEO[7] or corporation for shipping American jobs overseas'. Furthermore, the proposal promised to impose higher corporate tax on companies that attempted to outsource and promised special tax incentives for the companies that kept jobs in the US. [Policy Bulletin, 2004]

The economic logic of linking unemployment and outsourcing causally was used as a political mobilisation strategy by the Democrats whereby pro-labour and protectionist programmes of the party were placed against the failures of the Republican government in addressing the vulnerabilities of domestic labour. In a research survey conducted by Kate Kenski and Kathleen Hall to judge the perceptions of people towards the candidates' position on the major electoral issues, it was found that nearly 58.2% of the respondents believed that the Kerry administration is most likely to favour eliminating tax breaks for overseas profits of American corporations and using the money to cut taxes for business that creates jobs in the United States [Kenski and Jamieson, 2006, p. 246]. The electoral significance of the Kerry advocacy against outsourcing and rising unemployment was well proven in his defeat by the smallest margin as an incumbent since Woodrow Wilson.

Democrats' Policy Response

In the 2008 presidential elections, the Democrats had again made commitments for restricting immigration and inhibiting involvement of the Indian service industry in the US economy. The newly elected Democrat president Barrack Obama introduced stringent policy measures like the US Call Centre Bill, new visa policies and more recently the Immigration Bill. A radical shift on the policy front was, however, politically unfeasible. Therefore, an incremental approach was the right strategy to balance the interests of the two main stakeholders, the domestic labour and the big corporations, and at the same time maintaining and continuing its strategic political ties with India, its main destination for outsourced services.

It is also observed that the political circumstances that led to prioritisation of policy measures had also changed. After 2001 the government was preoccupied with the concerns of internal security as terrorism had appeared as a big threat to life and property for the citizens. War against terrorism was in the immediate agenda for the government of United States. During the last presidential elections, political resistance against outsourcing started surfacing after rising unemployment due to the recession became a serious concern in government circles. The strengthening of internal security measures had assured the protection of citizens from external and internal threats. The main issue to handle was now unemployment and IT globalisation.

The concerns over rising unemployment and the promises made by the Democrats to tackle the same through protection of existing jobs resulted in several protectionist policy responses. Visa restrictions in several categories, particularly those that were directly associated with the Indian service industry were imposed by the government. The H1B visa which basically permits US companies to hire skilled workers from foreign countries was severely restricted. Recently, the government added a stringent clause to the 'stimulus bill' that provides greater and tougher scrutiny by the government on banks and other businesses that hire skilled foreign workers under the H1B visa programme. As a result of such government control, the number of H1B visas issued to the IT professionals has declined tremendously. Similarly, the government has also reduced the number of L1 visas for inter-company transfer that provided a blanket cover to the organisation as a whole.

Second, the formulation of the US Call Centre Bill that seeks to inhibit offshoring raised serious concerns about its impact in the Indian IT-BPO industry. The Bill was tabled before the House of Representatives in December 2011. It was introduced by the Democrats Rep. Tim Bishop and Rep. David Mackinley of the House of Representatives. The Bill provides that any company which intends to carry out its business operation through call centres located abroad will be denied federal grants and loans. Second, if the company locates its call centres in another country without informing the same to the US Department of Labour in 120 days then a fine of $10,000 will be charged on it. The Bill was therefore a clear move towards protectionism as it attempts to safeguard the service sector jobs in the country. The initiative was largely political in nature as it sought to force the Democrats in reinstating its commitment to protect and create additional employment in the domestic economy during the election campaign. It acts as a bulwark against the Republican claims of promoting outsourcing as they consider it to be beneficial for the economy in the longer run.

Unemployment and Outsourcing as a political issue in 2012 Presidential elections

The issue of outsourcing resurfaced in the last Presidential elections. The Republican candidate Mitt Romney who was previously the governor of Massachusetts was accused by the Democrats of outsourcing American jobs to call centres in India. Romney favoured and advocated the continuance of tax breaks for companies that were involved in the outsourcing business. He forcefully advocated free-market principles so that it would bring maximum profits to the private corporations. His campaign defended the rights of corporations to be free enough to do anything that generate profits even if it required outsourcing jobs overseas.[8]

The Obama campaign strongly resisted the pro-outsourcing stance of Romney during his tour to the swing states of Ohio, Pennsylvania and Florida. Bain Capital, the private firm owned by Mitt Romney was alleged to have taken over companies and outsourced American jobs to India and China. It was reported in the *Wall Street Journal* that 'the firm invested in several companies that specialised in relocating jobs done by American workers to low-wage countries such as China and India'.[9] In one of his speeches during the elections campaign, Obama exclaimed that, 'Governor Romney's experience is in companies that were pioneers of outsourcing'.[10] In his deliberation, he portrayed himself as a defender of working class rights and Romney as a supporter of rich and wealthy classes by protecting their tax breaks.

The outsourcing plank thus provided a base for political confrontation between the two major parties in 2012 elections. Obama reverberated the protectionist stance of his party and promised to take his campaign forward to resist any such move that led to job losses in US. It was reported that unemployment in 2008 was as high as 2.6 million in which 113,000 belonged to professional and business services.[11] As the Presidential elections in 2008 coincided with the worst kind of economic recession hitting United States since the

Great Depression, it took nearly two years for the new administration to restore the economy and create avenues for employment. Some 4.9 million jobs were regained in a period of 32 months since the recovery process started in March 2010.

During his first term, Obama undertook certain policy initiatives for securing jobs within the country as generating employment was in the prime agenda of his party. Unemployment was found to be driven concomitantly by the economic recession of 2008 as well as outsourcing of IT and call centre jobs overseas. Both the pressures had to be handled separately with specific policy measures. In 2009, the government announced a fiscal stimulus package of $787 billion to recuperate the economy with three stimulations:

1 Stimulate Employment
2. Stimulate certain economic sectors particularly energy, science and technology, infrastructure, education, and heath care with significant outlays
3. Stimulate consumer spending[12]

The restrictions on outsourcing through new visa rules created avenues for employment generation within the country but posed difficulties for service companies in India in running their business. The three major policy measures taken to check unemployment arising out of outsourcing are as follows:

1. New Visa restrictions especially H1B and L1 visas
2. New tax stringencies imposed through the US Call Centre Bill
3. US Immigration Bill

The ensuing section will account for the economic impact of these policy measures on IT-BPO industry in conjunction with the political pressures built by IT leaders, NASSCOM and concerned government bodies on the US counterparts.

US Laws Restricting Outsourcing: Economic Consequences and Political Response in India

Protectionist programmes of the US government raised a new political economy debate over the limits of Globalisation in India. The growth story of the Indian IT industry that has consistently received support from the government for export-promotion is now showing signs of obfuscation of whether the fickleness of the US market and uncertainties over state support will require a new strategy of business or not. Recent political clamour over outsourcing to India creating policy uncertainties of the sort in US coupled with predicaments of Global recession of 2008 has wider economic and political implications in India. The newly-established regime of Democrats framed policies that resorted to protectionist measures for putting caps on outsourcing to countries like India and Philippines. The most significant amongst these were the visa policies, the US Call Centre Bill and the most recent US Immigration Bill.

Visa restrictions on IT professionals from India has been a major impediment before the Indian IT companies who are required to send their engineers and professionals for business purposes. While most of the service is offshored, the US companies also hire Indian professionals in search of skilled manpower and multilingual capabilities combined with the advantage of low cost. These professionals may also be sent by the Indian companies which provide outsourced services for coordinating the business from the US. Therefore, it facilitates the outsourcing business and provides better understanding of the requirements and expectations of the host company. The imposition of restrictions on hiring foreign workers through H1B visas and the reduction of L1 visas has limited the scope of outsourcing. The L1 visas will have a direct impact on outsourcing as it provides a blanket cover to the company to send their engineers and professionals to the US for a relatively shorter period. H1B visa will be a straight loss for the US companies which meet their labour requirement through body-shopping, whereby the migrant professional is issued a permit to reside and work in the US for 4-5 years. As it is observed that, ‘with the US Senate imposing restrictions on hiring foreigners on H1B visa, the feeling has come hitting hard on the highly skilled Indians that the door to the US might actually close for them’.[13] Second, it may be seriously affecting the possibilities of extending the period of work for those employees who are sent by the Indian companies providing outsourced services, for instance TCS or Wipro, for facilitating and coordinating the business.

The other protectionist step taken by the US government was the introduction of US Call Centre Bill in 2011 that in order to relocate the Call Centre outside the US, the concerned company will have notify the US Secretary of Labour failing which a penalty of $10,000 will be imposed. Such companies will also be debarred from receiving federal grants. It implies that the tax breaks will not be available for US companies that ship jobs overseas (through outsourcing). It is apprehended that once the Bill is passed, the US administration may further favour protectionist policies that will be detrimental to the Indian IT-BPO industry in the longer run.

The US government pronouncements on the Call Centre Bill and visa policies have hampered the expansion of outsourcing opportunities from the US companies. Showing serious concerns over the impact of the Bill on outsourcing industry, the government of India decided to resolve the issue bilaterally with the US government and at an inter-governmental forum. India’s Ambassador to the US Nirupama Rao has also sought to look into the political context in which the Bill has emerged in the Congress. Highlighting the significance of Indian IT companies for the US workforce, Ms. Rao observes that, ‘IT companies from India support approximately 98000 jobs in US and in creating new jobs have sustained a compound annual growth rate (CAGR) of 35% in the last 5 years’.[14] The introduction of new regulations has thus been found to be mutually debilitating for the two giant economies.

Both IT companies at the individual level and NASSCOM as a collective industrial organisation for the software and services companies in India have expressed their reservation over the introduction of the Bill. S. Mahalingam, CFO, TCS exclaimed that, ‘the new law will impact the growth of the already sluggish $ 14 billion Indian BPO market which is under pressure due to slowdown in US markets and competition from other locations.[15] NASSCOM reacted sharply to the prohibitive stances of the US government. In one of the recent statements to *Economic Times*, NASSCOM President Som Mittal said that, ‘The Bill will have a negative impact on India...the concern is not only about the content of the bill, but that US will come out with many more protectionist things’.[16] Further, one of the statements released by NASSCOM says that, ‘It is indeed disappointing to see US adopt protectionist measures like these (US Call Centre Bill) that restrict free trade and establish discriminatory trade practices’.[17] This wave of protectionism may also limit the possibilities of expansion to other regions which may introduce similar patterns of regulatory checks. Second, such prohibitive tendencies of the US administration may cause sharp resistance from other emerging outsourced nations like China, Philippines and Israel.

The most recent passage of the US Immigration Bill (2013) directly hits the interest of the Indian IT-BPO companies in India. The Bill has increased the cap on H1B visa from 65,000 to 1,15,000. However, the Bill tightens the conditions for US-based companies that hire employees under the visa category. The bill was introduced by 8 senators and was passed by

Senate on 28 June 2013.[18] The Indian business leaders and the government authorities in India have reacted to the content of the Bill that is taken to be debilitating for the Indian IT industry. The former Telecom Secretary R. Chandrashekhar in an interview with *Mint*, *The Wall Street Journal*, finds the bill mutually destructive for both the economies as he says that, ‘There are certain collateral provisions (of the Bill) which are detrimental to Indian industry...we believe that it is detrimental to the US companies and US economy as well and therefore this will have implications in the medium term and the long term in reducing the potential for such corporations and ultimately the competitiveness for US itself’.[19] He gave a call for the government and industry in strategising together to deal with global issues. In this regard, he stated that both the government and NASSCOM have been talking to the US on this issue.

IT-BPO industry in India particularly the small and medium enterprises (SMEs) attract a large number of projects from the US; therefore the matter has assumed both economic and political significance with the NASSCOM along with the government showing serious concerns over the prohibitive content of the Bill and taking up the matter with the US counterparts. Citing the challenges before the IT-BPO industry in view of the passage of most recent US Immigration Bill, NASSCOM President Som Mittal exclaims that, ‘Be it customers, US corporations, our government or NASSCOM, we are all ensuring that we provide our perspectives to the decision-makers there (in US)’. Substantiating the effects of the Bill on outsourcing business in India the technology transfer giant Gartner Inc. observed that, ‘the companies will file fewer visa petitions as cost per application will increase by $5000’.[20]

The President of the industrial body was a part of the delegation of the Commerce Minister Anand Sharma that recently visited the US. One of the chief objectives of the meeting was to communicate the concerns of the Indian IT-BPO firms to the authorities over the negative impact of the Bill on IT business in India. NASSCOM has also engaged an IT firm in the US to lobby with the members of Senate and the House of Representatives. Other than this, NASSCOM has also partnered with industrial bodies in the US like the Silicon Valley Leadership group to present India’s position on the Bill.

Protectionism embodied in all the policy measures will be extremely debilitating for the KPOs which is a step towards higher value-addition in the BPO segment. The expansion of KPO is a landmark development for the call centre business in India. It exhibits the penchant of the IT firms towards higher innovation and qualitative business. Underscoring the future prospects of KPOs in India, the Annual Report of the Department of Information Technology, Government of India, observes that, ‘With the BPO going strong for the past few years, the KPO- which may be called the highest level of BPO- is still at a nascent stage of development in the country’. But there are studies that show the steady expansion of Indian KPO segment in the global market. According to a joint study conducted by NASSCOM and Crisil cited in *Business Line*, while the global market for KPO would grow from $2.9 billion in 2010 to $7.9 billion in 2015, the Indian KPO segment may grow from $2 billion in 2010 to $5.6 billion in 2015.[21] Overall the KPO industry in India is said to achieve a CAGR of 22 touching $5.6 billion. Within the KPO industry, the business research segment is seen to assume the highest share of 39.4% with a market of $2.2 billion.[22] The evolution of the global KPO market and the rising KPO industry in India will drive trends that will ensure very high-value services in offshoring. These opportunities will help the Indian market climb the global value and knowledge chain’ [Annual

Report, 2006-07]. However, the regulatory conditions imposed by the US government will impede the possibilities of its expansion and may lead to regression.

Conclusion

As unemployment still continues as an agenda of party politics in United States, political uncertainties in IT business remain intact. Creation of jobs in professional, business and financial services within the domestic market has taken precedence in the policy agenda of the Obama administration. Therefore, the political economy context that has and is emerging in the US generates a sense of scepticism for the future prospects of the Indian IT-BPO industry. The disagreements between the two main political parties over outsourcing raise larger questions about their ideological underpinnings on economic progress and social equality. It marks a difference of perception over the issues of free trade and global integration with the developing nations. The protectionist wave in developed country may moderate the reformist drive of the developing nations, at least temporarily, as they look for alternatives to promote indigenous development. The e-governance drive of the Indian government is itself a marker of such a rethinking as it seeks to use the available technologies for social and economic development within the country. The government following the market-oriented model of development is running several schemes to improve public delivery system. This includes programmes like kisan call centres and UID (unique identity) at the Central level and state-run e-governance schemes such as e-seva, e-suvidha, e-procurement, etc., in Andhra Pradesh and Karnataka. Many of such projects are run in close collaboration with private companies or sometimes even by direct involvement of IT entrepreneurs in them. For example, the UID project was being undertaken by the government under the chairmanship of Nandan Nilekani, the co-founder of Infosys. As the global market becomes restrictive, the focus of economic policies may shift towards using local private capital for local development.

We also find that the economic logic of expanding trade in the global market has been contradicted by the political logic of job protection within the country. The mutual benefit accrued from outsourcing can be acknowledged from the fact that India still largely depends on United States for lending its services particularly in business and technical categories and that the US economy needs cost-effective solution for its sustenance which it finds in low-wage countries like India, China and Philippines. It is possible that outsourcing may not involve a net loss of jobs in the host country, taking into account jobs which get sustained in other sectors due to increase in real aggregate income. This important question yet needs to be examined, which has not been done here. Also, outsourcing has in a way checked brain drain from India as it creates ample job opportunities for IT and service professionals within the country. However, as the attrition rate particularly in the BPO and other service-oriented sectors remains substantially high, sustainability of jobs in them becomes largely questionable.

Moreover, as bilateral cooperation between the two countries takes new turns with several areas of common interest and concern like international security, nuclear energy and restoration of democracy in Afghanistan and Iraq, any disturbance in trade engagements in a critical sector like IT and business services may have undesirable consequences for the partnership between the two economic superpowers in these highly-significant political arenas.

NOTES

1. The IT-BPO industry (combined) includes software and services, BPO and KPO segments. Hardware is excluded from these segments.

2. www.deity.gov.in, Official website of Department of Electronic and Information Technology, Ministry of Communication and Information Technology, Government of

India, last accessed on 29 July 2013.

3. Strategic Review 2012, NASSCOM.

4. 'Electronics and Information Technology', Annual Report 2011-12, Department of Information Technology, Ministry of Information and Communication Technology, p. 1.

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DOCUMENTATION

The purpose of this section is to make available to the readers official documents such as reports of committees, commissions, working groups, task forces, etc., appointed by various ministries, departments, agencies of central and state governments and international organisations, which are not readily accessible either because they are old, or because of the usual problems of acquiring governmental publications, or because they were printed but not published, or because they were not printed and remained in mimeographed form. We also present in this section, official documents compiled from scattered electronic and/or other sources for ready reference of the readers. It will be difficult and probably not worthwhile to publish the documents entirely. We shall publish only such parts of them as we think will interest our readers. The readers are requested to send their suggestions regarding official documents or parts thereof for inclusion in this section.

We are also keen to publish Papers, Notes or Comments based on the material included in this section. We invite the readers to contribute the same to our journal, which we shall consider for publication in subsequent issues of the journal, after the usual refereeing process.

In the present section, we publish:

1. The Maharashtra Water Resources Regulatory Authority Act, 2005
2. Water Resources Department, Mantralaya, Mumbai 400 032, Dated The 11Th January 2011. Maharashtra Ordinance No. II of 2011. An Ordinance to Amend the Maharashtra Water Resources Regulatory Authority Act, 2005.
3. Approach Paper On Criteria For Determination of Bulk Water Tariff 2013-16
4. Economics of Irrigation in Water-Scarce Regions: Study of Maharashtra*
5. Extract from Maharashtra Water & Irrigation Commission Report, Volume I Approach (June 1999), (Chairman - M.A. Chitale), Chapters 1, 2, 3, 6, 8, 9, 10.

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*We are thankful to Gokhale Institute of Politics and Economics, Pune, for kindly permitting us to reproduce here some part of the "Economics of Irrigation in Water Scarce Regions - Study of Maharashtra", by N. Rath and A.K. Mitra, in Vol. 31, No. 1, March 1989 issue of *Artha Vijnana.*

THE MAHARASHTRA WATER RESOURCES REGULATORY AUTHORITY ACT, 2005

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THE MAHARASHTRA WATER RESOURCES REGULATORY AUTHORITY ACT, 2005

ACT NO. XVIII OF 2005

An act to provide for the establishment of the Maharashtra Water Resources Regulatory Authority to regulate water resources within the State of Maharashtra, facilitate and ensure judicious, equitable and sustainable management, allocation and utilisation of water resources, fix the rates for use of water for agriculture, industrial, drinking and other purposes, and matters connected therewith or incidental thereto.

WHEREAS it is expedient to make a law to provide for the establishment of the Maharashtra Water Resources Regularity Authority to regulate water resources within the State of Maharashtra, facilitate and ensure judicious, equitable and sustainable management, allocation and utilisation of water resources, fix the rates for use of water for agriculture, industrial, drinking and other purposes, and matters connected therewith or incidental thereto, for the purposes aforesaid; it is hereby enacted in the Fifty-sixth Year of Republic of India as follows:-

1
PRELIMINARY

1. Short title, extent and commencement.

(1) This Act may be called the Maharashtra Water Resources Regulatory Authority Act, 2005.
(2) It extends to the whole of the State of Maharashtra.
(3) It shall come into force on such date as the state Government may, by notification in *Official Gazette,* appoint, and different dates may be appointed for different areas and for different sections of this Act.

2. Definitions.

(1) In this Act, unless the context otherwise requires-

(a) "Aggregate Bulk Water Entitlement" means an aggregate of Entitlements issued to a group or association of Water User Entities for the purpose of joint management of the Bulk Water Entitlements;
(b) "allocation" means the portion or percentage of an Entitlement declared annually or seasonally by the Prescribed Authority to be made available to the holder of an Entitlement based upon the availability of water for the period within the sub-basin, river basin, project or storage facility for that season or year; and during water crisis or scarcity on the principle of proportionate entitlement.
(c) "Authority" means the Maharashtra Water Resources Regulatory Authority established under section 3;
(d) "Board" means the State Water Board constituted under section 15;
(e) "Bulk Water Entitlement" shall mean the volumetric entitlement to a share of the surface water resources produced by a project, river system or storage facility, for a specific category or Categories of Use, and deliverable within a specific period of time as specifically provided in the order granting the Entitlement;

This document can be cited as 'The Maharashtra Water Resources Regulatory Authority Act, 2005', 1/1 Law, Environment and Development Journal (2005), p. 80, available at http://www.lead-journal.org/content/05080.pdf

(f) "Category of Use" shall mean use of water for different purposes such as for domestic, agricultural irrigation, agro-based industries, industrial or commercial, environmental, etc., and includes such other purposes as may be prescribed;

(g) "Chairperson" means the Chairperson of the Authority;

(h) "Council" means the State Water Council constituted under section 16;

(i) "Entitlement" means any authorisation by any River Basin Agency to use the water for the purposes of this Act;

(j) "Government" or "State Government" means the Government of Maharashtra;

(k) "Governor's Directives" means the directives issued by the Governor under rule 7 of the 'Development Boards for Vidarbha, Marathwada and the rest of the Maharashtra Order, 1994' made under clause (2) of article 371 of the Constitution of India;

(l) "Individual Water Entitlement" means any authorization by the Authority to use the water other than Bulk Water Entitlement or an Aggregate Bulk Water Entitlement;

(m) "Integrated State Water Plan" means a water plan approved by the State Water Council;

(n) "Irrigation Project" means a project constructed to provide irrigation facilities to the land situated in the command area in accordance with the project reports and orders in this regard, as revised from time to time;

(o) "Member" means a Member of the Authority and includes the Chairperson;

(p) "prescribed" means prescribed by the rules made under this Act;

(q) "Prescribed Authority" means any authority at various levels within the water resource management system that has been duly authorised by the Authority to determine and declare, on an annual or seasonal basis, the quota or amount of water available within a system for use as an allocated percentage of the Entitlements duly issued by the Authority;

(r) "Project Level Entity" means a group of all Water User Entities, from a common supply source within a water resources project;

(s) "Quota" means a volumetric quantity of water made available to an Entitlement holder, which is derived by multiplying an Entitlement by the annual or seasonal allocation percentage;

(t) "regulations" means regulations made by the Authority under this Act;

(u) "River Basin Agency" means any one of the following River Basin Development Corporations operating in the River Basin and includes the Government Authorities as specified by the Government, from time to time,-

(1) **Mah. XV of 1996.** the Maharashtra Krishna Valley Development Corporation established under the Maharashtra Krishna Valley Development Corporation Act, 1996;

(2) **Mah. XXVI of 1997.** the Vidarbha Irrigation Development Corporation established under the Vidarbha Irrigation Development Corporation Act, 1997;

(3) **Mah. III of 1998.** the Konkan Irrigation Development Corporation established under the Konkan Irrigation Development Corporation Act, 1997;

(4) **Mah. IV of 1998.** the Tapi Irrigation Development Corporation, established under the Maharashtra Tapi Irrigation Development Corporation Act, 1997;

(5) **Mah. XXIII of 1998.** the Godavari Marathwada Irrigation Development Corporation established under the Maharashtra Godavari Marathwada Development Corporation Act, 1998;

(v) "Selection Committee" means a Selection Committee constituted under section 5;

(w) "State" means the State of Maharashtra;
(x) "State Water Policy" means the Water Policy of the State;
(y) "Sub-Basin" means a hydrologic unit or hydrologic sub-unit of a river basin within the State;
(z) "sub-surface entitlement" means an Individual or Bulk Water Entitlement to a volumetric quantity of water to be extracted in the command area of the irrigation project from a tube well, bore well or other well or by any other means of extraction of sub-surface water, or a group or field or wells duly and legally permitted, registered and constructed in accordance with standards prescribed by the Authority;
(za) "Utility" means any Water User Entity responsible for the management, treatment and distribution of domestic or municipal water supplies (including water use for Industries);
(zb) "Volumetric" means a measurement of water on the basis of volume as per the norms of the Bureau of Indian Standard;
(zc) "Water User Entity" means any Water User's Association, Utility, Industrial User's Association, Other User's Association or any other group (or individual) which is authorised by the Authority to receive and utilize a water Entitlement;
(zd) "Water User's Association" means a Water User's Association formed at the minor level or above, which represents the users of irrigation water from that segment of any project, canal or natural flow storage system;

(2) Words and expressions used and not defined in this Act but defined in various irrigation or water resources related Acts in the State shall have the meanings respectively assigned to them in those Acts.

2
MAHARASHTRA WATER RESOURCES REGULATORY AUTHORITY

3. Establishment and incorporation of Authority.

(1) The State Government shall within three months from the date of the commencement of this Act, by notification in the Official Gazette, establish an Authority to be known as the Maharashtra Water Resources Regulatory Authority to exercise the powers conferred on, and to perform the functions and duties assigned to it, under this Act.

(2) The Authority established under sub-section (1) shall be a body corporate by the name aforesaid, having perpetual succession and a common seal, with power to contract, acquire, hold and dispose of property, both movable and immovable, and to do all things necessary for the purposes of this Act, and may sue or be sued by its corporate name.

(3) The head office of the Authority shall be at Mumbai.

(4) The Authority shall consist of a Chairperson and two other Members.

(5) The Chairperson and the other Members of the Authority shall be appointed by the Governor of Maharashtra on the recommendation of the Selection Committee constituted under section 5.

4. Qualification for appointment of Chairperson and other Members and special invitees of Authority.

(1) The Chairperson, the Members and special invitees of the Authority shall be appointed as follows:-
(a) the Chairperson shall be a person who is or who was of the rank of Chief Secretary or equivalent thereto,
(b) one Member shall be expert from the field of water resources engineering,
(c) one Member shall be expert from the field of water resources economy,

(d) five special invitees as prescribed one from each river Basin Agency area, who are having adequate knowledge, experience or proved capacity in dealing with the problems relating to engineering, agricultural, drinking water, industry, law, economics, commerce, finance or management for assisting the authority in taking policy decisions.

(2) The Chairperson or any other Member of the Authority shall not hold any other office.

5. Constitution and functions of Selection Committee.

(1) The State Government shall, by notification in the *Official Gazette*, for the purposes of sub-section (5) of section 3, constitute a Selection Committee consisting of, -

(a)	the Chief Secretary of the State	*ex-officio* President;
(b)	the Secretary, Planning Department	*ex-officio* Member;
(c)	the Secretary (Command Area Development Authority), Water Resources Department	*ex-officio* Member;
(d)	the Secretary, Water Conservation Department	*ex-officio* Member;
(e)	the Secretary, Water Supply Department	*ex-officio* Member;
(f)	the Secretary, Urban Development Department	*ex-officio* Member;
(g)	the Secretary, Energy and Environment Department	*ex-officio* Member;
(h)	the Secretary, Agricultural Department	*ex-officio* Member;
(i)	the Secretary, Water Resources Department	*ex-officio* Member Secretary.

(2) The Government shall, within one month from the date of occurrence of any vacancy by reason of death, resignation or removal of the Chairperson or any Member, and six months before the superannuation or end of tenure of Chairperson or any Member, make a reference to the Selection Committee for filling up of the vacancy.

(3) The Selection Committee shall finalise the selection of the Chairperson and Members within one month from the date on which the reference is made to it under sub-section (2).

(4) The Selection Committee shall recommend a panel of two names for every vacancy referred to it.

(5) Before recommending any person for appointment as the Chairperson or other Member of the Authority, the Selection Committee shall satisfy itself that such person does not have any financial or other interest, which is likely to affect prejudicially his functions as a Member.

(6) No appointment of the Chairperson or other Member shall be invalid merely by reason of any vacancy in the Selection Committee.

6. Term of office, salary and allowances and other conditions of service of Chairperson and Members of Authority.

(1) The Chairperson or other Member shall hold office for a term of three years from the date on which he enters upon his office:

Provided that, the Chairperson or the other member may be re-appointed but for not more than two consecutive terms:

Provided further that, no Chairperson or other Member shall hold office after he has attained the age of seventy years.

(2) The salary and allowances payable to and the other terms and conditions of service of, the

Chairperson and other Members shall be such as may be prescribed.

(3) The salary and allowances and other conditions of service of the Chairperson and other Members shall not be varied to their disadvantage after appointment.

(4) The Chairperson and every Member shall before entering upon his office make and subscribe to an oath of office and of secrecy in such form and in such manner and before such authority as may be prescribed.

(5) Notwithstanding anything contained in subsection (1), the Chairperson or any Member may,-

(a) relinquish his office by giving in writing to the Governor notice of not less than three months; or
(b) be removed from his office in accordance with the provisions of section 7.

(6) The Chairperson or any Member ceasing to hold office as such shall,-

(a) not be eligible for further employment under the Government of Maharashtra for a period of two years from the date he ceases to hold such office;
(b) not accept any commercial employment for a period of two years from the date he ceases to hold such office.

Explanation- For the purposes of this sub-section,-

(i) "employment under the Government" includes, employment under any local or other authority within the territory of Maharashtra or under the control of the Government or under any corporation or society owned or controlled by the Government.

(ii) "commercial employment" means employment in any capacity under, or agency of, a person engaged in trading, commercial, industrial or financial business in the Water Resources Sector and also includes a director of a company or partner of a firm and also includes setting up practice either independently or as partner of a firm or as an adviser or a consultant.

7. Removal of Member.

(1) Subject to the provisions of sub-section (3), any Member of the Authority shall be removed from his office by order of the Governor on the ground of proved misbehavior after the State Government, has, on an inquiry, held in accordance with the procedure prescribed in this behalf, reported that the Member, ought on any such ground to be removed.

(2) The Governor may, during the period of inquiry as specified in sub-section (1), against any Member suspend such Member, of the Authority.

(3) Notwithstanding anything contained in subsection (1), the Governor may, by order, remove from office, the Chairperson or any other Member, if the Chairperson or such other Member, as the case may be-

(a) has been adjudged an insolvent; or
(b) has been convicted of an offence which, in the opinion of the Government involves moral turpitude; or
(c) has become physically or mentally incapable of acting as Chairperson or Member; or
(d) has acquired such financial or other interest as is likely to affect prejudicially his function as the Chairperson or Member; or
(e) has so abused his position as to render his continuance in office prejudicial to the public interest.

(4) Notwithstanding anything contained in subsection (3), no Member shall be removed from his office on the ground specified in clause (d) or clause (e), unless the Government has, on an

inquiry, held by it in accordance with such procedure as prescribed in this behalf by the Government reported that the Member ought on such ground or grounds to be removed.

8. Power of Government to depute officers and employees to Authority and their service conditions

(1) The Authority may, appoint a Secretary to exercise such powers and perform such duties under the control of the Chairperson and as may be specified by regulations.

(2) Authority may, with the prior approval of the Government, appoint such number of officers and employees as it considers necessary for the performance of its duties and functions.

(3) The salaries and allowances payable to, and other conditions of service of the Secretary, officers and employees shall be such as may be determined by regulations.

(4) The Government may, in consultation with the Authority, appoint any Government officer or employee on deputation to the Authority.

(5) The period of deputation of any such officer or employee to the Authority shall be five years except when any such person is required to be repatriated on the grounds, such as promotion, reversion, termination or superannuation or any other reason of deputation, he shall stand repatriated to service under the State Government:

Provided that, during the period of such deputation all matters relating to the pay, leave, allowances, retirement, pension, provident fund and other conditions of service of the employees on deputation shall be regulated by the Maharashtra Civil Services Rules or such other rules as may, from time to time, be made by the State Government.

(6) No officer or employee on deputation to the Authority shall be entitled to any deputation allowance.

(7) The salaries and allowances of officers or employees on deputation to the Authority shall be paid by the Authority.

(8) Save as otherwise provided in this section, the terms and conditions of services of employees on deputation to the Authority shall not be less advantageous than those applicable to them immediately before deputation and shall not be varied to their disadvantage except with the previous sanction of the State Government.

(9) The Authority may appoint consultants required to assist the Authority in the discharge of its functions on such terms and conditions as may be determined by regulations.

9. Proceedings of Authority.

(1) The Authority shall meet at the head office or any of its offices at such time as the Chairperson may direct and shall observe such rules of procedure in regard to the transaction of business at its meetings (including the quorum at its meetings) as may be determined by regulations.

(2) The Chairperson or if he is unable to attend a meeting of the Authority, any other Member nominated by the Chairperson in this behalf and, in the absence of such nomination or where there is no Chairperson, any Member chosen by the Members present from among themselves, shall preside at the meeting.

(3) All questions come up before any meeting of the Authority shall be decided by a majority of votes of the Members present and voting, and in the event of an equality of votes, the Chairperson or the person presiding shall have the right to exercise a second or casting vote.

(4) Save as otherwise provided in sub-section (3), every Member shall have one vote.

(5) All orders and decisions of the Authority shall be authenticated by the Secretary or any other officer of the Authority duly authorised by the Chairperson in this behalf.

10. Vacancies, etc., not to Invalidate act or Proceeding.

No act or proceedings of the Authority shall be questioned or shall be invalidated merely on the ground of existence of any vacancy or defect in the constitution of the Authority.

3
POWERS, FUNCTIONS AND DUTIES OF THE AUTHORITY

11. Powers, functions and duties of Authority.

The Authority shall exercise the following powers and perform the following functions, namely:-

(a) to determine the distribution of Entitlements for various Categories of Use and the equitable distribution of Entitlements of water within each Category of Use on such terms and conditions as may be prescribed;
(b) to enforce the decision or orders issued under this Act;
(c) to determine the priority of equitable distribution of water available at the water resource project, sub-basin and river basin levels during periods of scarcity;
(d) to establish a water tariff system, and to fix the criteria for water charges at sub-basin, river basin and State level after ascertaining the views of the beneficiary public, based on the principle that the water charges shall reflect the full recovery of the cost of the irrigation management, administration, operation and maintenance of water resources project;
(e) to administer and manage interstate water resources apportionment on river systems, of the State;
(f) to review and clear water resources projects proposed at the sub-basin and river basin level to ensure that a proposal is in conformity with Integrated State Water Plan and also with regard to the economic, hydrologic and environmental viability and where relevant, on the State's obligations under Tribunals, Agreements, or Decrees involving interstate entitlements:

Provided that, while clearing the new water resources projects by the concerned for construction proposed by River Basin Agencies, the Authority shall ensure that Governor's Directives issued from time to time, relating to investment priority for removal of regional imbalance are strictly observed;

Provided further that, in respect of the projects situated in Maharashtra and Vidarbha Regions, the powers to accord administrative approval or revised administrative approval, under this clause, shall in accordance with the Governor's directives, be exercised by the concerned River Basin Agency.

(g) to lay down the criteria and monitor the issuance of Entitlements.

These criteria among others shall also include the following,-

(i) The Entitlements shall be issued by River Basin Agency based on the Category of Use and subject to the priority assigned to such use under State Water Policy;
(ii) Bulk Water Entitlements shall be issued by the River Basin Agency for irrigation water supply, rural water supply, municipal water supply or industrial water supply to the relevant Water User

Entities including Municipalities, Water User's Associations, Industrial Users and State agencies responsible for delivery to the respective sector or to a Sub-surface Water User's Association or entity that operates a well field of multiple subsurface water tube wells, bore wells or other wells on behalf of multiple users;

(iii) Bulk Water Entitlements for irrigation, shall be issued by River Basin Agency, to the Water User's Associations at the primary unit level, Distributory level and Canal or Project level Associations and River Basin Agencies shall not receive Entitlements but shall act as conveyance entities for the Entitlements issued to the Water User's Associations;

(iv) Water User Entities including Water User's Associations, managing the aggregate of Entitlements on behalf of a group of Entitlement holders may be issued an Aggregate Bulk Entitlement;

(v) Individual Water Entitlements may be issued by River Basin Agency only for the construction and operation of individual lift irrigation schemes from surface water sources, bore-wells, tube wells or other facilities for extraction of sub-surface water. Such Entitlements shall be administered, registered, measured and monitored by the respective River Basin Agency in close co-ordination with relevant Government agencies. Where such facilities extract water from alluvial aquifers that are conjunctive with the surface water of a basin, the issuance and operation of such Entitlements shall be conjunctively co-ordinated with the use and yield of surface water resources of the basin and shall be compatible with the overall water resource plan of the local area and the respective river basin and the sustainable use of the sub-surface water resources.

(vi) Bulk Water Entitlements shall be for a specific proportion of flow, storage or other determination of the annual yield of a water resources or facility and the Entitlement shall be measured volumetrically and with respect to time of delivery and flow rate of delivery;

(vii) The allocation of a percentage of the water available under the Entitlements of each facility, in the drainage basin or river basin shall be determined jointly by the River Basin Agencies and Water User Entities based upon the hydrology and other relevant parameters with regard to the specific basin. This allocation shall be utilised for the determination of the amount of water to be made available under each Entitlement for that specific year or runoff season;

(h) to lay down the criteria for modification in Entitlements for the diversion, storage and use of the surface and subsurface waters of the State. These criteria shall among others, include the following:-

(i) Aggregate Bulk Water Entitlements will be considered as Bulk Water Entitlements under the provisions of this Act except that they shall not be a usufructuary right and will only be adjusted by the Authority if there is a compensating change, under the provisions of this Act, to any component Bulk Water Entitlement that comprise part of the Aggregate Bulk Water Entitlement;

(ii) In the event that any Water User Entity wishes to use its category priority to mandate a change in the use or volume of any Entitlement, that entity must demonstrate in a public hearing before the Authority, that it has exhausted all attempts to conserve, increase efficiency and manage its demand of water within its, Entitlement and has exhausted all opportunities to increase its Entitlement through a transfer within the voluntary, market-based economy. If, after such a public hearing, the Authority deems such a mandated transfer, on either an annual or permanent basis, to be legal and necessary in the interest of the people of the State, the Authority shall then determine a fair and just compensation as determined by the market value of the water resource, to be paid to the Entitlement holder by the entity exercising the mandated user category preference;

(i) to fix the criteria for trading of water Entitlements or Quotas on the annual or seasonal basis by a water Entitlement holder. These criteria shall among others, include the following,-

(i) Entitlements, except Aggregate Bulk Water Entitlements, are deemed to be usufructuary rights which may be transferred, bartered, bought or sold on annual or seasonal basis within a market system and as regulated and controlled by the Authority as established in the rules of the Authority;

(ii) Quotas of water determined by the seasonal or annual allocation assigned to an entitlement shall be volumetric usufructuary rights which may be transferred, bartered, bought or sold on an annual or seasonal basis within a market system as established and controlled by the rules of the Authority;

(iii) Bulk Water Entitlements or Quotas shall be transferable within the respective category of use as long as such transfers are compatible with the operation of the specific water resource facilities involved. Such annual transfers shall be managed and registered with the respective River Basin Agency which shall have the power to approve or deny such proposed transfers if they are incompatible with the operation of the facility or would damage the Entitlements or rights of other users within the system. The River Basin Agency may charge a nominal fee for the processing and registering such transfer but shall not participate in any compensation between Entitlement holders as a part of such transfer.

(j) Entitlements may be subject to review at intervals of not less than three years and then, only if warranted by concerns about, the sustainability of the level of allocation;

(k) Bulk Water Entitlements shall be registered by the River Basin Agency and shall be monitored by the Authority or its duly delegated competent representative;

(l) permanent transfer of Entitlements shall only be made with the approval of the respective River Basin Agency and the Authority and in compliance with the rules of the Authority promulgated for this purpose. All approved transfers shall be entered into the registry of Entitlements of the Authority;

(m) in the event of water scarcity, the Authority, in compliance with its policy and rules for allocating such scarcity, shall adjust the quantities of water to be made available to all Entitlements and shall permit the temporary transfer of Water Entitlements between users and Categories of Users in accordance with the approval of the River Basin Agencies;

(n) to establish regulatory system for the water resources of the State, including surface and subsurface waters, to regulate the use of these waters, apportion the Entitlement to the use of the water of the State between water using categories;

(o) to establish a system of enforcement, monitoring and measurement of the Entitlements for the use of water that will ensure that the actual use of water, both in quantity and type of use are in compliance with the Entitlements as issued by the Authority;

(p) to administer the use and Entitlement of water resources within the State in a manner consistent with the State Water Policy to ensure the compliance of the obligation of State with regard to the apportionment of interstate waters between the State and other States;

(q) to promote efficient use of water and to minimize the wastage of water and to fix reasonable use criteria for each Category of Use;

(r) to determine and ensure that cross-subsidies between Categories of Use, if any, being given by the Government are totally offset by stable funding from such cross-subsidies or Government payments to assure that the sustainable operation and maintenance of the water management and delivery systems within the State are not jeopardised in any way;

(s) to develop the State Water Entitlement data base that shall clearly record all Entitlements issued for the use of water within the State, any transfers of Entitlements and a record of deliveries and uses made as a result of those Entitlements;

(t) to facilitate and ensure development, maintenance and dissemination of a comprehensive hydro-meteorological information data base in co-operation with the River Basin Agencies;

(u) the Authority shall review and revise, the water charges after every three years;

(v) The Authority may ensure that the Irrigation Status Report is published by the Government every year, such report shall contain all statistical data relating to irrigation including details in respect of districtwise irrigation potential created and its actual utilisation;

(w) such other powers, functions and duties as may be prescribed.

12. General policies of the Authority.

(1) The Authority shall work according to the framework of the State Water Policy.

(2) The Authority shall recognise the policy of empowering River Basin Agencies in accordance with the State Water Policy.

(3) The Authority shall, in accordance with the State Water Policy, co-ordinate with all relevant State agencies to implement a comprehensive hydrometeorological data system for the State.

(4) The Authority shall, in accordance with State Water Policy, promote and implement sound water conservation and management practices throughout the State.

(5) The Authority shall support and aid the enhancement and preservation of water quality within the State in close coordination with the relevant State Agencies and in doing so the principle that 'the person who pollutes shall pay' shall be follow.

(6) The Authority shall fix the Quota at basin level, sub-basin level or project level on the basis of the following principles:-

(a) for equitable distribution of water in the command area of the project, every land holder in the command area shall be given Quota;

(b) the Quota shall be fixed on the basis of the land in the command area: Provided that, during the water scarcity period each landholder shall, as far as possible, be given Quota adequate to irrigate at least one acre of land;

(c) in order to share the distress in the river basin of sub-basin equitably, the water stored in the reservoirs in the basin or sub-basin, as the case may be, shall be controlled by the end of October every year in such way that, the percentage of utilizable water, including kharif use, shall, for all reservoirs approximately be the same:

(d) Subject to the condition of efficient use of water, the existing private sector lift irrigation management schemes shall be allowed to continue for a period of five years from the date of commencement of this Act and thereafter on the date that may be specified by the Government the provisions of sub-section (4) of section 14 shall apply:

Provided that, having regard to geographical conditions, different dates may be notified for different areas.

(e) the command area of private lift Irrigation schemes, on the date of commencement of this Act, shall be treated at par with the command area of the irrigation projects;

(7) The Authority shall ensure that the principle of "tail to head" irrigation is implemented by the River Basin Agency.

Mah. XXVIII of 1993.

(8) The Authority shall abide by the relevant provisions of the Maharashtra Ground Water Regulation (Drinking Water Purposes) Act, 1993.

(9) The Authority shall while framing policy, give preference to the projects so that, the physical backlog forming the basis of the financial backlog be eradicated in accordance with the Governor’s directive.

(10) (a) The Authority shall strive to make the water available to the drought prone areas of the State;

(b) The Authority shall ensure that, the funds made available to a drought prone district are spent preferably in the areas, where irrigation facilities are less than the other areas of that district.

(11) Notwithstanding anything contained in this act, a person having more than two children shall be required to pay one and half times of the normal rates of water charges fixed under clause (d) of section 11 of this Act to get entitlement of water for the purpose of agriculture under this Act:

Provided that, a person having more than two children on the date of commencement of this Act, shall not be required to pay such one and half times water charges so long as the number of children he had on such date of commencement does not increase:

Provided further that, a child or more than one child born in a single delivery within the period of one year from such date of commencement shall not be taken into consideration for the purpose of this subsection.

Explanation - For the purpose of this sub-section -

(a) Where a couple has only one child on or after the date of such commencement, any number of children born out of a single subsequent delivery shall be deemed to be one entity;
(b) "child" does not include an adopted child or children;

13. Powers of Authority and Dispute Resolution Officer. 5 of 1908.

The Authority and the Dispute Resolution Officer shall for the purposes of making any inquiry or initiating any proceedings under this Act, have the powers as are vested in a civil court, under the Code of Civil Procedure, 1908 in respect of the following matters, namely:-
(a) the summoning and enforcing the attendance of any witness and examining him on oath;
(b) the discovery and production of any document or other material object producible as evidence;
(c) the reception of evidence on affidavits;
(d) the requisition of any public record;
(e) the issue of commission for examination of witnesses;
(f) review its decisions, directions and orders;
(g) any other matter which may be prescribed.

4
STATE WATER PLANNING

14. Permission of River Basin Agency.

(1) From the date of commencement of this Act, no person shall use any water from any water source without obtaining the Entitlement from the respective River Basin Agency:

Provided that, no Entitlement shall be required in case of,-
(a) any bore well, tube well or other wells which are being used for domestic purposes; and
(b) tanks, small reservoirs or catchments of rainwater harvesting with an annual yield capacity as may be decided by the Authority.

Explanation:- For the purposes of this section, the expression ‘person’ shall includes individual, group of individuals, all local authorities, association, societies, companies, etc.

(2) Use of the water for the purposes of agriculture, through any existing well, bore well, tube well in the command area of a project on the date of commencement of this Act, shall be allowed to continue till such date as may be notified by the Authority.

(3) There shall not be any restriction on digging of any well, bore well or tube well in the command area of a project, till such date as may be notified by the Authority.

(4) Water shall not be made available from the canal for perennial crops in such area and from such date as may be notified by the Authority, unless the cultivator adopts drip irrigation or sprinkled irrigation or such other water saving technology approved by the Authority. The quantity of water so saved, after satisfying the further increased demand of drinking water, shall be distributed equitably in the command area and the adjoining area.

15. State Water Board.

(1) The State Government shall by notification in the Official Gazette, constitute a Board to be known as the State Water Board for the purposes of this Act.

(2) The Board shall consist of the following Members, namely;-

(a)	the Chief Secretary of the State	*ex-officio* President;
(b)	the Principal Secretary, Planning Department	*ex-officio* Member;
(c)	the Principal Secretary, Finance Department	*ex-officio* Member;
(d)	the Secretary, Water Conservation Department	*ex-officio* Member;
(e)	the Secretary, Water Supply Department	*ex-officio* Member;
(f)	the Secretary, Urban Development Department	*ex-officio* Member;
(g)	the Secretary, Energy and Environment Department	*ex-officio* Member;
(h)	the Secretary, Water Resources Department (Command Area Development Authority)	*ex-officio* Member;
(i)	the Secretary, Agriculture Department	*ex-officio* Member;
(j)	Divisional Commissioners of all Revenue Division in State	*ex-officio* Member;
(k)	the Secretary, Water Resources Department	*ex-officio* Member Secretary.

(3) The Board shall prepare a draft Integrated State Water Plan on the basis of basin and sub-basin wise water plans prepared and submitted by the River Basin Agencies.

(4) The Board shall submit its first draft Integrated State Water Plan to the Council for its approval within six months from the date on which this Act is made applicable in the State.

(5) The Board shall, while preparing the draft Integrated State Water Plan mentioned in sub-section (3), consider the directives of the State Water Policy.

(6) The Board shall meet at such time and place as the President of the Board may decide and shall follow such procedure as may be prescribed.

16. State Water Council.

(1) The State Government shall, by notification in the *Official Gazette,* constitute a Council to be known as the State Water Council for the purposes of this Act.

(2) The Council shall consist of the following Members, namely:-

(a)	the Chief Minister	*ex-officio* President;
(b)	the Deputy Chief Minister	*ex-officio* Vice President;
(c)	the Minister, Water Resources	*ex-officio* Vice President;
(d)	the Minister, Water Resources (Krishna Valley and Kokan Irrigation Development (Corporation)	*ex-officio* Member;
(e)	the Minister, Agriculture	*ex-officio* Member;
(f)	the Minister, Water Conservation	*ex-officio* Member;
(g)	the Minister, Water Supply	*ex-officio* Member;
(h)	the Minister, Finance and Planning	*ex-officio* Member;
(i)	the Minister, Urban Development	*ex-officio* Member;
(j)	the Minister, Industries	*ex-officio* Member;
(k)	the Minister, Environment	*ex-officio* Member;
(l)	the Minister (Representative for Marathwada region)	*ex-officio* Member;
(m)	the Minister (Representative for Vidarbha region)	*ex-officio* Member;
(n)	the Minister (Representative for Rest of Maharashtra)	*ex-officio* Member;

(o)	the State Minister, Water Resources Department	*ex-officio* Member;
(p)	the State Minister, Water Resources (Krishna Valley and Kokan Irrigation Development Corporation)	*ex-officio* Member;
(q)	the Secretary, Water Resources Department	*ex-officio* Member;
(r)	the Secretary, (Command Area Development Authority), Water Resources Department.	*ex-officio* Member Secretary.

(3) The Members of the Council at serial numbers (l), (m) and (n) of sub section (2) shall be nominated by the Chief Minister from among the Cabinet Ministers.

(4) The Council shall approve, with such modifications as deemed necessary, the draft of the Integrated State Water Plan submitted by the Board within a period of six months from the date of submission of draft Integrated State Water Plan keeping in view the directives given by the Governor for removal of regional imbalance. The water plan so approved by the Committee shall become "Integrated State Water Plan".

(5) The Integrated State Water Plan may be reviewed after every five years from the date of its approval by the Council.

(6) The Council shall meet at such time and place as the President of the Council may decide and shall follow such procedure as may be prescribed.

5
ACCOUNTS, AUDIT AND REPORTS

17. Grants and advances to Authority.

The State Government may, after appropriation duly made by the State Legislature, by law in this behalf, make such grants and advances to the Authority as it may deem necessary for the performance of its functions and discharge of its duties under this Act; and all grants and advances made shall be on such terms and conditions as the State Government may determine.

18. Budget of Authority.

The Authority shall prepare in such form and at such time in each financial year as may be prescribed, its budget for the next financial year, showing the estimated receipts and expenditure of the Authority and forward the same to the Government.

19. Accounts of Authority.

(1) The Authority shall maintain proper accounts and other relevant records and prepare an annual statement of accounts in such form as may be prescribed by the Government in consultation with the Accountant General.

(2) The accounts of the Authority shall be audited by the Accountant General at such intervals as may be specified by him and any expenditure incurred in connection with such audit shall be payable by the Authority to the Accountant General.

(3) The Accountant General and any person appointed by him in connection with the audit of the accounts of the Authority under this Act shall have the same rights and privileges and authority in connection with such audit as the Accountant General generally has in connection with the audit of Government accounts and, in particular, shall have the right to demand the production of books, accounts, connected vouchers and other documents and papers and to inspect any of the offices of the Authority.

(4) The accounts of the Authority, as certified by the Accountant General or any other person appointed by him in this behalf, together with the audit report thereon shall

be forwarded annually to the State Government by the Authority and the State Government shall cause the audit report to be laid, within a period of six months from the date of its receipt, before the State Legislature.

20. Annual Report of Authority.

(1) (a) The Authority shall prepare once every year in such form, and at such time as may be prescribed, an annual report, giving a summary of its activities during the previous year and copies of the report shall be forwarded to the State Government.

(b) Such annual report shall include an Annexure containing irrigation backlog of each district based on the State average Rabbi equivalent irrigation potential Districtwise sown area, standard Rabbi equivalent irrigation potential from State sector and local sector schemes, percentage of irrigation potential to the sown area, percentage less than the State average, backlog in Hectare for the latest year for which the data is available, and every year thereafter, physical backlog worked out on the basis of State average and financial backlog based on the latest schedule of rates.

(c) Such report shall also include Annexure showing Districtwise and Regionwise yearly expenditure incurred on the Irrigation Sector and cumulative figures upto latest year for which data is available and every year thereafter.

(d) The details of Annexures at clauses (b) and (c) may be modified in accordance with the Governor's directives, from time to time.

(2) A copy of the report received under sub-section (1) shall be laid, within six months, after it is received, before the State Legislature.

6
SPECIAL POWERS OF AUTHORITY FOR REMOVAL OF BACKLOG AS PER GOVERNOR'S DIRECTIVES

21. Special Responsibility of Authority.

(1) The Authority shall carry out a special responsibility in regard to the Districts and Regions, affected by backlog, in irrigation sector as per Governor's directives.

(2) For implementing the Governor's directives the Authority shall ensure that the manpower available with Water Resources Department of the Government is used for survey, planning and detailed design of the projects in backlog affected areas and new projects are available for construction in time, for removal of backlog.

7
MISCELLANEOUS

22. Disputes and Appeals.

(1) The Government shall by general or special order issued in this behalf authorise any competent officer or officers for each River Basin Agency as Primary Dispute Resolution Officer, to resolve the disputes with regard to the issuance or delivery of water Entitlement, under the Act.

(2) The Primary Dispute Resolution Officer shall follow such procedure as may be prescribed while hearing the disputes.

(3) Any person aggrieved by an order of the Primary Dispute Resolution Officer may, within sixty days from the receipt of such order, prefer an appeal to the Authority:

Provided that, the Authority may entertain an appeal after the expiry of the said period of sixty days if it is satisfied that the aggrieved person had sufficient cause for not preferring the appeal within the said period of sixty days.

(4) The Authority shall follow such procedure while hearing the appeals as may be prescribed.

23. Directions by Government.

(1) The Government may issue to the Authority such general or special directions in writing in the matters of policy involving public interest and the Authority shall be bound to follow and act upon such direction.

(2) If any question arises as to whether any such direction relates to a matter of policy involving public interest, the decision of the Government thereon shall be final.

24. Members, Officers and other staff of Authority to be public servants.

45 of 1860.

The Chairperson, Members, officers and other employees of the Authority shall be deemed, when acting or purposing to act in pursuance of any of the provisions of this Act or rules or regulations made thereunder, to be public servants within the meaning of section 21 of the Indian Penal Code.

25. Protection of action taken in good faith.

No Suit, prosecution or other legal proceedings shall lie against the Government or the Authority or any officer of Government or any Members, officer or other employees of the Authority for anything done or purported to have been done in good faith in pursuance of the provisions of this Act or rules or regulations made thereunder.

26. Punishment for non compliance of orders under this Act.

Whoever fails to comply with any order or direction given under this Act, within such time as may be specified in the said order or direction or contravenes or attempts to contravene or abets the contravention of any of the provisions of this Act or any rules or regulations made thereunder shall be punishable with imprisonment for a term which may extend to six months or with fine, which may extend to ten times of the annual water charges or, with both in respect of each offence

27. Offences by Companies.

(1) Where an offence under this Act has been committed by a company, every person who at the time, when the offence was committed, was in charge of, and was responsible to the company for the conduct of the business of the company as well as the company, shall be deemed to be guilty of the offence and shall be liable to be proceeded against and punished accordingly:

Provided that, nothing contained in this sub-section shall render any such person liable to any punishment under this Act if he proves that the offence was committed without his knowledge or that he exercised all due diligence to prevent the commission of such offence.

(2) Notwithstanding anything contained in sub-section (1), where an offence under this Act has been committed by a company and it is proved that the offence has been committed with the consent or connivance of, or is attributable to any neglect on the part of, any director, manager, secretary or other

officer of the company, such director, manager, secretary or other officer shall also be deemed to be guilty of that offence and shall be liable to be proceeded against and punished accordingly.

Explanation,- For the purposes of this section,-

(a) "company" means a body corporate and includes firm, association of persons or body of individuals whether incorporated or not.

(b) "director", in relation to firm, means a partner in the firm, and in relation to any association of persons or body of individuals, means any member controlling the affairs thereof.

28 Compounding of offences.

(1) The Authority may, either before or after the institution of the proceedings for any offence punishable under this Act, with the approval of the State Government, accept from any person charged with such offence, by way of composition of the offence, a sum not less than the amount of the maximum fine and not more than double the amount of the maximum fine for the offences punishable by or under this Act.

(2) On payment of such sum as may be determined by the Authority or the State Government or any officer authorised by the State Government under sub-section (1), no further proceedings shall be taken against the accused person in respect of the same offence, and any proceedings if already taken or initiated shall stand abated, and the accused person, if in custody, shall be discharged.

29. Cognizance of Offence.

No Court shall take cognizance of an offence punishable under this Act except upon a complaint, in writing made by the Authority or by any other officer duly authorised by the Authority for this purpose.

30. Powers of Government to make rules.

(1) The State Government may, by notification in *the Official Gazette,* and subject to the condition of previous publication, make rules to carry out the purposes of this Act.

(2) Every rule made under this Act shall be laid, as soon as may be, after it is made, before each House of the State Legislature, while in session for a total period of thirty days, which may be comprised in one session or in two or more successive sessions, and if, before the expiry of the session in which it is so laid or the session immediately following, both Houses agree in making any modification in rule or both Houses agree that the rule should not be made, and notify their decision to that effect in the *Official Gazette,* the rule shall, from the date of publication of such decision in the *Official Gazette,* have effect only in such modified form or be of no effect, as the case may be; so however, that any such modification or annulment shall be without prejudice to the validity of anything previously done or omitted to be done under that rule.

31. Powers of Authority to make regulation.

(1) The Authority may, with the previous approval of the State Government make regulations consistent with this Act and the rules made thereunder, for all or any of the matters to be provided under this Act by regulations and generally for all other matters for which provision is, in the opinion of the Authority, necessary for the exercise of its powers and the discharge of its functions under this Act.

(2) Pending making of the regulations by the Authority with the approval of the State Government, the rules and procedures followed by the Irrigation Department shall, *mutantis mutandis,* be followed by the Authority for carrying out its functions.

32. Power to remove difficulties.

(1) If any difficulty arises in giving effect to the provisions of this Act, the Government may, as occasion arises, by an order published in the *Official Gazette,* do anything not inconsistent with the provisions of this Act, which appears to it to be necessary or expedient, for removing the difficulty:

Provided that, no such order shall be made after the expiry of a period of two years from the date of commencement of this Act.

(2) Every order made under sub-section (1) shall be laid, as soon as may be, after it is made, before each House of the State Legislature.

WATER RESOURCES DEPARTMENT

Mantralaya, Mumbai 400 032, dated the 11th January 2011.

MAHARASHTRA ORDINANCE No. II OF 2011.

AN ORDINANCE

to amend the Maharashtra Water Resources Regulatory Authority Act, 2005.

In pursuance of clause (3) of article 348 of the Constitution of India, the following translation in English of the Maharashtra Water Resources Regulatory Authority (Amendment and Continuance) Ordinance, 2011 (Mah. Ord. II of 2011), is hereby published under the authority of the Governor.

By order and in the name of the Governor of Maharashtra,

H. B. PATEL,
Secretary to Government,
Law and Judiciary
Department.

[Translation in English of the Maharashtra Water Resources Regulatory Authority (Amendment and Continuance) Ordinance, 2011 (Mah. Ord. II of 2011), published under the authority of the Governor.].

Mah. XXXVIII of 1976.

WHEREAS the Maharashtra Irrigation Act, 1976 regulates the supply of water for irrigation and non-irrigation purposes;

Mah. XVIII of 2005. Mah. XXIII of 2005.

AND WHEREAS the State has, in the year 2005 enacted two separate Acts, viz. the Maharashtra Water Resources Regulatory Authority Act, 2005 and the Maharashtra Management of Irrigation Systems by Farmers Act, 2005;

Mah. XVIII of 2005. Mah. XXXVIII of 1976.

AND WHEREAS the Maharashtra Water Resources Regulatory Authority Act, 2005, and also the Maharashtra Irrigation Act, 1976, provide for the regulation of water resources and determination of tariff by the authorities thereunder;

Mah. XVIII Mah. of 2005. XXXVIII of 1976.

AND WHEREAS the said Maharashtra Water Resources Regulatory Authority Act, 2005, does not repeal the Maharashtra Irrigation Act, 1976;

Mah. XVIII of 2005

AND WHEREAS the Government of Maharashtra has, in exercise of the powers conferred by section 3 of the Maharashtra Water Resources Regulatory Authority Act, 2005, established, with effect from the 8th June 2005,the Maharashtra Water Resources Regulatory Authority;

AND WHEREAS it was expedient to clarify the roles of the State Government and the Maharashtra Water Resources Regulatory Authority, in relation to the allocation of water;

Mah. Ord. XI of 2010.

AND WHEREAS the Governor of Maharashtra promulgated the Maharashtra Water Resources Regulatory Authority (Amendment) Ordinance, 2010, on the 17th September 2010 (hereinafter referred to as "the said Ordinance");

AND WHEREAS upon the re-assembly of the State Legislature on the 1st December 2010, a Bill for converting the said Ordinance into an Act of the State Legislature was introduced in the Maharashtra Legislative Assembly as L. A. Bill No. LXXV of 2010, on the 1st December 2010;

AND WHEREAS the said Bill could not be passed by the State Legislature, as the session of the State Legislature was prorogued on the 16th December 2010;

AND WHEREAS as provided by article 213 (2) (a) of the Constitution of India, the said Ordinance shall cease to operate after the 11th January 2011, the date on which the period of six weeks from the date of reassembly of the State Legislature expires;

AND WHEREAS it is considered expedient to continue the operation of the provisions of the said Ordinance;

AND WHEREAS both Houses of the State Legislature are not in session and the Governor of Maharashtra is satisfied that circumstances exist which render it necessary for him to take immediate action to continue the operation of the provisions of the said Ordinance, for the purposes hereinafter appearing;

NOW, THEREFORE, in exercise of the powers conferred by clause (1) of article 213 of the Constitution of India, the Governor of Maharashtra is hereby pleased to promulgate the following Ordinance, namely:-

Short title and commencement.

1. (1) This Ordinance may be called the Maharashtra Water Resources Regulatory Authority (Amendment and Continuance) Ordinance, 2011.

(2) This section shall be deemed to have come into force on the 17th September 2010 and sections 2 to 6 shall be deemed to have come into force on the 8th June 2005.

Mah. XVIII of 2005.

Amendment of section 2 of Mah. XVIII of 2005.

2. In section 2 of the Maharashtra Water Resources Regulatory Authority Act, 2005 (hereinafter referred to as "the principal Act"),-

(i) after clause (k), the following clause shall be inserted, namely:-

"(k-1) "High Power Committee" means the committee constituted by the State Government under the Government Resolution, Irrigation Department, No. Misc. 1001/(154-01)/I.M.-(P), dated the 21st January 2003 ;";

(ii) after clause *(u)*, the following clause shall be inserted, namely:-

"(*u-1*) "sectoral allocation" means the allocation made in a water resources project by the State Government to the various Categories of Use;".

Amendment of section 11 of Mah. XVIII of 2005.

3. In section 11 of the principal Act,-

(1) for clause *(a)*, the following clause shall be substituted, namely:-

"*(a)* to determine the criteria for the distribution of Entitlements by the River Basin Agencies, within each Category of Use, on such terms and conditions as may be prescribed, after sectoral allocation is made under section 16A ;";

(2) clause *(n)* shall be deleted;

(3) for clause *(o)*, the following clause shall be substituted, namely:-

"*(o)* to establish a system of enforcement of the Entitlements issued by the concerned River Basin Agency to various Categories of Use and its regulation, through measurement and monitoring, with a view to ensure that the actual use of water, both in quantity and type of use, are in compliance with the Entitlements issued;".

Amendment of section 14 of Mah. XVIII of 2005.

4. In section 14 of the principal Act, in sub-section *(1)*, after the existing proviso, the following proviso shall be added, namely:-

"Provided further that, the Entitlement under this section shall be required only after the distribution of Entitlement has been determined and the criteria for issuance of Entitlement has been laid under section 11.".

Insertion of section 16A in Mah. XVIII of 2005.

5. After section 16 of the principal Act, the following section shall be inserted, namely:-

Sectoral allocation by State Government.

16A. *(1)* Notwithstanding anything contained in section 11 or any other provisions of this Act or in any other law for the time being in force, the State Government shall determine the sectoral allocation:

Provided that, sectoral allocation so determined shall ordinarily be reviewed at such intervals of not less than three years.

(2) After the sectoral allocation, as provided in sub-section *(1)* is determined, the Authority shall determine the criteria for the distribution of Entitlements under clause (a) of section 11.".

Insertion of sections 31A, 31B and 31C in Mah. XVIII of 2005.

6. After section 31 of the principal Act, the following sections shall be inserted, namely:-

Entitlement to apply only after delineation. Mah. XXIII of 2005

31A. Notwithstanding anything contained in this Act or any other law for the time being in force, the term "Entitlement" shall apply only to such areas where compliance of all relevant provisions including delineation under the Maharashtra Management of Irrigation Systems by Farmers Act, 2005 is made.

Mah. XXIII of 2005

Explanation.- In respect of the areas where the Maharashtra Management of Irrigation Systems by Farmers Act, 2005, has not become applicable, section 78 of that Act shall apply and be effective.

Permission, allocation, etc., to continue. Mah. Ord. II of 2011.

31B. Notwithstanding anything contained in this Act or in any other law for the time being in force, or in any order, judgement or decree of any court, tribunal or authority, any person or Water User Entity to whom a permission, allocation, sanction, authorization or Entitlement of water has been granted by the High Power Committee or the River Basin Agency or the State Government, prior to the 17th September 2010, being the date of commencement of section 1 of the Maharashtra Water Resources Regulatory Authority (Amendment and Continuance) Ordinance, 2011, shall be deemed to have been granted, in accordance with the provisions of this Act and accordingly the same shall continue and no such person or Water User Entity shall be required to obtain fresh permission, allocation, sanction, authorization or Entitlement to draw water.

Bar of certain suits or proceedings, etc. Mah. Ord. II of 2011.

31C. Notwithstanding anything contained in this Act or in any other law for the time being in force, a permission, allocation, sanction, authorization or Entitlement of water, granted by the High Power Committee or the River Basin Agency or the State Government prior to the 17th

September 2010, being the date of commencement of section 1 of the Maharashtra Water Resources Regulatory Authority (Amendment and Continuance) Ordinance, 2011, shall be valid and shall be deemed always to have been valid and accordingly no suit, prosecution or any other legal proceedings shall lie, challenging such permission, allocation, sanction, authorization or Entitlement to draw water, before any court, tribunal or other authority and no such suit, prosecution or other legal proceedings shall lie or continue on the ground that any permission, allocation, sanction, authorization or Entitlement, as required under this Act, has not been obtained".

Repeal of Mah. Ord. XI of 2010 by withdrawal and saving.
Mah. Ord. XI of 2010.

7. *(1)* The Maharashtra Water Resources Regulatory Authority (Amendment) Ordinance, 2010, is hereby withdrawn.

(2) Notwithstanding such withdrawal, anything done or any action taken (including any notification or order issued) under the principal Act, as amended by the said Ordinance, shall be deemed to have been done, taken or issued, as the case may be, under the corresponding provisions of the principal Act, as amended by this Ordinance.

STATEMENT

The Maharashtra Irrigation Act, 1976 (Mah. XXXVIII of 1976) regulates the supply of water for irrigation and non-irrigation purposes. In the year 2005, the State has enacted two separate Acts, viz. the Maharashtra Water Resources Regulatory Authority Act, 2005 (Mah. XVIII of 2005) and the Maharashtra Management of Irrigation Systems by Farmers Act, 2005 (Mah. XXIII of 2005). The Maharashtra Water Resources Regulatory Authority Act, 2005 (hereinafter referred to as "the MWRRA Act") and also the Maharashtra Irrigation Act, 1976, provide for the regulation of water resources and determination of tariff by the authorities thereunder. The State Government, in exercise of the powers conferred by section 3 of the Maharashtra Water Resources Regulatory Authority Act, 2005, established, with effect from the 8th June 2005, the Maharashtra Water Resources Regulatory Authority.

2. The Maharashtra Management of Irrigation Systems by Farmers Act, 2005 (hereinafter referred to as "the MMISF Act") provides for management of irrigation systems by farmers and matters connected therewith or incidental thereto. Section 77 of the MMISF Act provides that, on commencement of the MMISF Act, in relation to the areas under that Act, certain provisions of the Maharashtra Irrigation Act, 1976, relating to supply of water for irrigation and non-irrigation purposes shall be deemed to have been repealed. Section 78 of the MMISF Act provides that, the provisions of the Maharashtra Irrigation Act, 1976, which has not been specifically repealed shall remain in force and apply to the areas under the Management of Irrigation Systems by Farmers. Section 79 of the MMISF Act provides for overriding effect over the provisions of any other law for the time being in force, in respect of the areas under the Management of Irrigation Systems by Farmers. Section 65 of the MMISF Act provides that the provisions of sections 11 to 14 and section 22 of the MWRRA Act shall apply in implementing the provisions of the MMISF Act and the rules made thereunder.

3. A harmonious construction of the MWRRA Act and the MMISF Act makes it apparent that until the delineation of the areas under section 5 of the MMISF Act has been effected and various steps have been undertaken, the provisions of the Maharashtra Irrigation Act, 1976 and various Government Resolutions would continue to apply and after delineation of the areas and taking of various steps, the provisions of the MWRRA Act become applicable. It is in this background, the State Government and the High Power Committee and the River Basin Agencies have granted permissions, allocations, sanctions,

authorizations or Entitlements of water. However, in view of the fact that, the MWRRA Act does not repeal the Maharashtra Irrigation Act, 1976, certain doubts were raised regarding the roles of the State Government and the Maharashtra Water Resources Regulatory Authority, in relation to the allocation of water. The interpretation that, irrespective of whether the necessary pre-requisites under the MMISF Act have been complied with, the provisions of the MWRRA Act will apply simultaneously, would lead to destructive conflict of both the said laws and would make allocation of water chaotic and impossible.

4. The sectoral allocation of water between different categories of users such as drinking, industrial and irrigation was always intended to be within the purview of the State Government and only after such allocation, the Maharashtra Water Resources Regulatory Authority would determine the criteria for the distribution of the Entitlements within each category. In view of this, it was necessary to clarify that, the MWRRA Act, would have prospective effect and it is only after the various steps including delineation of the areas under section 5 of the MMISF Act have been taken, the provisions of the MWRRA Act would apply to those areas. It was also necessary to clarify that where the permission, allocation, sanction, authorization or Entitlement of water has been granted by the High Power Committee or the River Basin Agency or the State Government to a Water Users Entity, before the MWRRA Act becoming applicable, such Entity would not be required to obtain the permission, allocation, sanction, authorization or Entitlement of water afresh, unless the same is altered by following the process under all relevant laws. It was, therefore, expedient to clarify the position immediately by amending the MWRRA Act, by promulgating an Ordinance in this matter. The Governor of Maharashtra therefore, promulgated the Maharashtra Water Resources Regulatory Authority (Amendment) Ordinance, 2010 (Mah. Ord. XI of 2010), on the 17th September 2010.

5. Thereafter, a Bill for converting the said Ordinance into an Act of the State Legislature was introduced in the Winter session of the Maharashtra Legislative Assembly as L. A. Bill No. LXXV of 2010, on the 1st December 2010. However, the said Bill could not be passed by the State Legislature, as the session of the State Legislature was prorogued on the 16th December 2010. As provided by article 213 (2) (a) of the Constitution of India, the said Ordinance would cease to operate after the 11th January 2011, being the expiry of six weeks from the reassembly of the State Legislature.

6. As both Houses of the State Legislature are not in session and the Governor of Maharashtra is satisfied that circumstances exist which render it necessary for him to take immediate action to continue the operation of the provisions of the Maharashtra Water Resources Regulatory Authority (Amendment) Ordinance, 2010 (Mah. Ord. XI of 2010), for the purposes aforesaid, this Ordinance is promulgated.

Mumbai,
Dated:
11th January
2011.

K. SANKARANARAYANAN,
Governor of Maharashtra.

By order and in the name of the Governor of Maharashtra,

E. B. PATIL,
Secretary to Government.

ON BEHALF OF GOVERNMENT PRINTING, STATIONERY AND PUBLICATION, PRINTED AND PUBLISHED BY SHRI PARSHURAM JAGANNATH GOSAVI, PRINTED AT GOVERNMENT CENTRAL PRESS, 21-A, NETAJI SUBHASH ROAD, CHARNI ROAD, MUMBAI 400 004 AND PUBLISHED AT DIRECTORATE OF GOVERNMENT PRINTING, STATIONERY AND PUBLICATION, 21-A, NETAJI SUBHASH ROAD, CHARNI ROAD, MUMBAI 400 004, EDITOR : SHRI PARSHURAM JAGANNATH GOSAVI.

APPROACH PAPER ON CRITERIA FOR DETERMINATION OF BULK WATER TARIFF 2013-16

MAHARASHTRA WATER RESOURCES REGULATORY AUTHORITY, Mumbai (India) MARCH 2012

CONTENTS

FOREWORD

1. The Maharashtra Water Resources Regulatory Authority, established in August 2005 by the State government under an Act of the Legislature, completed its first tariff exercise in May 2011. The exercise ended with the issue of a Tariff Order conveying water charges for volumetric use by various categories of users for the period 2010-2013. The Order was preceded by the finalisation of the Criteria for Bulk Water Tariff in June 2010 through an elaborate process of public consultation as prescribed by section 11 (d) of the Act. Under another section of the Act {Section 11(u)} the Authority is required to review and revise the water charges every three years. Thus the first revision in water charges becomes due from 2013 for the period 2013-16.

2. The first tariff exercise, spread over two years, was a learning experience for the Authority. Based on this experience the Authority has prepared a set of Regulations outlining the procedures to be followed in the tariff fixation exercise. These Regulations are now being adopted for the new tariff exercise. The exercise begins with the preparation and circulation of this Approach Paper on Criteria for determination of Bulk Water Tariff for the period 2013-16. Before taking up this work, the Authority invited suggestions from line Departments, Water Utilities, NGOs, Experts and other stakeholders. A number of suggestions were received and the same were given due consideration in drafting the Approach Paper. The draft is now put out for public consultation, which is the next step in the exercise as per the Regulations.

3. Some of the new features of the paper are the inclusion of a separate chapter on transmission losses in the irrigation systems, a revision in the weightages attached to the matrix parameters and a revised approach to the costing exercise. For estimating the transmission losses all available data on efficiency assessment has been collated and applied. The revision in weightages are based on the Authority's perception of the demand supply dynamics and in the costing exercise the issue of establishment charges, which constitutes a major chunk of the cost of irrigation management, has been addressed. Most of the concessions of the earlier Criteria have been retained. The M & R norms have been reviewed by WALMI through an Expert Committee. The allocation of O & M cost to irrigation has been reviewed and the burden slightly brought down.

4. Needless to say that much still needs to be done in the State on water quality preservation and enhancement and on water coservation. Though tariff as a tool to promote these has limited effectiveness, efforts need to continue in this direction. In regard to irrigation management, it has to be recognised that the formation of User Associations and handing over of the systems to them for management is the solution of choice for many problems in the long term. A modest beginning has made in the State but given the constraint of funds needed for system rehabilitation, it is unfortunately a fact that even by the end of this decade, only about 20% of the irrigated area will be managed by farmers themselves. Issues like low water use efficiency and system losses due to pilferage and leakage, have to be viewed in this backdrop.

5. This Approach Paper is being widely circulated and also made available at all the taluka headquarters in the State. Based on the comments / suggestions received, the draft c\Criteria will be finalised and thrown open for public consultation. I would urge all stakeholders to critically examine the paper and come up with pertinent suggestions relating to tariff fixation for bulk water users in the State. This will enable the Authority to proceed with the process of issuing tariff orders based on Criteria determined after the widest possible consultation with the beneficiary public and in a transparent manner.

(A.K.D. Jadhav)
Chairman & Member (Econ)

Mumbai
Dated: 6th March 2012.

CHAPTER - I
BACKGROUND BRIEF DETAILS OF EARLIER PROCESS (2010-13) AND OVER VIEW OF PROPOSED APPROACH FOR 2013-16

1.1. The Maharashtra Water Resources Regulatory authority (MWRRA) Act, 2005, which came into force on 8/6/2005, provides for the establishment of the Maharashtra Water Resources Regulatory Authority (MWRRA) to regulate the water resources within the State, facilitate and ensure judicious, equitable and sustainable management, allocation and utilization of water resources, fix the rates for use of water for agriculture, industrial and drinking and other purposes and matters connected therewith and incidental thereto. The State government of Maharashtra accordingly established the MWRRA on 12/8/2005. It is the first State in the country to establish a regulatory BODy in the water sector.

1.2. In regard to bulk water tariff, Sections 11 (d), 11 (r) and 11 (u) deal with the powers, duties and functions of the Authority in this regard.

Section 11 (d) - to establish a water tariff system and to fix the criteria for water charges at sub-basin, river basin and State level after ascertaining the views of the beneficiary public, based on the principle that the water charges shall reflect the full recovery of the cost of the irrigation management, administration, operation and maintenance of water resources project.

Section 11 (r) - to determine and ensure that cross-subsidies between the Categories of Use, if any, being given by the Government are totally offset by stable funding from such cross-subsidies or Government payments to assure that the sustainable operation and maintenance of the water management and delivery systems within the State are not jeopardized in any way.

Section 11 (u) - The Authority shall review and revise the water charges after every three years. The MWRRA (Amendment & Continuance) Act, 2011, published on 22/4/2011 has not made any changes in the above Sections relating to tariff.

1.3. In Sept. 2007, the Authority embarked on its first tariff exercise for the first Control Period 2010-13. An elaborate public consultation process was undertaken to discuss the draft Approach Paper. The revised paper and draft Criteria and finally the draft tariff proposal were also finalised after exhaustive public consultations. The first tariff orders were issued by the Authority on 30-5-2011 (volumetric bulk water rates for industry, domestic and agriculture) and on 29-6-2011 (by Water Resources Dept. after approval of the Authority for area based rates for agriculture). **Annexure 1.1** gives the detailed calendar of events for the first tariff order.

1.4. The Criteria for Bulk Water Tariff for 2010-13, which was finalised in June 2010 and which formed the basis for the tariff proposal prepared by WRD and subsequently the tariff orders, is at **Annexure 1.2.** As per Section 3 of this Criteria, the validity of the Criteria is for 3 yearsm, i.e., till the end of June 2013. Further, before taking up review and revision of the water tariff for the subsequent Control Periods, the Authority is required to review and revise the Criteria by following the procedure determined in the relevant Regulations.

1.5. The earlier drill was for finalizing the tariff for 2010-13 was used by the Authority as guidance for preparing draft Regulations for Fixing Criteria for and Issuance of Tariff Orders for Bulk Water. These Regulations which have been submitted to the WRD for conveying approval of the State government, are being adopted in this new tariff exercise for 2013-16. The identified steps in the Regulations are

(i) preparation of draft Approach Paper (DAP) through Consultant/ Committee of Experts/or by Authority itself.
(ii) circulation of the DAP to line departments, utilities, NGOs and experts and hosting on Authority's web site making available the DAP at all taluka headquarters.
(iii) preparation of draft Bulk Water Criteria based on comments received on DAP and its circulation for public consultation.
(iv) holding of public hearings on the draft Criteria at all the revenue divisional headquarters in the State.
(v) finalising Criteria and directing WRD to submit draft tariff proposal
(vi) scrutinizing the tariff proposal and directing WRD to make it available at all taluka headquarters and publish abridged form in newspaper.
(vii) based on suggestions received, finalise and issue tariff orders.

1.6. The Authority decided to prepare the DAP after inviting suggestions from line departments, utilities, NGOs & Experts. This *'stage gate'* method of preparation of the paper is in conformity with the suggestion of an NGO. In the present case, involvement of stakeholders is being ensured at preparation stage itself, thus resulting in a better acceptability of the end product. A letter was accordingly issued on 6/7/2011 to all concerned inviting suggestions for the DAP. An advertisement was also placed on 13/7/2011 in one English and 35 Marathi papers covering every district inviting suggestions on issues that could be included in the paper. Time was given till 31/8/2011 for sending suggestions.

1.7. Response was received from some experts, municipalities & NGOs. **Annexure 1.3** gives a list of persons / organizations who have offered suggestions. A meeting was held at Pune on 15/11/2011 with select CEs & SEs of WRD when many suggestions were made. While discussion on these suggestions have been made as appropriate in the relevant Chapters of this DAP, it is necessary to respond here to one suggestion of an NGO that the new tariff exercise be deferred to 2015-16 by which time an impact evaluation of the first tariff order be carried. The Act requires that the water charges be reviewed and revised every three years. Thus the revision becomes due in 2013. Postponing this to 2016 would be violative of the Act. While there is merit in the argument that evaluation of the first tariff order is required to be done, efforts will be made to accomplish this along with the new tariff exercise. In any case, the total picture for 2010-11 and perhaps 2011-12 also would be available before the next tariff order effect 2013 is issued. The impact of various concessions, mainly in agriculture, would need time before they are properly assessed and operation of these concessions for 3-4 years is a sine-qua-non for such an assessment. Issues like transmission loss have received coverage in this DAP.

1.8. Section 11 (d) of the Act requires the Authority to fix Criteria for water charges at sub-basin, river basin and State level. The Criteria for 2010- 13 was fixed at State level rather than at river basin / sub-basin level, i.e., an uniform tariff structure for the State as a whole was adopted. The main reason for this was that the Irrigation Development Corporations were yet to be converted as River Basin Agencies, i.e., as independent financial entities with basin based revenue sources. Since this position has not changed now also, the Authority proposes to develop an uniform tariff across the State for 2013-16 also. The Criteria for 2013-16 is accordingly being formulated also at State level.

1.9. Besides this introductory Chapter I, the DAP has six other Chapters. Chapter-wise contents in brief are as below :

Chapter - II - Transmissions Losses in Irrigation Systems and Water Use Efficiency in the State based on data compiled from various sources.

Chapter - III - The Operation & Maintenance Cost of Irrigation Management with M&R norms as per revised WALMI study and establishment norms as per extant Government orders.

Chapter - IV - The various relevant Suggestions Received & Issues Identified from line departments, utilities, NGOs and experts together with issues identified by the Authority also.

Chapter - V - Gives Data Base for agriculture, irrigation, domestic and industrial use relevant for the tariff exercise for 2013-16.

Chapter - VI - The methodology for Data Projection for 2013-16 of water use and other data like irrigation potential, establishment costs with actual projection for 2013-14, 2014-15, 2015-16.

Chapter - VII - Proposed Methodology for Working out Bulk Water Tariff (2013-16) with allocation of O&M cost among the three categories of users and working out of volumetric and area based tariff (for agriculture).

1.10. In the earlier Approach Paper for 2010-13 exhaustive coverage was given to topics like international experiences in bulk water pricing, recommendations of various Water Pricing Committees, legal frame work for bulk water sector in the State, water conservation and recycling technologies and water rates in other States. No suggestions were received on these topics warranting a reference to them in the present Approach Paper. Hence these topics have not been repeated in the present paper.

Annexure 1.1
(Refer Para 1.3)

Criteria for Bulk Water Tariff
& Issue of Tariff Order for 2010-13
Calender of Events

1.	Circulation fo draft TOR for Consultancy for Bulk Water Tariff to Line Departments, Utilities, NGOs	Sept.-Nov. 2007
2.	Notice Inviting Expression of Interest from Consultants for preparing Criteria for Bulk Water Tariff	28th Jan. 2008
3.	Processing of tenders & finanisation of Award	Feb.- March 2008
4.	Award of work to ABPS	31st March 2008
5.	Receipt of WALMI report on M&R norms	July 2008
6.	Draft Approach Paper submitted by Consultant	19th Sept. 2008
7.	Draft paper circulated to Line Depts., Utilities, NGOs, experts	Oct. 2008 - Jan. 2009
8.	Nine meetings with Public held as under to discuss draft Approach Paper	
	(i) Mumbai	05-02-2009
	(ii) Pune	12-02-2009
	(iii) Pen	17-02-2009
	(iv) Aurangabad	20-02-2009
	(v) Amravati	25-02-2009
	(vi) Nagpur	26-02-2009
	(vii) Kolhapur	25-05-2009
	(viii) Oros	26-05-2009
	(ix) Nashik	15-06-2009
9.	Revision of Approach Paper by Consultant and preparation of draft Criteria	July - August 2009
10.	Submission of revised Approach Paper by ABPS and finalisation of draft Criteria by Authority	Sept. 2009
11.	Circulation of revised drafts to Line departments, Utilities, NGOs, Experts and placing Marathi copies at taluka levels.	Oct. - Dec. 2009
12.	State Level Workshop at Pune on revised Approach Paper & draft Criteria	21st Jan. 2010

13.	Six meetings with public held at revenue divisional headquarters to duscuss revised drafts	
	(i) Amravati	16-02-2010
	(ii) Aurangabad	22-02-2010
	(iii) Nashik	23-02-2010
	(iv) Navi Mumbai	02-03-2010
	(v) Pune	03-03-2010
	(vi) Nagpur	02-04-2010
14.	Finalisation of Criteria for Bulk Water Tariff by Authority and forwarding to WRD for tariff proposal	June 2010
15.	Receipt of draft Tariff Proposal from WRD	Dec. 2010
16.	Vetting of Tariff Proposal in Authority and sending to WRD for public consultation	Jan. 2011
17.	Publication of tariff proposal in press and making available copies in talukas	Mar. 2011
18.	Receipt from WRD of comments of public on draft tariff proposal and holding of meeting with few NGOs	May 2011
19.	Issue of Tariff orders by Authority - Volumetric	30 May 2011
20.	Issue of Tariff orders by WRD - Area Based	29 June 2011

Annexure 1.2
(Refer Para 1.4)

Final Criteria (2010-13)
for
Determination of Bulk Water
Tariff in the State of
Maharashtra
MAHARASHTRA WATER RESOURCES
REGULATORY AUTHORITY JUNE 2010

CRITERIA FOR DETERMINATION OF BULK WATER TARIFF IN MAHARASHTRA

1. BACKGROUND

1.1. The Maharashtra Water Resources Regulatory Authority Act (MWRRA), 2005, was enacted inter-alia for the purpose of regulating water resources in the State of Maharashtra and for facilitating and ensuring judicious, equitable and sustainable management and allocation of water resources in the state. The Act was brought into force by the State government by Gazette no. 2005/(72/05)/1/WRI dt. 8-6-2005. Subsequently vide notification no. 2005/78/05 dt. 12-8-2005 the Maharashtra Water Resources Regulatory Authority was established to carry out the tasks specified in the Act.

1.2. Under Section 11 (d) of the Act, one of the duties of the Authority is to establish a water tariff system and to fix the criteria for water charges after ascertaining the views of the beneficiary public based on the principle that the water charges shall reflect the full recovery of the cost of irrigation management, administration, operation and maintenance of the water resources project.

1.3. In pursuance of this duty, the Authority first engaged a Consultant to prepare a draft Approach Paper on "Developing Criteria for Bulk Water Tariff". Initiating the consultation process, this draft Paper of the Consultant was circulated by the Authority in October 2008 among stakeholders, line departments, water utilities and prominent NGOs seeking their suggestions and comments. The Authority thereafter conducted public consultations at nine places in the State between February and June 2009. Based on the comments received and views expressed in the public consultations, the Authority revised the draft Approach Paper and also prepared a draft Criteria for Bulk Water Tariff (CBWT) based on the revised paper. These documents were again circulated in October - November 2009 to stakeholders, line departments, water utilities and prominent NGOs inviting their views. The Authority thereafter conducted a State level workshop at Pune on 21st January 2010. The workshop was in panel format where panelists interacted with representatives of major stake holders, NGOs and other experts who gave their views and suggestions on the Approach Paper. Thereafter the Authority also conducted public hearings in February - April 2010 at the six revenue divisional headquarters of the State to ascertain the views of the beneficiary public from the region on the revised Approach Paper and draft CBWT. Prior to the hearings, the revised approach paper and the draft CBWT were made available to the general public by keeping them at the taluka level offices of the WRD. Based on the inputs received in this consultation process, the Authority has finalized the CBWT. The finalized CBWT will be forwarded to the Water Resources Department (WRD) for submitting the draft tariff proposal for the three year period 2010-2013 in conformity with the CBWT.

2. SCOPE OF THE CBWT

2.1. The scope of these Criteria is limited to determination of bulk water tariffs for the State as a whole for the three categories of users viz. agriculture, domestic and industries, as envisaged in the preamble of the Act. For agriculture, the Criteria will cover principles of determination of area based tariff also.

3. VALIDITY OF THE CBWT

The validity of these Criteria is for three years till the end of the control period, i.e., 30th June 2013. Before taking up review and revision of the bulk water tariff for the subsequent Control Periods, the Authority shall take up review and revision of the CBWT by following the procedure determined in the relevant Regulations.

4. DEFINITIONS

a) **'Act'** means the Maharashtra Water Resources Regulatory Authority Act 2005.

b) **'Agricultural User'** means any Water User Association, where formed, at minor level, distributary level, canal level or project level, which is supplied bulk water for distribution among its members, or an individual farmer, where Water User Association has not been formed or formed but not become operational, who is supplied water directly by the project authority, primarily for growing crops.

c) **'Authority'** means the Maharashtra Water Resources Regulatory Authority.

d) **'Basic Rate'** for any category of user means the volumetric rate applicable for rabi season.

e) **'Bulk Water'** means any water supplied by flow or lift to Agricultural/ Domestic/Industrial Users from reservoirs/canal systems in the State constructed and operated by the Water Resources Department (WRD) or Irrigation Development Corporation (IDC) or made available to these users by WRD / IDC by flow or lift from regulated rivers and their tributaries flowing in the State or from natural BODies or lakes. It also includes supplies drawn by water utilities / entities/ for its / their own use from dams / storages constructed and operated by them or obtained for its / their own use by flow or lift from natural BODies or lakes through structures constructed and operated by them.

f) **'Bulk Water Tariff'** means the tariff levied on bulk water users by the Water Resources Department on volumetric basis, as per the tariff order issued and in force on the date of levy.

g) **'Collection Efficiency'** in relation to any category of user means the ratio of revenue realized from that user to the tariff billed to that user in any water year, excluding arrears.

h) **'Control Period'** for the purposes of the applicability of tariffs shall be the three consecutive water years starting from 1st July 2010 to 30th June 2011, 1st July 2011 to 30th June 2012 and 1st July 2012 to 30th June 2013.

i) **'Culturable Command Area (CCA)'** means the area under an irrigation project which is cultivable and can get irrigation facility through the canal system.

j) **'Domestic User'** means any public body or organisation (Gram Panchayat, Urban Local Body Municipal Corporation, Maharashtra Jeevan Pradhikaran) to whom bulk water is made available by the Water Resources Department / IDC for distribution to domestic and other users, with or without treatment.

k) **'Drought'** means a period declared as 'Scarcity' by the State when soil moisture and rainfall are inadequate to support healthy crop growth during the crop growing season causing crop stress and wilting.

l) **'Energy Charges'** means the electricity supply charges levied on various category of bulk water users by the electricity distribution licensee for lifting of water.

m) **'Hot Weather'** for purposes of water tariff means season from 1st March to 30th June or as notified by the State except for Konkan & Vidarbha regions, the season will be from 1st April to 30th June.

n) **'Industrial User'** means any industry (including industrial development Corporations) to whom bulk water is made available by the WRD or IDC for use as raw material or in process.

o) 'kharif' for purposes of water tariff means the season from July to October except in Konkan and Vidarbha where it will extend to 15th November.

p) **'Major'. 'Medium', 'Minor Irrigation Project'** means project with CCA greater than 10,000 ha, between 2,000 & 10,000 ha and less than 2,000 ha, respectively

q) **'Modern Irrigation Method'** means micro-irrigation (drip & sprinkler) or any other method specified by the Authority from time to time.

r) **'Operation & Maintenance (O&M) Cost'** means the sum of establishment cost and the cost of maintenance and repairs (M&R) of the irrigation system of water resources projects worked out as per norms.

s) **'Rabi'** for purposes of water tariff means season from November to February except for Konkan & Vidarbha where the season will be reckoned from 15th November to 31st March.

t) **'State'** means the State Government of Maharashtra

u) **'Stakeholder'** means any bulk water user or Entitlement holder or any registered organisation representing officially the interests of either of them.

5. GUIDING PRINCIPLES

In preparing the CBWT, the Authority has kept in view by the provisions in the MWRRA Act 2005, Maharashtra Management of Irrigation Systems by Farmers (MMISF) Act, 2005, the State Water Policy 2003 and the Maharashtra Irrigation Act (MIA), 1976. The recommendations of various Central and State committees set up in the past on the subject of water tariff were also considered where relevant.

6. PROCEDURE TO BE FOLLOWED FOR ISSUE OF TARIFF ORDER AND ITS REVIEW

6.1. After the CBWT is finalized by the Authority, the WRD will submit the Draft Tariff Proposal in the format prescribed by the Authority for the three year period July 2010 to June 2013.

The proposal wills, inter-alia, project the annual O&M cost and specify user category wise tariff proposed to be levied in accordance with the CBWT.

6.2. The draft tariff proposal shall be submitted by the Water Resources Department within four weeks of the receipt of the CBWT from the Authority.

6.3. On receipt of the draft tariff proposal from the WRD, the Authority shall undertake a technical scrutiny of the proposal with reference to its conformity with the CBWT and validity of the data used. It may seek such clarification from WRD and follow such consultation with stake holders as considered necessary so as to finalize and approve the tariff proposal.

6.4. The Authority shall issue the tariff orders for the volumetric rates for bulk water consumers in agriculture, domestic & industry. The tariff orders for the area based rates for crops in agriculture will be issued by WRD.

6.5. Stake holders / WRD will have the right to approach the Authority for a review of any provision in the tariff order, as per procedure to be laid down by the Authority.

7. COST ELEMENTS TO BE CONSIDERED IN O&M COST

7.1. The cost elements to be considered for annual O&M cost likely to be incurred shall include

(a) M&R works on the canal systems and head works of WRD / IDC projects and also on allied infrastructure relevant to water supply to be incurred during the year

(b) Project establishment cost comprising salaries of WRD / IDC employees deployed in maintenance of irrigation projects including basic pay, DA, bonus, other allowances etc. as approved by the State government. Establishment cost will also include travelling and other related allowances, rent, legal charges, auditor fees as related to water management. It may be ensured that staff strength is as per norms prescribed by the State government.

7.2. O&M cost shall not include

(a) All Capital costs of irrigation projects including depreciation, interest on loans, special repairs, cost of rehabilitation

(b) Impact of increase in salaries on account of acceptance of recommendations of the Sixth Pay Commission

(c) M&R costs of hydro power components

(d) Establishment cost of staff which is over and above the norms of the State government.

8 NORMS FOR MAINTENANCE & REPAIRS & RESPONSIBILITIES OF SERVICE PROVIDER

8.1. The State Government shall prescribe norms for the M&R of canal system, head works and appurtenant works which are adequate for their routine maintenance. The Authority may on scrutiny of the norms, direct the State government to review and or revise the norms if in its opinion; the norms are inadequate for proper upkeep of the assets created. The projection of funds required for M&R should be as per these prescribed norms.

8.2. The WRD as a service provider has some responsibilities for proper maintenance of created assets, improvement in water use efficiency and making available adequate funds to the WUA for maintenance of the system below the minor. For proper assessment of the transmission losses in canal systems, WRD is required to take up installation and periodical calibration of measuring devices in the system. Procedure to be followed by service provider for above responsibilities is given in Annex 5 & 6 and should be strictly observed.

9. NON TARIFF AND OTHER INCOME

9.1. Non tariff income, (i.e., income from sale of tenders, scrap, royalty for hydro power, pisciculture, recreation, tourism in reservoirs) shall not be considered while assessing likely revenue from tariff.

10. GOVERNMENT SUBSIDY

10.1. The State government shall make the required budget provision for meeting the estimated annual O&M cost. Revenue gap, if any, between the estimated O&M cost and estimated tariff realization based on the tariff order will be treated as State government subsidy.

11. REVENUE GAP / SURPLUS

11.1. At the end of each water year in the control period, WRD shall furnish to the Authority details of category wise and source wise water drawals, tariff levied, revenue realized, M&R costs required as per norms for the irrigated & unirrigated potential, actual M&R costs, establishment cost and subsidy provided, if any. Arrears of tariff (levy & collection) for previous years shall not form a part of assessment of revenue gap / surplus.

12. APPORTIONMENT OF O&M COST

12.1. The total O&M cost as specified in Para 7.1 (a) & (b) shall be apportioned among each of the three category of users, viz., agriculture, domestic and industry based on three fundamental parameters viz. (i) Affordability, (ii) Accessibility and (iii) Quantity & Timeliness of Supply. This will be done in three stages. As mentioned in Para 12.2 to 12.6 below.

12.2. Firstly a percentage weight shall be assigned to each of the three parameters which shall be common to all users. The values thus assigned shall be

Parameter Weightage

(i) Affordability - 60%

(ii) Accessibility - 20%

(iii) Quantity & Timeliness - 20%
of Supply (Q&T)

12.3. Secondly, a percentage weightage shall be assigned to each category of user for each of three parameters. The weightages thus assigned shall

	Agriculture	Domestic	Industry	Total
Affordability	15	10	75	100
Accessibility	30	25	45	100
Q & T	30	25	45	100

12.4. The Application of parameters values to the above percentages shall result in the following

	Agriculture	Domestic	Industry
Affordability	15x0.6 = 9	10x0.6 = 6	75x0.6 = 45
Accessibility	30x0.2 = 6	25x0.2 = 5	45x0.2 = 9
Q&T	30x0.2 = 6	25x02. = 5	45x0.2 = 9
	21	16	63

The above percentages shall be used for allocation of O&M cost to each category of user for working out basic rate.

12.5. Assuming 15% of domestic water drawal is used for industry and 15% of industrial water demand is used for domestic supply

Effective drinking water allocation of O&M cost

$$= 0.16 \times 0.85 + 0.63 \times 0.15$$
$$= 0.136 + 0.095$$
$$= 0.231$$

Effective industrial water allocation of O&M cost

$$= 0.63 \times 0.85 + 0.16 \times 0.15$$
$$= 0.536 + 0.024$$
$$= 0.560$$

12.6. Thus the effective allocation of O&M cost to the above two categories of users based on billing to water utilities would be

Domestic - 23%
Industry - 56%

12.7. The allocation of 21% of O&M cost to agriculture considers revenue both from canal flow areas and well irrigation areas in the command since substantial recharge in these wells occurs from canal water seepage and infiltration. The contribution to revenue by these two sub users is 16% from canal flow areas and 5% from well areas. Since well irrigation has now been made free of charge by State government as policy, flow irrigation areas will share only 16% of the O&M cost. The shortfall in revenue of 5% due to well irrigation being made free of charge and has to be made good by the State government as subsidy. Thus the tariff rates for area based and volumetric flow irrigated areas will aim to recover only 16% of the O&M cost from agriculture.

13. PRINCIPLES / INCENTIVES / CONCESSIONS / DISINCENTIVES / PENALTIES TO BE ADOPTED IN TARIFF FIXATION

13.1. Agriculture

13.1.1. Principles

(i) While fixing the basic rate in rabi season for crop wise area based tariff, it may be ensured that the tariff does not exceed 3 to 5% of the gross value of produce in case of food crops and 8 to 10% of the gross value in case of cash crops (viz sugarcane, banana, horticulture)* For horticultural crops, provisions of 13.1.2. (iv) will also apply and it needs to be also ensured that area based rate for horticultural crop is not more than 75% of the rate for sugarcane & banana from water use considerations.

(ii) With a view to reduce the number of crop categories in area based tariff, grouping of crops shall be done under three heads viz. seasonal crops, perennial crops and paddy. Sub-grouping within seasonal crops may be broadly done keeping in view crop water requirement and gross value of produce.

(iii) The above basic rate will be for rabi crops. Where the crop nomenclature is same in kharif or hot weather as in rabi, 50% of basic rate will be charged for the crop in kharif and 150% of basic rate in hot weather. Where the crop in these two seasons is different from the rabi crop criterion 13.1.1. (i) will be followed. The same will apply to two seasonal and perennial crops.

(iv) After fixing area based rates, volumetric rate for bulk water will be fixed following the procedure given in Annex 1.

(v) Bulk water tariff for government operated and private lift schemes will be as per format in Annex 2. (vi) No distinction will be made in tariff rates between normal and scarcity period. However, the State may consider remission in / waiver of water charges in scarcity period by providing subsidy.

* Note: For reckoning gross value of produce for each crop, published state average data will be considered, (e.g., Report of Committee on Agricultural Costs & Prices) except for sugarcane where the farm harvest price obtained from Maharashtra State Cooperative Sugar Factories Federation shall form the basis. The source of such data will be intimated in tariff order.

13.1.2. Concessions:

(i) In area based tariff, farmers in the State with holding size less than 2 ha will be levied concessional tariff of 75% of basic rate, while for districts in Vidarbha included in the Prime Minister's package and in naxalite affected areas as declared by the State government, farmers with holding size less than 4 ha will be charged 50% of basic rate.

Both concessions will be excluding cash crops viz. sugarcane, banana and horticulture.

(ii) For projects implemented in areas under tribal sub plan, no tariff shall be levied for all tribal farmers

(iii) For project affected people, tariff will be levied at 75% of basic rate for all crops.

(iv) Since some horticultural crops like mango, orange, grapes, chickkoo, tamarind, gooseberry (amla), coconut take time to yield, area based tariff for the crops and period specified below will be 25% of the basic rate.

(a) grapes - 3 years

(b) orange - 4 years

(c) mango/coconut/amla/tamarind/chickkoo - 5 years

However, if inter crop is taken in this period, tariff to be charged as per relevant crop and no separate tariff will be charged for the horticultural crop.

(v) (Volumetric rate for paddy will be 50% of area based rate (see para 10 of Annex 1).

13.1.3. Incentives

(i) For adoption of modern irrigation methods in area based supply - 75% of applicable rate will be charged

Provided that the concession will not be available to horticultural farmers who are covered in 13.1.2. (iv) above and will become applicable only when full basic rate is paid.

13.1.4. Disincentives / Penalty

(i) Family size

Farmers having more than two children born after one year of enactment of the Act, tariff at 1.5 times rate applicable will be charged in the light of the provisions of Section 12 (11) (a) & (b) of the Act

13.2. Domestic Water

13.2.1. Principles

(i) Basic rate will be linked to source of supply as indicated in Annex 3 and will remain same in kharif, rabi and hot weather.

(ii) While entering into bulk water supply agreement with municipalities / ULBs / Metro Corporations, industrial use, including commercial use, will be separately identified and charged appropriate industrial rate.

13.2.2. Incentives

(i) rebate for effluent treatment

If Metro Corporations / municipality/utility / any domestic bulk user treats sewage effluent to required standard, as certified by MPCB, for enabling use of such treated effluent for irrigation/gardening, the tariff for the quantum of water used to produce such treated effluent will be 75% of the applicable water tariff.

13.2.3. Concessions

stepped tariff - tariff for rural and urban users will be different as under

(i) GP - 75% of applicable rate

(ii) ULB - 90% of applicable rate

(iii) Municipalities/Corporations - 1.25 times applicable rate.

13.2.4 Penalty / Disincentives

(i) additional requirement of municipalities

Such additional requirement is to be met where possible by recycling. However it will be considered only after review of norms of supply and water audit and progress in setting up of STPs

(ii) reservation on reservoirs in drought period

Full levy will be charged for reservation made for drinking water use including evaporation and transmission losses.

(iii) Municipal Corporations/Municipalities shall within two years of the issue of the tariff order prepare an implementation programme for setting up new/additional STPs of required capacity to treat the sewage effluent to required standards. Penal tariff of one and half times basic rate will be charged thereafter for Municipal Corporations/Municipalities who do not submit the programme to MPCB and the Authority.

13.3. Industrial Use

13.3.1. Principles

(i) Basic rate will be linked to source of supply as indicated in Annex 4.

(ii) Basic rate will be applicable for rabi season for industrial use. For kharif season, 50% of basic rate will be charged and for hot weather 1.5 times of basic rate.

(iii) For industries using water as raw material, 5 times basic rate will be charged.

(iv) While entering into bulk water supply agreement with industrial users, domestic use will be separately identified and charged appropriate domestic rate. (Refer Note No. 4 of Annex 4)

13.3.2. Concessions

Agro industries - (poultry, canning, sugarcane processing, dairying) 75% of applicable rate will be charged Rebate for recycling - If industry reduces its demand to 75% by recycling (utilization reduced by a minimum of 25%), 75% of applicable rate will be charged for reduced demand. Mechanism to be developed by WRD to verify the reduction.

13.3.3. Penalties / Disincentives

"Polluter pays" principle

Every industry is expected to treat effluent to desired standard before release into natural water course. In such case, applicable rate will be charged. If effluent is not treated to required standard of MPCB, rate equal to twice the applicable rate will be charged. This will be in addition to any other action that the MPCB may separately take.

13.4. General (for all Categories)

(i) Penal rate at 1% per month or 12% per year will be levied for delayed payments beyond permissible limit.

(ii) For advance payment before start of season, 5% rebate in tariff will be given only for agriculture.

(iii) All future agreements for non-irrigation use will include justification for demand with norms (lpcd for drinking water depending on urban/rural use and m^3/unit production depending on type of industry.

(iv) Any withdrawal for non-irrigation use beyond + 10% of prescribed quantity in the agreement will be charged penal rate of 1.5 times of applicable rate.

(v) While entering into an agreement with WRD, non irrigation users will indicate the phasing planned for reaching the ultimate requirement. Till such time, the non irrigation user will be levied tariff as under each year

   (a) applicable rate for quantum for the year indicated in the phasing.

   (b) penal rate of 1.5 times applicable rate for deviation of + 10% more/less from the above quantum.

   (c) a commitment charge of 5% of applicable tariff for balance quantum, i.e., ultimate requirement minus present use. WRD will be free to divert the balance quantity for that year to any category of user. But such user will not derive any entitlement right over such use.

14. Fixing of Basic Volumetric Tariff for Non-irrigation, Crop wise Area Based Tariff and Basic Volumetric Tariff for Agriculture for State as a whole.

(i) For domestic and industrial bulk user entities the Basic Volumetric Rate will be worked out by applying the percentage cost allocable as per Criteria (16% to domestic and 63% to industry). to the volume of water likely to be used.

(ii) Detailed tariff will be calculated from this rate depending on source of supply (vide Annex 3 and 4) and concessions applicable, if any, as proposed in the Criteria.

(iii) Total revenue from each category will be assessed as above after accounting for dual use by Domestic /and industrial users if any. If the revenue is more than the O&M allocation, the basic rate will be reduced and the exercise done again. If it is less, the basic rate will be increased. This exercise will be repeated till O & M allocation and revenue realized match.

(iv) For agriculture, fixation of crop-wise and basic volumetric tariff will be an iterative exercise involving the following steps.

(a) As per Criteria 12.4, 21% of O & M cost is to be allocated to agriculture.

(b) As per Criteria 12.7, 5% of the allocation is to be treated as direct State Government subsidy on account of the fact that groundwater use from canal percolation is now being made available free of cost.

(c) Thus only 16% of O & M cost is to be allocated to agriculture for recovery through tariff.

(d) As per Criteria 13.1.1. (i) crop-wise area based rates are to worked out. While doing this it has to be ensured that the rate for any crop does not exceed extant tariff of 1-7-2003.

(v) The basic volumetric rate based on area rate is to be worked out as per procedure in Annex-I of Criteria. The Revenue Realization (RR) from Agriculture should be assessed on the basis of area to be irrigated and volume to be supplied. If RR is more than allocation of O & M, then the area rates should be revised downwards and the exercise repeated. If RR is less than the O&M allocation, which is expected to be the case, the difference between O&M allocation and RR will be attributable to the growth-cum-equity related subsidies proposed by the Authority and accepted by the government.

(vi) The aggregate of RR from Agriculture, ground water subsidy and growth-cum-equity subsidies should be equal to the O&M cost allocation of 21% to Agriculture as per Criteria no. 12.4.

List of Annex

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2 2-A 2-B	Methodology for Computation of tariff for Lift Irrigation Schemes Operated by Government and Private Entities.
3	Non-irrigation Use for Domestic Water - Water Supply for Domestic Use (Drinking) from Various Sources -Parameters for Fixing Water Rates.
4	Non-irrigation Use for Industry - Water Supply for Industries (Industrial use)) from Various Sources - Parameters for Fixing Water Rates.
5	Responsibilities of the Service Provider (WRD) in Relation to Water Tariff. 6. Assessment of Transit Losses in Canal Systems.

Annex-1
Methodology for Computing Bulk Water Tariff in Agriculture
[See Criteria 13.1.1. (iv)]

1. Water Resources Department, Government of Maharashtra shall compute average volumetric tariff for rabi season separately for Major/Medium and Minor Projects adopting following procedure.

2. *Ideal situation*

The ideal situation is on completion of rehabilitation works under MWSIP projects when irrigation norm as state average reaches 150 ha/Mm^3 with efficiency of 0.64 for major and medium project upto minor head and 0.80 for minor project.

3. *Today's situation*

Till above is achieved, an irrigation norm of 110 ha/Mm^3 of storage as presently obtained will be considered for major, medium and minor projects corresponding to an efficiency of 47% upto minor head.

4. *Water Use Efficiency*

Presently, as per water diverted annually for flow irrigation at source (head works, point of lift etc.) and area of canal irrigation, the norm for irrigation achieved is 110 ha/Mm.^{3} As per the Project Performance Indicators set out in the Maharashtra Water Sector Improvement Project, the end of project target value is about 150 ha/Mm.^{3} As per the Entitlement Manual issued by the Authority Jan. 2007, the norm for efficiency adopted in the pilot projects under the Entitlement programme is 0.8 in unlined main / branch canal and 0.8 in unlined distributary, i.e., 0.64 upto head of minor. Since this is post rehabilitation, the present efficiency level upto minor level can be taken as $0.64 \times \frac{110}{150} = 0.47$.

5. *Procedure for assessing crop water requirement volume in Major/Medium project in rabi season.*

(a) Today's situation

(i) The 3 year average rabi irrigated crop pattern in the state for major/medium projects will be assessed as percentage area of each crop to ICA. Let this be P_1, P_2, P_3 .... P_n for crops A, B, C, ... N.

(ii) Crop water requirement for rabi will be assessed as follows:
Area irrigated for 1 Mm^3 storage = 110 ha.
Water utilized at minor head for rabi will be calculated taking kharif : rabi + hot weather use as 10:90 and rabi use as 85% of rabi + H.W. use and efficiency of 47% upto minor head.
Thus 1Mm^3 at storage annual use
= 1,000,000 x 0.9 x 0.85 x 0.47
= 3,59,550 Cum (m^3)
This is for 110 ha. For a block of 100 ha ICA water required

$$= 3,59,550 \times \frac{100}{110} = 3,26,864 \text{m}^3$$

(b) *Ideal situation*

In ideal situation, irrigation intensity will improve in ratio $\frac{150}{110}$ due to increase in efficiency.
For each rabi crop, assess crop water requirement per ha in m^3 by modified Penman/duty delta method.
Let this be V1, V2, V3 .... Vn
Total volume of water required at field level for a block of 100 ha. ICA

$$\text{Vfield}(\text{m}^3) = 100\left(\frac{\text{P1}}{100} \times \frac{150}{110} \times \text{V1} + \frac{\text{P2}}{100} \times \frac{150}{110} \times \text{V2} + \ldots .. \frac{\text{Pn}}{100} \times \frac{150}{110} \times \text{Vn}\right)$$

$$\text{VMinor} = \frac{\text{v field}}{0.75}$$

Note: For perennial and two seasonal crops, crop water requirement will be for the season only.

6. *Procedure for assessing tariff levied*

(a) Today's situation

Let T_1, T_2, T_3 ... be the area based tariff in Rs./ha for crops A, B, C .... derived as per Criteria.
Total tariff from a ICA block of 100 ha.

$$T_{\text{Today}} \text{ Rs} \quad \text{Rs} = 100\left(\frac{\text{P1}}{100} \times \text{T1} + \frac{\text{P2}}{100} \times \text{T2} + \ldots .\right)$$

(b) Ideal situation

$$T_{ideal}\ Rs = 100\left(\frac{P1}{100}\times\frac{150}{110}\times T1+\frac{P2}{100}\times\frac{150}{110}\times T2+\ldots..\right)$$

Note: For perennial and two seasonal crops, part tariff for season only will be considered by reducing total annual tariff prorata based on seasonal to total water requirement.

7. *Average Volumetric Tariff*

Today's situation

Volumetric Tariff Rs/m^3 = $\frac{T_{Today}}{3,26,864}$

Ideal situation

Volumetric Tariff Rs/m3 = $\frac{T_{ideal}}{V_{minor}}$

8. Actual volumetric tariff will be 0.75 times above.

9. Volumetric tariff for crops other than paddy in Kharif will be 50% of actual tariff calculated at 7 above and hot weather 150%.

10. For paddy areas in the State, volumetric rate should not be greater than the area based rate keeping in view that paddy, although a high water consuming crop, is not very remunerative like a cash crop and hence farmers may be discouraged from forming WUAs and switching over to volumetric rate in paddy areas. Volumetric rate for paddy may therefore be kept at 50% of rate derived by considering area rate & volume of water required, i.e.,

Paddy rate in volumetric terms in Rs/m3 will be $\dfrac{0.5 \text{ x area rate in Rs/ha}}{\text{volume of water in m}^3 \text{ required at field level to irrigate 1 ha paddy}}$

11. If with above exercise, the volumetric rates exceed the extant tariff levels fixed in July 2003, State Govt. may consider required subsidy in order not to give tariff shock to farmers.

12. The above methodology is only for working out volumetric rate for WUA at minor level. For WUAs at project level, canal level and distributary level (PLA, CLA, DLA) in major and medium projects, volumetric tariff calculations project-wise considering actual efficiencies obtaining in the project will be submitted to the Authority for approval.

Annex-2
[See criteria 13.1.1. (v)]

Methodology for computation of tariff for Lift Irrigation Schemes operated by Government and private entities

Sr. No.	Type of Lift Irrigation Scheme	Energy charges	Bulk Water Tariffs
1.	Private operated	Payable by private operator	For water supplied on area basis, tariff will be based on location of lift and type and season of crops as per Annex-2A Average Seasonal Volumetric rate will be 0.75 times volumetric rate derived from above area rates as per procedure in Annex 1.
2.	Government operated (Head works, pump house and other appurtenant works to be maintained by WRD, GoM even after WUAs are formed in the command area)	Payable by beneficiaries. However, if State Government feels need for subsidizing partly energizing charges, it may do so. Procedure laid down in Annexure 2B shall be followed for recovery of water charges.	As per Annex-2B.

Annex-2A

Annexure to Water Rates

Water Rates for Lift Irrigation Schemes from

(Rs. / ha)

Sr no.	Source of supply	Sugarcane and banana		Other perennials (Horticulture)		Kharif crops	Rabi crops	Hot crops
		Flow	Drip irrigation	Flow	Drip irrigation			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1.	Assured Water Supply Major/Medium reservoir/storage tank without canal/							
2.	Regulated Water Supply with Transmission Loss Regulated river portion below dam/canal lift / K.T. weir with back up reservoir / tail race from reservoir							
3.	Partly Assured Water Supply Minor reservoir with canal / K.T. weir without back up reservoir/ unregulated rivers without even any K.T. weir or in unregulated river portion flowing within a command area where there is no bandhara or K.T. weir							
4.	Reservoir Constructed by the Water User Entity / User Entity Shared Proportional cost Water user agency has shared proportional cost of infrastructure or constructed dam/bandhara/ katcha bndhara/ K.T. weir at own cost							

Annex-2B

Procedure for Fixing Project-wise Tariff, Including Energy Charges, for Lift Irrigation Schemes owned by Government.

1. This procedure has been evolved from the experience gained from three lift schemes with varying heads under operation since 2005-06 viz. Mahisal, Takari and Sina-Madha in Krishna basin. For each of these schemes the project authorities have furnished actual operational data. Authority has taken one sample year comprising energy charges, area irrigated, revenue assessed per ha. Based on this data, the following procedure for non-WUA areas is prescribed till WUAs are formed.

2. At the beginning of the season, project authorities estimate the likely irrigation demand and likely energy charges to be levied (on the basis of energy bills received). The combined rate, (i) energy charges, (ii) crop wise irrigation charges [based on prevailing Govt. approved rates with 20% local cess and other miscellaneous cess/charges] per ha per rotation is worked out and this rate is got approved from the concerned Chief Engineer. The farmers are apprised of this rate (advance payment based on this rates is also received to field officer from some of these schemes).

3. **Procedure to be followed for working out actual water charges.**

   * energy rate per ha of irrigation is to be assessed on the basis of total energy charges of the schemes based on actual consumption as received by the concerned project officer from MSEB.
   * irrigation charges per ha with 20% local cess, as fixed by the State govt. to be levied season-wise, crop-wise on the basis of actual area irrigated is assessed based on number of rotations.
   * the water charges per ha including energy rate per ha and irrigation charges including 20% local cess per ha is worked out and this rate is then converted into per rotation for recovery purposes.
   * for sustainability, maximum area under scheme should be brought under irrigation so that there will be minimum energy charges per ha to the user. It should be aimed so as to have full recovery of electricity charges from all water users.
   * water rates for govt. operated Lift schemes will be schemes-wise and hence there will be separate rate for each scheme which will depend on type of lift and energy consumed.

   As and when WUAs are formed in command area, the tariff will be levied for volumetric supply at the volumetric rate fixed for flow areas by Authority and prorata energy charges per ha as per actual area irrigated under WUA.

4. **Procedure to be followed for recovery of energy charges from beneficiaries for government operated Lift Irrigation Scheme where water is lifted and fed into Tanks/Percolation Tanks.**

Energy rate per ha of irrigation is to be assessed on the basis of total energy charges of the scheme based on actual consumption, as received by the concerned project officer from MSEB, and total area in ha getting benefit of irrigation from such tanks.

Annex-3

Non-Irrigation Use for domestic water Water Supply for Domestic Use (Drinking) from various sources Parameters for Fixing Water Rates [See Criteria 13.2.1.(i)]

Rs./10000 litres (10 cu.m)

Sl. No.	Source of Supply	Water Rate
1.	**Assured Water Supply**	Basic rate
	Major/Medium reservoir/storage tank without canal/	
2.	**Regulated Water Supply with Transmission Loss**	Two times of basic rate
	Regulated river portion below dam/canal lift / K.T. weir with back up reservoir / tail race from reservoir	
3.	**Partly Assured Water Supply**	50% of basic rate
	Minor reservoir with canal / K.T. weir without back up reservoir/ unregulated rivers without even any K.T. weir or in unregulated river portion flowing within a command area where there is no bandhara or K.T. weir	
4.	**Reservoir Constructed by the Water User Entity / User Entity Shared Proportional cost**	33% of basic rate
	Water user agency (Gram Panchayats, ULBs, Municipal Corporations and other such utilities) has shared proportional cost of infrastructure or constructed dam/bandhara/katcha bandhara/K.T. weir at own cost	

Note:

1. Different water rates will be applicable as per the source of supply as mentioned above.
2. The above basic rate will be applicable in all the three seasons uniformly.
3. For Municipalities/Corporations/Cantonment Boards, 1.25 times applicable basic rate will be charged.
4. For Nagar Parishads / ULB, 90% of applicable basic rate will be charged.
5. For Grampanchayats, 75% of applicable basic rate be charged.
6. If a Metro Corporation / municipality / utility / any domestic bulk user treats sewage effluent to required standard, as certified by MPCB, for enabling use of such treated effluent for irrigation / gardening, the tariff for the quantum of water used to produce such treated effluent will be 75% of the applicable water tariff.
7. Water rates are to be rounded to nearest value of Rs. 10.

Sample Example: Water Rate for a Gram Panchayat drawing water from an unregulated river will be charged basic rate x 0.75 x 0.5

Annex-4

Non-Irrigation Use for Industry Water Supply for Industries (Industrial Use) from various sources Parameters for Fixing Basic Water Rates [See Criteria 13.3.1. (i)]

Rs./10,000 litres (10 cu.m)

Sl. No.	Source of Supply	Water Rate
1.	**Assured Water Supply**	Basic rate
	Major/Medium reservoir/storage tank without canal/	
2.	**Regulated Water Supply with Transmission Loss**	Two times of basic rate
	Regulated river portion below dam/canal lift / K.T. weir with back up reservoir / tail race from reservoir	
3.	**Partly Assured Water Supply**	50% of basic rate
	Minor reservoir with canal / K.T. weir without back up reservoir/ unregulated rivers without even any K.T. weir or in unregulated river portion flowing within a command area where there is no bandhara or K.T. weir	
4.	**Reservoir Constructed by the Water User Entity / User Entity Shared Proportional cost**	33% of basic rate
	Water user agency (Gram Panchayats, ULBs, Municipal Corporations and other such utilities) has shared proportional cost of infrastructure or constructed dam/bandhara/katcha bandhara/K.T. weir at own cost	

Note:

1. Different water rates will be applicable as per the source of supply as mentioned above.

2. The above rates are for industries using water for industrial use. Where water is used as raw material, water rate will be charged 5 times of appropriate basic rate applicable to source of supply.

3. (a) The above basic rate will be applicable in 'rabi' season.
   (b) There will be incentive to tune of 50% in water rates for the water supply during the kharif season.
   (c) The water rate will be 50% more during the hot weather season.

4. At the time of agreement (Please refer 13.3.1. (iv) industries will have to clearly indicate the drinking water demand for residential complexes under their industry. Such use should have separate pipe lines and water meters. In such cases, differential tariff for drinking water use and industrial use will be charged as fixed for these categories of uses. In the absence separate pipelines and water meters for domestic supply or if domestic supply exceeds the quantum as per agreement, industrial tariff will be levied for such use/ over use.

5. (a) Every industry is expected to treat effluent to desired standard before release into the natural water course. In such case, basic rate will be charged. If effluent is not treated to required MPCB standard, rate will be twice basic rate.
   (b) Agro industries (canning, poultry, sugarcane, dairying) 75% of basic rate will be charged.
   (c) If industry reduces its demand by minimum of 25% by recycling, tariff will be 75% of basic rate for reduced demand.

6. Water rates are to be rounded to nearest value of Rs. 10.

Example: Process industry drawing water in hot weather from partly assured water supply sources will be charged basic rate x 0.5 x 1.50.

Annex-5
(See Criteria 8.2.)
Responsibilities of the Service Provider (WRD) in Relation to Water Tariff

1) Improvement in Collection Efficiency

The issue of collection efficiency of water tariff has been discussed in Chapter 2. The collection efficiency for industry is in the range of 90% while for drinking water it is in the range of 60% to 70%. The collection efficiency for irrigation has however remained very low in the range of 25% to 46%. Maharashtra Irrigation Act 1976 vide Section 88 (2) has stringent provision for recovery of water tariff as arrears of land revenue. The criteria now developed has provision for incentives for advance or timely payments by users. Efforts need to be made to improve collection efficiency of irrigation water tariff to atleast 75% in the next 3 years. To enable the Authority to monitor this closely, Circle wise information may be submitted annually for each irrigation project, the agricultural tariff levied and tariff realized both current and arrears, separately.

2) Ensuring water to tail end farmers

As per Section 12 (7) of the MWRRA Act, the Authority is to ensure that the principle of 'tail to head' irrigation is implemented by the River Basin Agency. As per Section 18 of the MMISF Act Rules, it is the responsibility of the Canal Officer to monitor and ensure that every member of the Water User Association receives the quantum of water as per applicable water entitlement. The issue of equity and timeliness of supplies was stressed by the stake holders during public consultation. Since about 90% of the irrigated area in the State still is supplied water on area basis, a special responsibility devolves on the Department to ensure equity and timeliness in supplies to individual farmers. The percentage of area irrigated in head, middle and tail areas of canal command should nearly be the same. The information on this issue shall be included in Irrigation Status Report to be published every year. To enable the Authority to monitor this closely, Circle wise information may be submitted to it at the end of each season for each major & medium project, giving the percentage of area irrigated in the head, middle and tail reach of each project. In volumetric supply to WUA, the Department has to ensure that the supplies out of the Applicable Entitlement are made as demanded by WUA in each rotation.

3) Improvement in Water Use Efficiency

While at the project planning stage, an overall efficiency of 47% to 50% is assumed, in actual practice, the efficiencies obtaining on the ground are 25 to 35% implying that significant quantum of the released water is lost in seepage and as application losses in the field. Improvement in water use efficiency not only improves productivity but also more area can be irrigated with saved water. This will lead to more revenue collection from irrigation sub sector and can justify reduction in tariff rates for agriculture at time of review and revision of tariff.

From the water audit reports published annually by WRD, it is seen that the average water use efficiency for the projects in the state in terms of area irrigated in ha per Mm^3 of water drawn has increased from 94 to 110. This trend should be maintained and the WRD should aim to achieve the following targets in the 3 years.

Year	Target ha/Mm^3
2010-11	120
2011-12	125
2012-13	130

While submitting tariff proposals in future, WRD should report progress in above with reasons for shortfall, if any, and remedial steps proposed. To enable the Authority to monitor this closely, Circle wise annual information may be submitted for each of the irrigation project (major & medium), the season wise area irrigated per Mm3 of stored water.

4) Asset Management

(a) *For systems not handed over to WUA*
WRD should assess the annual requirement of funds for works component of maintenance based on approved norms for irrigated areas and unirrigated areas and requirement for other ancillary components (dam, outlets & gates etc.) and project this in their budget requirement along with requirement for special repairs separately. On allocation of budget, WRD & field SEs should ensure funds are not allocated in an adhoc manner but to each project as per maintenance requirement depending on norms, irrigated area and un-irrigated area. Utilization of funds for maintenance should be done by field officers after prioritizing the works from safety considerations.

(b) *For systems handed over to WUA*
The MMISF Act 2005 envisages that once minor level WUAs are formed, the system below the minor will be handed over to the WUA for operation & maintenance. Volumetric supply as per Entitlement will be done by WRD to the WUA at the minor head and volumetric rate charged. The Act further envisaged that WUA may levy water rates from its members as may be approved by the General Body of the WUA.

WALMI in their study on O&M have recommended a maintenance a grant of Rs. 380/ha of irrigated area and Rs. 190/ha for balance CCA. The distribution of this grant has been apportioned by WALMI as 40% for main & branch canal, 25% for distributaries and 35% for minor.

Vide GR dated 23-7-2001, WRD has conveyed norms for sanction of grants to WUA for maintenance. After recovering water charges from the members and depositing it with the government, WUA is entitled to receive maintenance grants (excluding cess) as per percentages in table below

Share of WUA in grant

Project	Functional Association Minor level WUA	Upper level association			Total
		Distributary level WUA	Canal level WUA	Project level WUA	
Minor	75%	-	-	-	75%
Medium	50%	15%	10%	3%	78%
Major	50%	20%	20%	3%	93%

The above norms were checked by the Authority for the adequacy to meet the M&R norms recommended by WALMI for irrigated and un-irrigated areas. It is seen that at least 95% of the water charges deposited by WUA at minor level need to be ploughed back to the WUA for proper maintenance against 75% decided in the GR for minor projects and 50% for major and medium. Otherwise it is apprehended that the systems will gradually deteriorate with impact on equity and productivity. The balance 5% could be retained by State government as a royalty charge. However there is need for WRD to develop a mechanism to ensure that

- Water charges as due are first collected from members by WUA as per provisions in the MMISF Act 2005.
- 95% of above amount collected by WUA, less cess, is returned immediately to the WUA to be utilized for maintenance of system handed over to WUA. A certificate to this effect is required to be kept on record, signed jointly by WUA and WRD official in-charge.

WRD will have to continue maintaining the system above minor till higher level associations are formed. Thereafter the required maintenance funds for main canal, branch canal and distributary as per norms are to be provided as grants to these upper level associations as water charges collected are almost fully to be given back to minor level associations. Grants given by WRD to maintain main canal, branch canals and distributaries should be properly utilized by concerned upper level association and should be verified / cross checked by WRD officials and certified accordingly. Such certificates will be a pre-requisite for further releases.

Dams and appurtenant works should however be continued to be maintained by WRD by making required budget provision as per norms even after higher level associations have been formed.

Annex-6
(See Criteria 8.2)
Assessment of Transit Losses in Canal Systems

1. Assessment of transit losses both for non-irrigation and irrigation uses in the State has an important linkage to improvement in overall water use efficiency and water tariff both at bulk and retail levels. In irrigation, transit losses due to seepage in canals, leakages in gates, thefts and pilferages, reduces the area that can be potentially irrigated in a project and also reduces the reliability of supply, both in respect of timeliness and quantity especially to the tail enders. In domestic supply, unaccounted for water comprising transit losses and pilferages reduces not only the potential revenue from retail tariff to water utilities but also the per capita availability to consumers forcing them to supplement the supply from private sources at an exorbitant cost.

2. For a proper assessment of Transit losses in Canal Systems, WRD should give due importance to precise measuring and accurate accounting of water. For agricultural withdrawals, WRD should install suitable measuring devices in the open channels starting from head regulator of main canal, branch canal, distributaries and minors. These devices should be properly installed and calibrated. Concerned project authorities should periodically note the readings at these devices work out the discharge from the relevant rating curves and assess the transit losses in the reaches between the measuring devices. A project wise study on the transit losses in each major and medium irrigation project in the State, in each season, should be carried out by the SE in charge of the project. For minor irrigation projects, a few projects in each district may be taken. The WRD should within 3 months evolve standard format for working out transit losses for guidance of field staff. The study should form a part of the Irrigation Status Report as a separate chapter.

3. To enable WUAs to supply water equitably to all farmers, measuring devices like V - notches should be installed in field channels.

4. While field SEs would be responsible for installation of measuring devices, the organisation under Chief Engineer, Maharashtra Water Resources Development Centre / WALMI, Aurangabad and MERI Nashik should be entrusted by WRD with the additional responsibility of calibration, periodical inspection and checking of performance of measuring devices for irrigation and non irrigation uses in the State. The organisation under this Chief Engineer should be suitably strengthened to carry out this responsibility by Government within 6 months. Detailed guidelines need to be issued by WRD for this purpose within 3 months. The Chief Engineer should submit a yearly report on the activities of his organisation in this respect to the Authority.

5. Industrial and domestic bulk users should install standard meters which are properly calibrated to handle a wide variation in discharge at their supply points. Such meters should also be installed at effluent discharge points to account for water returned by these units after treatment.

Annexure 1.3
(Refer Para 1.4)

List of Departments/Utilities/Entities/NGOs/Experts who submitted suquestions for the Approach Paper (2013-16)

Experts

1. Shri Ramaswamy R. Iyer, former Secretary (WR) GoI
2. Mr. Graeme Turner (World Bank Consultant)
3. Mr. Larry D. Simpson (World Bank Consultant)
4. Shri S.N. Sahasrabudhe, former E.D., WRD
5. Dr. S.S. Magar, former Special Invitee, MWRRA
6. Shri Manohar Mungekar

Utilities

1. Pune Municipal Corporation
2. Solapur Municipal Corporation

NGOs

1. PRAYAS
2. SOPPECOM
3. Lokabhimukh pani Dhoran Sangharsh Manch
4. Shramik Mukti Dal

Line Departments

1. Meeting held at Pune on 15-10-2011 with select CEs & SEs of WRD to elicit suggestions. Written comments received subscequently.

CHAPTEER - II

TRANSMISSION LOSSES IN IRRIGATION SYSTEMS & WATER USE EFFICIENCY

2.1. Transmission loss in irrigation systems is a natural phenomenon and all water released at canal head does not reach the root zone of the crop for consumptive use - by the plant. Transmission loss is mainly due to seepage and evaporation and in cases due to pilferage or unauthorized drawal en-route. The quantum of loss depends on various factors like the length of the canal system, size of the canal, type of soil strata, whether canal is lined or unlined, quality and condition of lining, condition of unlined canal (rain cuts, burrons etc.) and so on.

2.2. The term overall irrigation efficiency is used to convey the quantum of losses and is the ratio between the volume of water delivered at the root zone of the crop for its consumptive use to volume of water delivered at the source. The overall irrigation efficiency comprises two parts viz. conveyance efficiency and field application efficiency. The conveyance efficiency again has two parts viz. conveyance efficiency from canal head to outlet head and from the outlet head to the field. The terms can be mathematically represented as:

$$\text{Conveyance efficiency Ec1 in Main and Branch Canal} = \frac{\text{Volume of water made available at outlet head}}{\text{Volume of water released at canal head}}$$

$$\text{Conveyance efficiency Ec2 in distribution system} = \frac{\text{Volume of water delivered to field}}{\text{Volume of water drawn from outlet}}$$

$$\text{Field application efficiency Ea} = \frac{\text{Volume of water delivered to root zone}}{\text{Volume of water drawn at field head}}$$

The field application efficiency depends on preparation of the field, type of soil, stream size, method of water application etc. Overall efficiency E = Ec1 x Ec2 x Ea.

2.3 Generally, measurement of discharge upto the outlet are made at various types of measuring devices (MD) installed in the canal system like Parshall Flume, Cut Throat Flume or at gated Cross Regulator. Measurement of discharge below outlet can be done by say a V-notch but is usually not done. Thus there is no water account in the micro level distribution system. Field application efficiency is even more difficult to measure. Efficiency below outlet (Ec2 x Ea) is usually assumed as 0.75 for all crops except paddy where a lower value of 0.65 - 0.60 is taken as the practice of ponding for paddy cultivation entails more losses. However, since bulk of the transmission loss occurs in the main branch and distributary canals, a proper assessment of this loss will lead to a reasonably good estimate of overall project efficiency.

2.4. In Maharashtra, there are about 210 major & medium completed projects and about 310 ongoing projects. Together with about 5400 completed and ongoing minor projects, an ICA of 38 - 40 lakh ha has been created. Out of the 33 billion cubic metres (BCM) of storage created in the State, the diversion for irrigation is 18 - 20 BCM. There are thousands of kilometers of canals in the State and hence transmission loss is bound to be high, i.e., upto two thirds of the water released from storage, although at planning stage only about half of the released water is assumed as lost.

2.5. In the earlier Approach Paper for Criteria for Bulk Water Tariff (2010-13), there was not much coverage on the issue of transmission losses. Although water conservation in agriculture was discussed, actual data on transmission loss in canals was not included. In the Criteria, the following efficiencies were assumed in major & medium projects for arriving at volumetric tariff for agriculture (Annex I of the Criteria).

	Before canal system rehabilitation	After canal system rehabilitation
1 Efficiency in main canal branch & distributary upto outlet	0.47	0.64
2 Efficiency below outlet	0.75	0.75
3 Overall efficiency	0.35	0.48

It was also mentioned in 2010-13 Criteria that presently 110 ha were being irrigated in the State on an average per Mm3 of surface water.

2.6. **Transmission Losses in Canal System**

In the Approach Paper for the tariff exercise for 2010-13, data on existing transmission losses in the canal systems could not be compiled and presented. During the public consultation that was held to discuss the Approach Paper and draft Criteria, agriculturists and some NGOs expressed concern about the lack of data on transmission losses. It was also argued that the theft and pilferage component of such losses was significant and if checked and prevented, more area could be brought under irrigation, thus reducing the tariff burden on farmers.

2.7. Under Section 11 (d) of the MWRRA Act, the Authority is required to establish a water tariff system and fix the Criteria for water charges on the principle that full recovery of the cost of irrigation management actually incurred is reflected. However the Authority is also required, under other provisions in the Act not related to tariff, to promote efficient water use and to minimize wastage of water {Section 11 (q)} and to promote sound water conservation and management practices {Section 12 (4)}. In deference to the concern of the stakeholders and keeping in view the provisions in the Act relating to water use efficiency, the Authority has collected and presented in this Chapter transmission loss data as available with WRD. While efforts need to be made to minimize losses thereby increasing the irrigated area and thus reducing the agricultural tariff, the tariff fixation exercise had to be based on recovery of actual O&M costs. In so far as losses due to pilferage are concerned, as the area under Participatory Irrigation Management is expanded by formation of Upper Level Associations (Project, Main Canal & Distributary) and minor level Water User Associations and systems handed over to them, this is expected to significantly reduce progressively in the future.

2.8. In the tariff Criteria for 2010-13, the Authority vide Annex 6 has placed some responsibility on the service provider, WRD, for systematic assessment of transmission losses in the State. This exercise has been started by WRD. The Authority has also vide Annex 5 of the Criteria set targets for WRD to report progressive water use efficiency improvement in terms of area irrigated per unit of storage. Data presented now shows an improving trend as shown in Para 2.17.

2.9. **Conveyance Efficiency of Main Canal**

WRD is conducting study on conveyance efficiency in main canal in 35 major projects in the State. This efficiency is defined as the ratio of water released in the main canal to the sum of water supplied to distributaries and lift schemes. The results are published in the Water Auditing Reports brought out annually. Data for 2007-08, 2008-09, and 2009-10 are given in **Annexure 2.2.**

2.10. **WRD Norms for Transit Losses**

In 1992,WRD issued revised norms for transit losses in lined and unlined canals to be assumed at design stage. These norms are tabulated below

Channel discharge	Loss in cumec/Mm^2	
	Lined canal	Unlined canal
Upto 7 m^3/sec	1.25	7
Above 7 m3/sec.	0.9	4.5

2.11. **Field Studies on Conveyance Loss Itiadoh Project (Godavari basin)**

2.11.1 As a part of the CWC sponsored study on Post Project Performance Evaluation, WRD had in 2005 carried out a detailed study of the conveyance loss in the Itiadoh project. The entire canal system comprising 72.5 km main canal, 40.23 km Wainganga branch and minors is unlined. Conveyance losses on main and branch canal were worked out by observation of water released and water accounts delivery into various off takes. Conveyance losses in selected minors were worked out by installing flumes and using inflow-outflow method. The results are presented below:

Canal	Chainage/length	Conveyance loss Cumec/Mm^2	Conveyance loss in %	Efficiency in %
Main	Head reach 0 - 40 km	7.83	21.0	78.3
	Tail reach 40 - 72.5 km.	6.95	22.4	
Branch	Head reach 0 - 19 km	10.75	20.0	
	Middle reach 19 - 35 km	8.76	21.3	78.84
	Tail reach 35 - 43.2 km.	11.03	22.2	
Minor 2A	Off taking at chainage 5910 m of main canal and 1150 m long	12.2	26.7	
Arjuni minor	Off taking at chainage 25100 m of main canal and 876 m long.	11.73	23.53	73.84
Borgaon minor	Off taking at chainage 66180 m of main canal and 3948 m long	6.47	28.25	

2.11.2. Field application efficiency by ponding method was carried out in select plots of 9 minor and the efficiency varied from 0.80 to 0.91 (average 0.85) for paddy. The overall project efficiency is thus 0.783 x 0.7884 x 0.7384 x 0.85 = 39%

2.12. **Irrigation Efficiencies in Five Projects**

Data on irrigation efficiencies in five projects in the State was obtained from the IWRS Publication ‘Efficiency of Water Resources System’ (2004). The results reported are

	Project & Basin	Conveyance Efficiency (%)			Overall	Field application efficiency	Project efficiency
		Main	Branch	Field Channel			
i)	Nazare (medium) Krishna basin, Pune district	92	79	68	49	77	38
ii)	Manyad (medium) Tapi basin, Jalgaon district	84	83	64	44	69	31
iii)	Nirguna (medium) Tapi basin, Akola district	85	75	72	46	83	38
iv)	Asola Mendha (major), Godawari basin, Chandrapur district	94	75	*	70	58	41
v)	Kalote Mokashi (minor) West flowing, Raigad district	86	89	67	51	59	30

* No field channel

2.13. In 2006-07, Akola Irrigation Division carried out efficiency studies for the rabi season for the Nirguna medium project. Water account was maintained in the efficient canal reaches for a total water drawn of 18.25 Mm3 irrigating 1410.38 ha. The results were

Canal	Efficiency
Main canal	0.85
Digras distributary	0.86
Deulgaon minor	0.88
Field channel	0.75
Overall conveyance	0.49
Field application	0.75
Overall efficiency	0.37

This is consistent with the efficiency of 0.38 reported in the CWC report.

2.14. **Loni Minor Irrigation Project**

WALMI, Aurangabad, between 1991 & 1994 carried out an Adaptive Research Study of the Loni Minor Irrigation Project in Khultabad taluka of Aurangabad district. The project is located on a 'nala' which is a tributary of Gun 'nala' joining Shivna River. This study included an assessment of conveyance losses in the project's canal system. The project has a live storage of 0.773 Mm3 and irrigable area of 170 ha. The main canal is 2.52 km long with a design discharge of 0.164 m3/sec. The conveyance losses were measured by inflow - outflow method for each rotation for all the 3 years.

	1991-92	1992-93	1993-94
Conveyance efficiency in main canal (%)	81	87	74
Conveyance efficiency in field channel (%)	72	70	70
Field application efficiency (%)	86	85	85
Overall project efficiency (%)	50	51	44

Average project efficiency 48%.

2.15. **New Projects Identified for Study of Losses**

At the instance of the Authority, WRD has identified the following 8 major & 4 medium projects in the State for study of transmission losses. The work has been entrusted to WALMI who are presently collecting necessary data on design features of the measuring devices in these projects.

Major

(i) Nira canal (Krishna)
(ii) Khadakwasla (Krishna)
(iii) Jaykwadi (Paithan LBC) (Godawari)
(iv) Pravara canal (Godawari)

(v) Kukadi (Krishna)
(vi) Upper Wardha (Godawari)
(vii) Pench (including Ramtek) (Godawari)
(viii) Itiadoh (Godawari)

Medium
(i) Ner (Krishna)
(ii) Bembla (Godawari)
(iii) Chargaon (Godawari)
(iv) Pakadi guddam (Godawari)

2.16. **Water Use Efficiency**

The Criteria (2010-13) has the following stipulations for WRD to comply with

(i) Vide Annex 5, Para 3 of the Criteria, targets were fixed for water use efficiency improvement in terms of area irrigated per Mm^3 of water. The following year-wise targets were fixed.

Year	Target ha/Mm^3 (State average)
2010-11	120
2011-12	125
2012-13	130

To monitor the above targets, Circle-wise information was required to be submitted to the Authority.

(ii) Vide Annex 6, project-wise study in each major & medium project in the State should be carried out by the SE in charge of the project. For minor projects, a few in each district were to be taken.

2.17. **Circle-wise Monitoring of Water-use efficiency**

The Benchmarking Reports of WRD brought out every year, contain project-wise information for 48 major and 164 medium projects in the State on area irrigated per unit of water. The Reports of the years 2007-08, 2008-09 and 2009-10 were scrutinized and projects having unacceptably high or low values were not considered treating the data as erroneous which will vitiate the average values. Only projects having irrigated area in the range of 60 ha to 250 ha per Mm^3 were considered. In Thane Circle, where paddy is predominant crop, projects with 25 ha per Mm^3 & above only were considered. 43 major and 134 medium projects were accordingly selected and the results presented in Annexure 2.1. The abstract values are given below, year-wise.

Year	Annual Irrigation Water Use (Mm^3)	Annual Irrigated Area (ha)	Area Irrigated per Mm^3
2007-08	13212	13,49,327	102
2008-09	12842	12,65,410	99
2009-10	9520	10,46,189	110

For 2010-11, the Benchmark & Water Audit Reports will be available only by middle of 2012. However, the Irrigation Status Report for 2010- 11 has reported the following State average figures for all projects in the State.

Year	Annual Irrigation Water Use (Mm^3)	Annual Irrigated Area (ha)	Area Irrigated per Mm^3
2010-11	15,407 Mm^3	18,41,000 ha	119 ha/Mm^3

Thus an increasing trend in water use efficiency is visible.

Annexure 2.1
(Refer para 2.17)

Annual Area Irrigated per Unit of Water Supplied (ha/Mm^3) in the Year 2007-08 to 2009-10
(Reference:- Report on Benchmarking of Irrigation Systems in Maharashtra State and Water Auditing of Irrigation Systems in Maharashtra State Year 2007-08 to 2009-10)

Sr. No.	Circle	Category of Project	Name of Project		Designed live Mm^3 storage	ICA ha	Area irrigated per unit water used ha/ Mm^3			
							2007-08	2008-09	2009-10	Average
1	2	3	4	5	6	7	16	17	18	19
1	Akola Irrigation	Major	1	Nalganga	69.32	8604	159	144	-	152
	Circle Akola		2	Pus	91.26	8215	126	70	108	101
		Medium	1	Gyanganga	33.93	4249	225	159	-	192
			2	Koradi	20.70	4061	222	228	-	225
			3	Lowerpus	59.63	6600	113	133	150	132
			4	Mas	22.04	4415	168	214	-	191
			5	Morna	41.46	4633	108	220	116	148
			6	Nirguna	28.85	5836	190	145	88	141
			7	Paldhag	7.51	1932	166	127	182	158
			8	Saikheda	27.18	3116	129	94	-	112
			9	Shahanoor	46.04	7466	162	166	-	164
			10	Sonal	16.92	2447	216	-	143	180
			Average				146	116	113	125
2	Buldhana Irrigation	Major	1	Wan (Buldhana)	81.96	15100	122	73	86	94
	Project Circle	Medium	1	Mun	36.83	7804	95	117	164	125
	Buldhana		2	Torna	7.90	1465	-	110	113	112
			Average				118	84	113	105
3	Command Area	Major	1	Jayakwadi(stg I)*	2171.00	183322	107	67	94	89
	Development	Medium	1	Ambadi	11.53	2147	-	188	165	177
	Authority		2	Gadadgad	4.64	1180	161	238	-	200
	Aurangabad		3	Galhati	13.84	2200	-	70	123	97
			4	Girja	21.25	3443	198	146	119	154
			5	Jivrekha	6.13	1064	144	136	-	140
			6	Kalyan Girja	8.47	1377	192	99	-	146
			7	Karpara	24.90	2151	84	-	154	119
			8	Kolhi	3.23	472	-	93	245	169
			9	Masoli	27.13	2591	78	107	-	93
			10	Sukhna	18.49	2511	235	135	-	185
			11	Khelna	11.07	2429	150	-	229	10
			12	Jui	6.03	2206	200	-	130	165
			13	Anjana Palashi			-	174	188	181
			14	Tembhapuri			-	145	184	165
		Average					108	69	100	92
4	Command Area	Major	1	Jayakwadi(stg II)	312.00	54737	78	66	89	78
	Development			Majalgaon						
	Authority Beed		2	Manjra	173.32	18223	122	105	109	112
			3	Lower Terna	113.95	11610	151	139	249	180
		Medium	1	Banganga	4.96	906	177	113	156	149
			2	Chandani	21.58	2024	114	87	151	117
			3	Devarjan	10.68	1882	179	196	-	188
			4	Gharni	22.46	2234	124	129	-	127
			5	Kada	8.56	1214	91	105	184	127
			6	Kadi	5.47	1084	100	77	99	92
			7	Khandala	5.24	830	235	189	210	211
			8	Khandeshwar	8.78	1471	166	157	159	161
			9	Khasapur	13.04	2146	177	172	154	168
			10	Kundlika	37.69	2964	105	144	110	120

(Contd.)

Annexure 2.1 (Contd.)

Sr. No.	Circle	Category of Project		Name of Project	Designed live Mm^3 storage	ICA ha	Area irrigated per unit water used ha/ Mm^3			
							2007-08	2008-09	2009-10	Average
1	2	3	4	5	6	7	16	17	18	19
			11	Kurnoor	32.28	3644	87	90	91	89
			12	Masalga	13.59	1364	126	190	-	158
			13	Mehakari	12.98	4048	86	97	0.82	88
			14	Raigavan	11.26	1700	-	139	111	125
			15	Ramganga	5.34	963	131	-	146	139
			16	Rooty	6.57	1862	-	145	134	140
			17	Sakat	13.48	2355	196	-	139	168
			18	Sakol	10.95	2064	190	200	-	195
			19	Talwar	3.23	668	158	108	112	126
			20	Tawarja	20.34	3603	139	76	-	108
			21	Terna	19.66	1652	169	150	-	160
			22	Tutu	15.29	2348	148	185	-	167
			23	Turori	6.20	830	222	125	-	174
			24	Vati	8.27	1760	117	157	-	137
			25	Wan(Beed)	19.34	5262	101	81	113	98
			26	Benitura	11.47	2293	96	90	86	91
			27	Bindusara	7.11	1288	124	94	118	112
			28	BODhegaon	3.65	990	69	163	116	116
			29	Borna	8.97	1376	92	79	146	106
			30	Harni	11.17	1680	143	0.135	147	142
			31	Mahasangvi	5.88	1943	102	140	148	130
			32	Renapur	20.55	2445	132	105	95	111
			33	Sangameshwar	15.04	3350	181	175	129	162
			34	Saraswati	6.21	1230	163	129	108	133
			35	Sindphana	7.35	1782	168	225_	178	190
		Average					111	97	119	109
5	Command Area Development Authority Jalgaon	Major	1	Girna	525.06	69350	72	69	115	85
			2	Hatnur	255.00	37838	82	118	104	101
		Medium	1	Abhora	6.02	1115	170	108	165	148
			2	Agnavati	2.76	605	-	116	162	139
			3	Aner	59.21	7180	95	67	151	104
			4	Bhokarbari	6.54	1205	85	94	160	113
			5	Bori	25.15	4553	105	111	152	123
			6	Burai	14.21	1.760	-	188	135	162
			7	Hiwara	9.60	2231	179	128	121	143
			8	Kanoli	8.45	1363	107	146	-	127
			9	Karwand	21.39	4534	166	211	119	165
			10	Malangaon	11.33	1587	131	125	128	128
			11	Manyad	40.27	4864	112	98	123	111
			12	Panzra	35.63	6868	137	136	111	128
			13	Rangavali	12.89	3124	169	173	127	156
		Average					86	91	119	99
6	Command Area Development Authority Nagpur	Major	1	Pench*	1374.00	101200	76	96	79	84
			2	Bagh	268.00	23740	124	155	-	140
			3	Itladoh*	318.86	17500	97	98	142	112
		Medium	1	Chandrabhaga	8.26	3181	92	89	95	92
			2	Chulband	21.46	3167	199	231	246	225
			3	Kanholibara	20.49	3371	128	128	164	140
			4	Kesarnala	3.93	780	95	79	-	87’
			5	Kolar	31.32	5940	118	154	62	111
			6	Makardhokda	25.90	5477	110	167	151	143
			7	Mordham	4.95	1315	96	148	148	131
			8	Umri	5.14	12	80	126	155	120
			9	Wunna	21.64	1214	68	244	-	156

(Contd.)

Annexure 2.1 (Contd.)

Sr. No.	Circle	Category of Project	Name of Project		Designed live Mm^3 storage	ICA ha	Area irrigated per unit water used ha/ Mm^3			
							2007-08	2008-09	2009-10	Average
1	2	3	4	5	6	7	16	17	18	19
			10	PandhraBODi	13.14	862	188	-	151	170
		Average					90	110	89	96
7	Command Area	Major	1	Chanakapur	76.85	14042	163	172	168	168
	Development		2	Bhandardara*	304.10	23077	83	77	87	82
	Authority Nasik		3	Mula	608.82	82920	83	74	111	89
			4	Gangapur	159.42	15960	144	143	-	144
			5	Ozarkhed	60.32	10400	96	107	-	102
			6	Palkhed	21.24	43154	80	61	147	96
			7	Waghad	72.20	6750	113	98	156	122
		Medium	1	Adhala	27.60	3914	102	73	109	95
			2	Alandi	27.46	6296	106	103	128	112
			3	Bhojapur	10.21	4500	87	-	126	107
			4	Ghatshil Pargaon	8.50	1660	182	170_	208	187
			5	Haranbari	33.02	9726	176	162	215	184
			6	Kelzar	16.20	3394		177	225	201
			7	Mand Ohal	8.78	2266	78	76	68	74
			8	Nagyasakya	11.24	2400	181	119	153	151
		Average					90	82	111	94
8	Command Area	Major	1	Kukadi *	864.39	119166	95	84	97	92
	Development		2	Ghod	154.80	20500	118	105	117	113
	Authority Pune		3	Krishna	602.73	69269	86	60	68	71
		Average					95	76	86	86
9	Command Area	Major	1	Bhima	1688.41	205277	106	126	125	119
	Development	Medium	1	Ekrukh	61.16	6944	203	152	151	169
	Authority Solapur		2	Hingani(p)	31.97	6592	143	131	155	143
			3	Jawalgaon	25.21	6192	160	140	145	148
			4	Mangi	30.53	4646	140	140	163	148
		Average					107	127	126	120
10	Chandrapur	Major	1	Asola Mendha	56.38	9919	154	139	-	147
	Irrigation Project		2	Dina	68.30	7826	224	188	202	205
	Circle Chandrapur	Medium	1	Amalnala	24.48	2962	162	177	-	170
			2	Chandai	10.69	2056	183	241	-	212
			3	Chargaon*	19.87	1.500	-	73	185	129
			4	Dongargaon (Chandrapur)	04.44	631	75	65	121	87
			5	Ghorazari	43.16	3846	170	-	241	206
			6	Labhansarad	7.35	2024	144	227	-	186
			7	Naleshwar	10.23	1888	202	242	-	222
			8	Pothra	34.72	8948	84	106	89	93
		Average					167	159	189	172
11	Nagpur Irrigation	Major	1	Lower Wunna	189.18	19500		104	85	95
	Circle Nagpur	Average					-	104	85	95

(Contd.)

Annexure 2.1 (Concld.)

Sr. No.	Circle	Category of Project	Name of Project		Designed live Mm^3 storage	ICA ha	Area irrigated per unit water used ha/ Mm^3			
							2007-08	2008-09	2009-10	Average
1	2	3	4	5	6	7	16	17	18	19
12	Nanded Irrigation Circle Nanded	Major	1	Vishnupuri	80.79	28340	125	128	128	127
			2	Manar	138.21	23310	116	109	-	113
			3	Puma	890.22	57988	64	92	166	107
			4	Upper Penganga	964.09	125495	-	77	188	133
		Medium	1	Dongargaon (Nanded)	8.81	830	113	136	-	125
			2	Karadkhed	11.01	1780	166	130	-	148
			3	Kudala	4.35	567	167	128	142	146
			4	Kundrala	10.41	1012	167	199	-	183
			5	Loni	8.38	1377	127	102	-	115
			6	Mahalingi	4.78	784	171	149	-	160
			7	Nagzari	6.56	960	100	96	-	98
			8	Pethwadaj	9.04	1478	112	159	-	136
		Average					86	92	155	111
13	Pune Irrigation Circle Pune	Major	1	Neera(Complex)*	932.01	102576	99	110	124	111
			2	Khadakwasla*	793.47	62146	107	125	136	123
			3	Pawana	241.11	5304	166	-	153	160
			4	Chaskaman	214.50	44170	113	149	130	131
		Medium	1	Khairy	13.74	2318	156	135	199	163
			2	Mhaswad	46.22	4049	148	177	1i0	152
			3	Ranand	6.42	1093	187	180	186	184
			4	Sina	52.30	8445	81	93	112	95
			5	Tisangi	24.46	4049	116	104	145	122
			6	Vadiwale	30.39	4468	155	206	-	181
			7	Andhali	7.42	1498	147	-	155	151
			8	Kasarsai	16.25	4119	163	214	206	194
			9	Nazare	16.65	3195	141	181	151	158
		Average					103	118	128	116
14	Sangli Irrigation Circle Sangli	Major	1	Radhanagari	219.97	26560	137	124	129	130
			2	Tulashi	91.92	4720	-	68	106	87
			3	Warna	779.35	137254	148	131	111	130
			4	Dudhganga	679.11	73340	113	78	86	92
		Medium	1	Chikotra	43.05	6863	161	144	169	158
			2	Chitri	52.48	9160	215	210	187	204
			3	Jangamhatti	33.21	4457	181	132	171	161
			4	Kadavi	70.56	9908	129	106	109	115
			5	Kambli	3.10	972	94	123	85	101
			6	Kasari	77.96	9995	114	109	148	124
			7	Kumbhi	76.50	9170	81	86	91	86
			8	Patgaon	104.80	10000	101	76	104	94
			9	Nher*	11.79	2636	143	-	137	140
		Average					133	111	115	120
15	Thane Irrigation Circle Thane	Major	1	Kal	528.19	12731	39	33	32	35
			2	Bhatsa	942.10	47860	38	42	50	43
			3	Surya	286.31	8988	57	39	33	43
		Medium	1	Wandri	35.94	0.4088		26	26	26
		Average					43	37	35	38
16	Upper Wardha Project Circle Amravati	Major	1	Upper Wardha*	548.14	75000	-	98	76	87
		Average					-	98	76	87
17	Yavatmal Irrigation Circle Yavatmal	Major	1	Arunavati	169.92	20515	84	103	-	94
		Medium	1	Adan	67.25	7804	104	243	-	174
			2	Navargaon	12.47	2056	111	125	-	118
		Average					92	155	-	124
18	Aurangabad Irrigation Circle Aurangabad	Medium		Shivana Takli			194	71	79	115
		Average					194	71	79	115
		Major	43							
		Medium	134							

Annexure 2.2
(Refer para 2.9)

Conveyance Efficiency of Main Canals
(Reference:- Report on Water Auditing of Irrigation Systemes in Maharashtra State, Year 2007-08 to 2009-10)

Sr. No.	Circle	Category of Project		Name of Project	Designed live storage Mm^3	ICA ha	Conveyance Efficiency of Main Canal for Rabi** %							
							2007-08		2008-09		2009-10		Average	
							LBC	RBC	LBC	RBC	LBC	RBC	LBC	RBC
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(15)	(16)
1	Akola Irrigation	Major	1	Nalganga	69.32	8604	-	74		69			-	72
	Circle Akola		2	Pus	91.26	8215	67	69	73	72	-	-	70	71
2	Buldhana Irrigation Project Circle Buldhana	Major	3	Wan (Buldhana)	81.96	15100	94	-	94	-	94	-	94	-
3	Command Area Development Authority Aurangabad	Major	4	Jayakwadi(stg I)*	2171.00	183322	81	65	91	61	86	43	86	56
4	Command Area Development Authority	Major	5	Jayakwadi(stg II) Majalgaon	312.00	54737	-	70	-		-	-		70
	Beed		6	Manjra	173.32	18223	75	75	44	51	-	-	60	63
			7	Lower Terna	113.95	11610	65	64	-	-	-	-	65	64
5	Command Area Development Authority	Major	8	Girna	525.06	69350	60	72	59	77	56	-	58	75
	Jalgaon		9	Hatnur	255.00	37838	-	60		56		53	-	56
6	Command Area Development Authority		10	Bagh	268.00	23740	57	58	-	-	-	81	57	70
	Nagpur		11	ltiadoh*	318.86	17500	-	65	-	-	-		-	65
7	Command Area	Major	12	Chanakapur	76.85	14042	70	76	73	77	71	70	71	74
	Development Authority		13	Kadva	52.91	10117	-	45			-	30	-	38
	Nasik		14	Bhandardara*	304.10	23077	45	53	38	51	33	46	39	SO
			15	Mula	608.82	82920	65	73	58	67	53	66	59	69
			16	Gangapur	159.42	15960	60	-	67	-	55	-	61	-
			17	Upper Godavari			56	62	50	46		89	53	66
			18	NM Weir			70	16	31	12	47	35	49	21
8	Command Area	Major	19	Kukadi *	864.39	119166	53	59	51	48	0	64	35	57
	Development Authority		20	Ghod	154.80	20500	66	47	75	56	60	47	67	50

(Contd.)

Annexure 2.2 ***(Concld.)***

Sr. No.	Circle	Category of Project		Name of Project	Designed live storage Mm^3	ICA ha	Conveyance Efficiency of Main Canal for Rabi** %							
							2007-08		2008-09		2009-10		Average	
							LBC	RBC	LBC	RBC	LBC	RBC	LBC	RBC
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(15)	(16)
	Pune		21	Dhom			48	52	61	54	56	50	55	52
			22	Kanher			58	66	55	42	43	38	52	49
9	Command Area Development Authority Solapur	Major	23	Bhima	1688.41	205277	34	45	71	55	49	47	51	49
10	Chandrapur Irrigation Project Circle Chandrapur		24	Bor	127.42	13360	70	-	37	-	65	-	57	
11	Nanded Irrigation	Major	25	Vishnupuri	80.79	28340	-	67					-	67
	Circle Nanded		26	Manar	138.21	23310	86	82	-	-	-	-	86	82
			27	Purna	890.22	57988	85	-	-	-	-	-	85	-
			28	Upper Penganga	964.09	125495	87	83	86	84	-	-	87	84
12	Pune Irrigation Circle	Major	29	Neera(Complex)*	932.01	102576	51	54	51	53	49	53	50	53
	Pune		30	Khadalavasla*	793.47	62146	-	34 ’	-	33		63		43
			31	Chaskaman	214.50	44170	71	-	0.42	-	46	-	53	-
13	Thane Irrigation Circle	Major	32	Kal	528.19	12731	29	40		-	25	60	27	50
	Thane		33	Bhatsa	942.10	47860	-	46	-	-		92	-	69
			34	Surya	286.31	8988	-	40		-	46	61	46	51
14	Aurangabad Irrigation Circle Aurangabad	Major	35	NMC Expr Canal	0.00	34203	-		81	-	-	-	81	-

Note:- * Projects selected by WRD for Efficiency Study

** Conveyance efficiency of main canal is the ratio of the sum of water supplied to distributaries and lifts to water released in the main canal

CHAPTER - III
OPERATION & MAINTENANCE COST OF IRRIGATION MANAGEMENT

3.1. Operation & Maintenance (O&M) cost of irrigation management means the sum of cost of establishment deployed for irrigation management and the cost of maintenance & repairs (M&R) of the irrigation system (comprising bead works, appurtenant works and canal system) of water resources projects. As per Section 11 (d) of the MWRRA Act, the water charges are to reflect the full recovery of the cost of irrigation management, administration and maintenance of water resources projects. Therefore the full O&M cost is to be recovered from bulk water charges to the various categories of users.

3.2. In Section 11 (r) of the Act, cross subsidies between categories of use and government payments (subsidy) are envisaged to assure that the sustainable operation and maintenance of the water management and delivery systems within the State are not jeopardized in any way. The issue of subsidy and cross-subsidy was discussed in detailed in Para 8.6 of Chapter VIII of the Revised Approach Paper for CBWT 2010-13. Subsidy is a government payment and can be either an identified quantum or an amount beyond the pale of reasonable estimate at tariff proposal stage. For example, by making ground water free of water charges, the government implicitly agreed to meet the shortfall in O&M requirement by a subsidy. This amount can be quantified from area under groundwater irrigation, crops grown and tariff levied for each crop prior to the decision. However, by providing concessions for water conservation (recycling, adoption of drip & sprinkler, etc.), no estimate can be made at tariff proposal stage as to how much revenue shortfall will occur as it depends on the response of the users to the concessions. At revenue collection stage, subsidy will be required to off-set the short fall in revenue collection against billed amount. This amount is again depends on the collection efficiency. Part of this shortfall will get covered by collections of past arrear in tariff. The Authority is however concerned only with subsidy at tariff fixation stage. Other than the ground water issue, which has a bearing on allocation of O&M cost to canal flow users, it is thus not considered necessary at tariff fixation stage to estimate other subsidies.

3.3. It was also emphasized in the previous Approach Paper (2010-13) that as long as each user is charged as per its ability to pay, no cross subsidy is said to exist. The common myth that industry cross subsidies domestic and agricultural users thus gets dispelled as the Authority's objective in tariff fixation is that every user should be charged as per ability to pay. Ideally the tariff structure should be such that cross subsidy should be absent and government subsidy is kept to minimum. The Authority's objective is thus to move as near as possible to this tariff structure.

Establishment cost

3.4. There are mainly 15 irrigation management circles in the State. In 2003, WRD, in consultation with Finance Department, fixed norms for regular temporary establishment (RT) and issued a GR for the same on 6/2/2003 (**Annexure 3.1**). 23754 posts were sanctioned starting at the level of SE and upto the level of Sectional Engineer together with supporting administrative staff. These posts are a part of the 45297 posts sanctioned in the GR for the Department as a whole.

3.5. In respect of Converted Regular Temporary Establishment (CRT), the State government in August 2003 accepted the recommendations of a Committee set up in Sept. 2001 to finalise the norms for this category and vide GR dt. 20/8/2003 (**Annexure 3.2**), 21243 posts were sanctioned for the 15 management Circles. CRT is a dying cadre and vacancies due to retirements etc. are not filled but the posts are allowed to lapse. Hence, since 2003, a number of posts have got abolished with attendant progressive decline in establishment strength of CRT cadre.

3.6. The full cost of establishment of the 15 Circles including RT & CRT, has to be considered for bulk water tariff purposes. Consequent upon formation of WUAs and handing over of irrigation systems below the minor to them, many CRT posts like canal inspector and labourer would not be required as responsibility for operation & maintenance of the system below the minor will vest in the WUAs. A Committee under Director General, WALMI had in 2008 studied this aspect and their report is now under consideration of the WRD for revision in norms for establishment. Even in the RT cadre, all sanctioned posts are not filled. Only the actual costs of establishment based on posts filled is considered for recovery through water tariff.

3.7. The establishment costs have increased since 2008-09 due to acceptance and implementation of the recommendations of the Sixth Pay Commission. Sanction of additional DA also leads to annual increase in establishment costs. The grievance of the stake holders that the proportion of establishment component is higher than that of M&R works component and the State government should reduce the burden on this account on water charges, has to be therefore viewed in this backdrop.

Maintenance & Repairs (M&R)

3.8. While finalizing the CBWT (2010-13), the M&R norms were got reviewed by a Committee of Experts under WALMI, Aurangabad. The recommendation of WALMI made in their report of July 2008 formed the basis for M&R norms for fixing the tariff for 2010-13. The norms proposed by WALMI in their report is at **Annexure 3.3.**

3.9. As a part of the Criteria exercise for 2013-16, MWRRA suggested to WRD that the norms of 2008 be got reviewed again by WALMI. Accordingly WRD requested WALMI in July 2011 to take up this work using data of the following projects

Major	Minor
(i) Kal-Amba	(i) Paradgaon
(ii) Palkhed	(ii) Loni
(iii) Bhandardara	(iii) Machnoor (KT Weir)
(iv) Katepurna	(iv) KT weirs in Kolhapur
(v) Ujani	(v) Junoni storage tank
(vi) Takari-Mhaisal (lift)	
(vii) Jayakwadi	

3.10. WALMI constituted a 3 member expert team of retired Executive Directors of WRD and Chairman, SOPPECOM. A feature of this revised study was association of representatives of Water User Associations in the team. The following were associated from WUAs.

(i) Shri Bharat Kawale, Samaj Parivartan Kendra, Ozar, Nashik Chairman of
(ii) Vignahar WUA No. 110 Sirigonda
(iii) Jaikisan WUA, Shendu, Amravati
(iv) Sidheswar WUA, Paithan, Aurangabad
(v) Gadhavi WUA, Madeghat, Bhandara
(vi) Deokop WUA, Tal. Palghar, Thane

3.11. The Committee sought data from field officers for the years 2007-08 to 2009-10. A meeting of all SEs was also convened at Aurangabad on 7/9/2011 to discuss the furnished data. A meeting of the Committee was again held at Pune on 6/1/2012. Based on this meeting, WALMI has submitted an interim report suggesting that the existing norms be retained for another 2-3 years and based on the implementation experience, a decision of their adequacy can thereafter be taken.

3.12. WALMI in their report of 2008 on Revision of Maintenance & Repairs Norms for Irrigation Projects in the State had inter-alia recommended that the proposed norms may be increased by 10% automatically every year to account for price escalation. This recommendation of WALMI was based mainly on price escalation in M&R requirements of old projects while in fact the projects to be maintained are a mix of old as well as new projects for which maintenance expenditure is lower. Thus while averaging out the M&R requirement for the State as a whole, the escalation factor will be about 5% and not 10%. While processing the WALMI report for approval of norms, WRD have accordingly opined that the norms be increased by 5% annually instead of the recommended 10% to cope with inflation and price rise. This decision is considered acceptable and the Authority therefore proposes a 5% annual increase in the earlier norms of 2008 for the period 2013-16. Since tariff is worked out considering the O&M requirements of the mid-year of the control period, i.e., 2014-15, the resultant increase will be 10% over the earlier norms.

Annexure 3.3
(Refer para 3.8)

A Study of Revision of Maintenance & Repairs Norms For State Sector Irrigation Projects in Maharashtra Proposed Norms for M & R for 2010-13 Abstract of WALMI Report of 2008

1. Basic Norms

1.1. *Headworks:* Rs. 11,000/Mm^3 of Design Live Storage

- Irrespective of good or bad year
- Provision for M & R of gates shall be additional as suggested by Chief Engineer, Mechanical, Nashik.

1.2. *Canals:*

1.3. (a) Rs. 380/ha of actual irrigated area.
- Actual irrigated area as per average of previous 3 years
- Perennials, other perennials and two seasonal counted once
- Area irrigated on wells not to be considered
- In a project, if steps for levying 50% of water fees on the kharif crops are taken and guarantee of supply of water provided, the kharif irrigation may be included in the irrigated area

(b) Rs. 190/ha of balance area
- Balance Area = CCA - Actual area irrigated

(c) (c) Total amount worked out as per (a) & (b) above may further be allocated component wise as given below
- Main / Branch Canal: 40%
- Distributaries: 25%
- Minors: 35%

1.4. *K.T. Weirs*

(a) Rs. 2300 / sq. meter of gate area for K.T. weirs with reservoir backup

(b) Rs. 1450/ sq. meter of gate area for K.T. weirs without reservoir backup

1.5. *Govt. LIS:*

(a) Electricity charges & maintenance of pump house & rising main : as per actual.

(b) For canals of LIS : as per item 1.2 above.

1.6. *Storage Tanks:*
As per Head works (Refer item 1.1.)

2. Adjustment for specific conditions
(i.e., increase over & above basic norms, if and as applicable)

2.1. *Age of the Project*

Age (Years)	Add for Head works & Main/Branch Canals
35 to 70	7.5%
Above 70	15%

N.B.: If any modernization or rehabilitation of the concerned component has been carried out within last 35 years, then the additional provision indicated above shall not be admissible.

2.2. *Black Cotton Soils*
(Applicable if dominant soil type in the command of the project is B.C. Soil. Dominant means percentage greater than 50%)

Project	Add in respect	Add to basic norms worked out as per 1.2 (c) above
Major	Minors only	To the extent of percentage of command area of the project covered by B.C. soil as per soil survey
Medium	Distributaries & minors	100%
Minor	Main / Branch canal, distributary minors	100%

2.3. Project situated in hilly areas / high rainfall zone (Average rainfall > 2000 mm / year)

Add 100% to basic norms on all components of the project, i.e.,

- Add 100% to the amount worked out as per (1.1) for Head works. (Not applicable if dam is fully masonry / concrete dam)
- Add 100% to the amount worked out as per {1.2 (c)} for Main Branch Canals, Distributaries & Minors

(N.B.: Item 2.2 & 2.3 not applicable to KT weirs).

CHAPTER - IV SUGGESTIONS RECEIVED & ISSUES IDENTIFIED

4.1. AGRICULTURE

Dates of Seasons

4.1.1. In the Criteria for Bulk Water Tariff (CBWT) (2010-13), the dates for the three seasons viz. kharif, rabi & hot weather in Konkan & Vidarbha and in the remaining part of the State were defined as under:

Season	Regions other than Konkan & Vidarbha	Konkan & Vidarbha
Kharif	July to October	July to 15th November
Rabi	November to February	November to 31st March
Hot weather	1st March to 30th June	1st April to 30th June

While issuing the area based tariff order for agriculture for 2010-13, vide order dt. 29/6/2011, WRD has further clarified the above with specific dates as under:

Season	Regions other than Konkan & Vidarbha	Konkan & Vidarbha
Kharif	1st July to 14th October	1st July to 14th November
Rabi	15th October to 28th February	15th November to 31st March
Hot weather	1st March to 30th June	1st April to 30th June

It is proposed to adopt the above dates as decided by WRD for the period 2013-16 also.

Grouping of Crops

4.1.2. As recommended in Section 13.1.1. (ii) of CBWT (2010-13), the following sub grouping of crops was proposed in the tariff proposal and subsequent tariff orders for 2010-13.

Kharif

3. Cereals & other crops
4. Groundnut
5. Vegetables & onions
6. Paddy

Rabi
7. Vegetables
8. Wheat
9. Other rabi

Two seasonal
10. Chilli, Ginger, Tur
11. Cotton. Hot weather
12. Vegetable
13. Groundnut
14. Paddy Perennial
15. Sugarcane, banana
16. Horticulture

While no changes in the above groups is proposed for 2013-16, as proposed by WRD also the following minor changes are however proposed to be included

Present Nomenclature	Proposed Nomenclature
Rabi	
7. Other rabi	7. Other rabi & jowar, onion
Two seasonal	
8. Chilli, ginger, tur	8. Chilli, ginger, tur etc.

Concessions

4.1.3. Under Section 13.1.2. of CBWT (2010-13), the following concessions were proposed for agriculture

(i) 75% of basic rate in tariff for farmers with holding size less than 2 ha (excluding sugarcane, banana, horticulture)

(ii) 50% of basic rate in tariff for farmers in districts included in Prime Minister's package and in naxalite affected areas declared by the State (excluding sugarcane, banana, horticulture).

(iii) No tariff for tribal farmers in projects under tribal sub plan

(iv) 75% of basic rate for all crops for project affected people.

(v) 25% of basic rate for horticultural crops for first 3 to 5 years, depending on type of crop. However, if inter-crop is taken, relevant tariff only for inter-crop will be charged. Further area rate for horticulture will not be more than 75% of sugarcane & banana rate.

(vi) 50% of area rate for volumetric rate for paddy.

4.1.4. WRD has expressed a view that the concessions in para 4.1.3 are difficult to implement and their numbers should be reduced. If the onus of submitting required documentary proof for availing the concessions along with the application for water is placed on the farmer, the difficulty expressed can be tackled. WRD while calling application for water sanction shall specifically mention in "PRAGATAN" of such details to be furnished by farmer in his application. It is therefore proposed that we may continue the area concessions and the concessions for tribal farmers & project affected persons for 2013-16 also.

4.1.5. Regarding concessions for horticultural crops, a suggestion has been received that the stipulation that area rate should not exceed 75% of rate for sugarcane & banana should be dropped and also if inter-crop is taken, higher of the two rates (viz. horticultural rate or inter-crop rate) should be considered. There is need to promote horticulture in the State to improve the earnings of farmers and also to increase the nutritional level of food consumption in the State. It is proposed that we may continue with both the concessions for horticultural crops.

Incentives

4.1.6. In the CBWT (2010-13), an incentive was given for adoption of modern irrigation methods in area based supply by making the tariff rate as 75% of the applicable rate. There is need to promote adoption of drip & sprinkler for perennial crops in flow areas. Under Section 14 (4) of the Act, the Authority has a mandate to promote this. With a view to further accelerate the pace of adoption of drip & sprinkler irrigation technologies and to tackle the likely scarcity of fresh water in coming years, it is proposed to further reduce the tariff from 75% to 60% of applicable rate in CBWT (2013-16) if modern irrigation methods are adopted. This will require separate incentives for encouraging construction of farm ponds.

Disincentives / Penalty

4.1.7. The MWRRA Act, under Section 12 (11) has prescribed a penal rate of one and half times the normal tariff for a person having more than two children. This is applicable only to agricultural entitlement. In CBWT (2010-13), this penalty was indicated accordingly in agricultural area based tariff. There have been demands that the Authority should not operate this provision. Keeping in view that the statute requires this penalty in tariff be linked to family size, the Authority is required to continue this penalty in 2013-16 also as it is for the State government to take a view on need for amending or deleting this provision.

Private Lift Schemes

4.1.8. The CBWT (2010-13) did not spell out the methodology for working out water rates for private lift schemes for the various crops. The procedure was detailed in the tariff proposal of WRD which was circulated for public consultation. In a nutshell, the procedure earlier finalised is

(i) Rates will depend on source of supply (Annex 2A of CBWT - 2010-13). While basic rate will be charged for assured water supply, the rates will reduce to 0.75 of basic rate for regulated water supply, 0.5 for partly assured water supply and 0.33 for sharing in cost of infrastructure like dam, bandhara or KT weir.

(ii) For area based supply to perennial & horticulture crops, the relevant area based tariff rate will be first considered. A concession of 35% will be given on this rate for investment made by farmers in pump equipment etc.

(iii) The annual energy charge for a 5 hp pump to irrigate 1 ha was taken as Rs. 1500 and a lumpsum O&M cost of Rs. 1000/year was taken for maintenance of assets.

(iv) Thus the basic applicable rate is 0.65 (flow rate) - O&M cost - energy cost. (0.65 because 35% concession is given for investment).

(v) The basic rate will be reduced by 25% for perennial and horticultural crops for adoption of drip and sprinkler. (vi) For other crops in kharif, rabi & hot weather, the present rates of 2003 were retained.

(vii) For volumetric supply, the volumetric rate fixed for WUAs at minor level will be applicable.

4.1.9. No suggestion has been received from any private lift operator with supporting data to warrant any change in the above approach. The Authority has collected latest energy rates on private lift schemes from MERC which are given in **Annexure 4.1.** For other crops in kharif, rabi & hot weather, a nominal increase in tariff as appropriate will be prescribed.

Government Lift Schemes

4.1.10. Annex 2-B of CBWT (2010-13) gives the procedure for fixing projectwise tariff, including energy chares for Lift Irrigation schemes owned by Government. As per this procedure, energy charges are fully borne by the beneficiaries as also tariff at rates fixed for each crop for area based supply and at volumetric rate for volumetric supply.

4.1.11. One of the comments now received on the above methodology is that this perpetrates inequity between upland farmers and lowland farmers as the former will end up paying more tariffs. Government lift schemes usually cater to drought prone regions of the State. The suggestion is that the O&M cost for government operated lift and flow irrigation schemes should be added together and included in total O&M cost of the irrigation system in the State for recovery through water tariff. It has also been suggested that volumetric supply at rates same as flow rates should be the basis for operating government lift schemes. This suggestion needs in-depth examination by WRD.

4.2. **DOMESTIC**

Principles

4.2.1. In CBWT (2010-13), the water rate was linked to source of supply (refer Annex 3 of the Criteria). The basic rate was for assured water supply. Since transmission losses are to be borne by the Water User Entity, if the source was regulated water supply with transmission loss, the water rate was fixed at twice the basic rate. If the source was partly assured, the rate was 50% of the basic rate and if the Entity shares in the proportional cost of the infrastructure, then the concessional rate was fixed as 33% of the basic rate. No comments/suggestions have been received on this categorization and hence it is proposed to retain this in CBWT (2013-16) subject to the new proposal in para 4.4.3. on entities sharing cost of infrastructure. Solapur Municipality has proposed that since they are maintaining some weirs, they should be given concessional tariff. Since the weirs have been constructed by WRD and no sharing in construction cost has been done by the Municipality, maintenance of weirs cannot be considered for concessional tariff. It is for the Municipality to recover the maintenance cost from retail tariff charged to consumers.

4.2.2. The basic rate was kept uniform for all the three seasons in the CBWT (2010-13) and it is proposed that we may continue with this approach in the new Criteria also. Also commercial use will be continued to be treated as industrial use.

Concession

4.2.3. In CBWT (2010-13), a stepped tariff was proposed to differentiate rural and urban uses. While Gram Panchayats (GP) were levied 75% of applicable rate, urban local bolides (ULB), i.e., Nagar Palikas / Nagar Parishads were levied 90% and Municipal Corporations 1.25 times applicable rate. While stepped tariff at above rates will be continued in 2013-16, it is clarified that the rate of 1.25 times basic rate will be applicable only to the following 23 A, B, C & D class Municipal Corporations

A	B	C	D
i. Greater Mumbai	i. Pune	i. Thane	i. Kalyan- Dombivli
ii. Navi Mumbai	ii. Nagpur	ii. Nashik	ii. Ulhasnagar
		iii. Pimpri - Chinchwad	iii. Bhiwandi-Nizampur
			iv. Mira-Bhayander
			v. Malegaon
			vi. Sangli-Miraj-Kupwad
			vii. Solapur
			viii. Kolhapur
			ix. Aurangabad
			x. Nanded-Waghala
			xi. Amravati
			xii. Jalgaon
			xiii. Ahmednagar
			xiv. Dhule
			xv. Vasai-Virar
			xvi. Akola

All other municipalities will be treated on par with ULBs (Nagar Parishads) and will be charged 90% of basic rate.

Incentive

4.2.4. In Section 13.2.2. of CBWT (2010-13), a rebate was provided to domestic bulk user entities for treating sewage to required MPCB standards and enabling use of such treated effluent for irrigation/gardening. The quantum of water to produce such treated effluent was levied only 75% of applicable tariff. It has come to the notice of the Authority that in all agreements entered into by WRD with domestic user entities, a stipulation is always included that the effluent must be treated to required MPCB standards. In most cases, such treated effluent are either discharged into canals or rivers for identified irrigation uses downstream. It is therefore proposed to do away with this concession.

4.2.5. Municipal Corporations and Municipalities (Nagar Palikas) do find it difficult to fund STPs and meet the running costs of the treatment plants. On 15/10/2010, Urban Development Dept. has issued a GR (enclosed as Annexure 4.2) to promote recycling and reuse of sewage in urban areas. All ULBs are required to ensure that 20% of the total sewage of the town is recycled and reused. The reuse can be for agricultural, commercial or industrial purposes. WRD, in all their agreements with domestic water user entities, should take note of this circular and permit the ULB to recycle and reuse upto 20% of the total sewage for the purposes envisaged in the GR of UDD without insisting for its release after treatment into a natural water courses provided there are no prior irrigation or other commitments downstream. Further, in such cases, if any Municipal Corporation/Nagar Palika desires to treat and reuse more than 20% of its sewage effluent, it can be permitted by WRD to do so provided there is no downstream commitment in their original bulk water sanctions. Municipal Corporations / Nagar Palikas should levy the tariff for bulk water as fixed by the Authority for each category of user for sale of treated sewage to any entity. This approach will not only improve the river water quality but also reduce the burden on fresh water.

Penalty/Disincentives

4.2.6. Vide Section 13.2.4. of the CBWT (2010-13) municipalities were required to meet their additional requirement by recycling. The National Water Mission has an objective of 20% increase in water use efficiency. Municipalities can contribute in this effort by adopting recycling. Singapore is an example where 20% recycling is being done to meet industrial needs and this is progressively being increased to 50%. It is also reviewing the per capita norms with the objective of progressively bringing it down. Instead of conserving water, there have been demands that allocation should be automatically increased by 10% each year.

4.2.7. With a view to promote recycling, all Municipalities should by 2016 either make 20% of treated sewage available for other industrial user or reduce their demand by 20% by meeting the industrial component of their sanctioned use with recycled water. They should also carry out water audit to assess per capita norms and identify and quantify non revenue water including line losses. Beyond 2016, WRD would insist for this when existing agreements come up for review. To start with, Metros like Mumbai, Pune, Nagpur and Aurangabad should take the lead.

4.2.8. Vide Section 13.2.4. (iii) in CBWT (2010-13), Municipal Corporations were enjoined to submit within 2 years an implementation programme for new STPs. It is clarified that this is applicable to the 23 Municipal Corporations listed in Para 4.2.3. of this Chapter. Since tariff orders were issued in May 2011, the plans are required to be submitted by May 2013. Otherwise from kharif 2013, penal tariff of $1\frac{1}{2}$ times applicable rate will be charged.

4.3. **INDUSTRIAL USE**

Principles

4.3.1. In CBWT (2010-13), the water rates were linked to source of supply (Annex 4 of Criteria). The categorization of source of supply and the applicable rates for the various sources are similar to domestic. The basic rate was not uniform in all seasons - while the basic rate was applicable to 'rabi', the rate in kharif was 50% of this rate and the hot weather it was 150%. Since no comments/suggestions have been received on this, it is proposed that we may continue the same for 2013-16.

4.3.2. Two categories of industries were earlier identified viz. industries using water for process (cooling, washing etc.) and industries using water as raw material (beverages). The basic rate for industries using water as raw material was fixed at five times the basic rate.

Three Tier Tariff for Industries

4.3.3. The extant industrial tariff is a two tier tariff differentiating only between process industries and industries using water for beverage. The rate for the latter is 5 times the rate for former. Industries causing heavy chemical pollution like chemical industries, dyeing, viscose, paper, electroplating, galvanizing, tanneries, bleaching, degreasing etc. are treated on par with thermal plants, food processing, chilling & cold storage, who do not cause any chemical pollution. The cost of bulk water for process industries is Rs. 32/10 cu.m or Rs. 64/10 cu.m depending on source of supply (dam or canal / river). The treatment costs to remove chemical pollutants can be as high as Rs. 60 - 100/10 cu.m. Thus the industries have no incentive to recycle & reuse since raw water is cheaper than treated water. To promote recycle & reuse and improve water quality in rivers, it is proposed to introduce a three tier tariff structure for industries from 2013-16 viz.

(i) Basic rate for thermal, food processing plants Agro Industries who do not cause any pollution in COD terms

(ii) Twice basic rate for chemical & other industries who cause chemical pollution measured as COD.

(iii) Five times basic rate for beverage industries.

Grouping of industries into above 3 categories will be done in consultation with MPCB.

Concession

4.3.4. In CBWT (2010-13), (Section 13.3.2.) agro industries (poultry, canning, sugarcane processing, dairying) were given a rebate in water tariff and only 75% of applicable rate was charged. One more type of agro industry has now come to the Authority's notice, viz., corn processing. It is proposed that we may continue the concession to agro industries in 2013-16 and include corn processing also as an agro industry.

4.3.5. A concession was also provided in the same Section of the CBWT to incentivize recycling by industries, i.e., if an industry reduces its demand by atleast 25% by recycling, 75% of applicable tariff will be charged for reduced demand. It is proposed that we may continue this concession in 2013-16 also.

Zero Discharge Industries

4.3.6. The concept of zero discharge is being promoted in developing countries where an entity treats and reuses the whole of the effluent and the chemical & organic sludge is disposed off as per accepted practice. The entity draws thus only a small fraction of its allocation (10 - 15%) to cover evaporation and line losses plus any use in the process itself. To promote this, it is proposed that zero discharge industries be charged in 2013-16 only 25% of the applicable tariff for topping water drawn by them.

Separate Category for Industries drawing untreated/partially treated sewage water from GPs/ULBs/Municipalities/Corporations and treating *it for process industries.*

4.3.7. (1) If a process industry desires to be allocated untreated sewage effluent of GPs/Nagarpalikas let into any natural water course and applies to WRD for allocation out of this and treats it at its cost (primary, secondary, tertiary) for use in process industries, no bulk water tariff or royalty will be levied and the untreated sewage effluent will be allocated free of cost to the industry. WRD have however suggested levying of a royalty charge for such use instead of not charging anything.

(2) If a process industry is allocated secondary treated sewage effluent of a Municipal Corporation treated to prescribed MPCB standard and which has an agreement with WRD to return a part of the allocated water after treatment and if the Bio-chemical Oxygen Demand (BOD) of such effluent is higher than the normal BOD level of stored reservoir water requiring the industry to further incur cost on tertiary treatment to bring down the BOD to the level of stored

reservoir water, then such category of use will be treated on a separate footing. Keeping in view that quality of water allotted is inferior to stored water in terms of BOD and investment has been made by the entity for tertiary treatment, the tariff will be 25% of basic rate.

4.3.8. In CBWT (2010-13) under Section 13.3.3., the 'Polluter Pay' principle was enunciated. While all industries are supposed to treat the effluent to required MPCB standards before they discharge it into natural water courses, those failing to do so were charged penal tariff of twice basic rate. This penal provision is suggested to be continued in 2013-16.

4.3.9. Commitment charge proposed in earlier Criteria for non-irrigation users is also suggested to be continued.

4.4. **Other Issues**

Equity Issues in Agriculture

4.4.1. Though not raised by any one for this Approach Paper, NGOs had raised the issue in the past of introducing equity principles in water viz. ensuring minimum needs for drinking and subsistence agriculture at no cost and minimum cost. The Authority while determining the Criteria for 2010-13 has loaded about one third of the O&M cost to domestic and agriculture while about two thirds is borne by industry. Further Gram Panchayats enjoy concessional tariff compared to urban areas. The tariff for cereal crops is fixed considering 3-5% of Gross Value of Produce while for cash crops, it is 8-10%. Concessions are also given to small marginal farmers based on land holding. If further dispensations are to be given then the provisions have to be first introduced by the State govt. in the State Water Policy and also in the MMISF & MWRRA Acts. In the absence of this, it would not be possible for the Authority to link this with water tariff.

Irrigation Restoration Charges

4.4.2. Vide GR dt. 5/3/2009, the State government has fixed the revised rate for irrigation restoration charges w.e.f. 1/4/2009 as Rs. 1 lakh/ha. of irrigation foregone as a result of water diverted to non irrigation. However, this amount is rarely used by WRD to actually carry out rehabilitation works like lining to save water and restore irrigation and the amount is usually credited into Government account. Also the user entity paying the restoration cost does not get any tariff concessions as this is not treated as sharing in infrastructure cost. It is proposed to replace this practice with the following revised norm

i) Whenever irrigation is affected due to diversion of water to nonirrigation, the restoration cost will be estimated by WRD on a case-by-case basis considering rehabilitation actually required (lining, additional storage etc.) to save the diverted water. This amount shall be paid by the beneficiary entity to the concerned Irrigation Development Corporation (IDC) before allocation sanction is issued and the amount shall be used by the IDC for actual restoration of the system as intended.

Entities sharing cost of dam and enjoying tariff rebate in perpetuity

4.4.3. Presently, a non-irrigation entity which shares cost in dam, KT weir and barrage pays only 1/3rd basic rate. An entity may share 10% of project cost and may recover this in some years due to reduced tariff. But the entity continues to enjoy the reduced tariff benefit for the whole agreement period. This is a loss of revenue to State Govt. It is therefore proposed to do away with the concept of sharing a cost of dam and all such sharing will be called payment of advance tariff. Once this payment gets adjusted, the number of years to be calculated by NPV method with 10% interest, tariff rebate will cease as and when advance tariff s extinguished.

However this will not apply to entities who fully bear the cost of the dam / barrage / weir and thus fully own the structure for whom royalty at prescribed rate will be charged.

Charging for Evaporation Loss

4.4.4. Entities allocated water from reservoir, are also allocated prorata evaporation quantum. WRD charges the entity not only for the quantity pumped but also the evaporation component. This is not done for entities who draw water from river/canal downstream of dam who are charged double normal tariff for water released from dam. To streamline this aspect, it is proposed that since evaporation is a natural phenomenon it should be treated as a system loss due to human intervention and thus no one should be liable to pay for this. Thus for dam users, tariff will be levied on quantum lifted. For downstream users, since tariff is already doubled to account for transmission losses, it would be fair to charge this tariff only on quantum lifted from river/weir and not water released from dam.

Revenue from Penalties

4.4.5. Additional revenue from penalties imposed on various categories of users would accrue to the State govt. over and above the revenue from normal water charges. While at tariff fixation stage, it will be planned to recover the full O&M costs from water charges, the additionality from penalties cannot be estimated at tariff stage. It is proposed that such additional revenue be set off against shortfall in revenue collection and loss in revenue due to incentives offered for recycling etc. and will not be considered as a part of tariff for recovering O&M cost.

Fixed Charges for Private L.I. Schemes

4.4.6. WRD has suggested introduction of a fixed charge in addition to area based tariff payable by all farmers under a private lift scheme. The justification for this proposal put forward by WRD is that if only a few farmers irrigate, then full energy costs are shareable by them and thus the burden on them is increased. This may discourage them from taking a crop in next season leading to closure of the scheme.

Annexure 4.1
(Refer Para 4.1.9)

NORMS FOR PRIVATE LIFT SCHEMES

ENERGY CHARGES

1. 1. Effective monthly tariff for agriculture category (5 HP pump).
(Ref. MERC Order dt. 12/9/2010, 2/12/2010, 31/10/2011)

Metered Connection	Rs. /month
(i) Fixed charges at Rs./HP/month for 5 HP	= 75
(ii) Energy charges in Rs/kwh at Rs. 1.75/kwh considering consumption of 1318 hrs/HP/year	= 706
Total	= 781
Unmetered Connection	
(i) For Bhandup, Pune, Nashik zones with consumption norm above 1318 hrs/HP/year where base tariff is Rs. 234/HP/month	= 1170
(ii) For other zones in State with consumption norm below 1318 hrs/HP/year where base tariff is Rs. 200/HP/month	= 1000
Average	= 1085

2. Considering 75% as unmetered connections
and 25% as, metered connection
weighted average tariff = Rs. 781 x 0.25 + Rs. 1085 x 0.75
= Rs. 1000/month
or Rs. 12000/year.

With 50% Govt. subsidy on energy charges
weighted average tariff = Rs. 6000/year
Considering 3.6 ha irrigated area with 5 HP pump
(1 ha sugarcane, 2.6 ha other crops) tariff per ha $= \frac{6000}{3.6} =$ 1670/ha

O&M Costs

3. Cost of 5 HP pump = Rs. 30000
Annual Maintenance at 12% = Rs. 3600
Cost per ha $\frac{3600}{3.6}$ = Rs. 1000

Hence for 2013-16, the energy charges for private lift schemes will be taken as Rs. 1670/ha for 5 HP pump and O&M cost at Rs. 1000/ha

Annexure 4.2
(Refer Para 4.2.5)

Recycling and reuse of sewage in urban area

Government of Maharashtra Urban Development department

GR No. Misc- 2010/1015/ Case No. 121/ UD-20 Mantralaya Mumbai- 32 Dated: 15th October 2010

Preface: As per the norm set for the urban area by the Central Government, for treatment of sewage, it's recycling and reuse, minimum 20% of total sewage should have to be available for reuse. While commencing the "Maharashtra Suvarn Jayanti Nagaroththan Mahaabhiyan" in the state, the Govt. has accepted this norm for recycling and reuse of sewage. The issue of establishing methodology for taking well planned action so as to bring minimum 20% of the total sewage in the town under reuse, as per this norm, was under consideration of Government. After overall thinking, Government is taking following decision.

Government Resolution:

1. All urban local bodies by their own efforts or by inducing the residents should ensure that minimum 20% of total sewage in the town is recycled and reused.

2. To encourage the reuse of the sewage available in urban area, it is essential to carry out the study for identification of categories of use, wherein such reuse is possible. As the possibility of reuse of sewage depends on the local circumstances of the town, the ULBs should carry out prior study of the following purposes, in which there is a possibility of reuse of water that would be available from recycling of sewage.

   1) Reuse for Agriculture purpose. e.g. gardening, agriculture etc.
   2) Reuse for commercial purpose. e.g. use for purposes other than drinking. e.g. vehicles washing garages, brick kilns, major constructions etc.
   3) Reuse for industrial purpose. e. g. factories, power projects etc. All ULBs should carry out study as above and should finalize the possible and feasible purposes of reuse of sewage available in the town for which it will be possible & feasible and should prepare a DPR, for recycling and reuse of sewage, with the help of expert consultants.

3. To help the ULBs in the issue of recycling and reuse of sewage and to prepare DPRs, the expert consultants will be identified and list of panel of such approved expert consultants is being published - 100 - separately. Also the model tender documents and model agreements will be prepared and circulated to all ULBs separately, for making the ULBs possible to take up the projects of recycling and reuse of sewage, under Private Participatory Project Principle.

4. Within first stage of "Maharashtra Suvarna Jayanti Nagaroththan Mahaabhiyan" of the state government, financial assistance is made applicable, for development of infrastructure facilities as per government approved standards or enhance in their standard, in the field of water supply, drainage and urban sanitation, and to take up pollution control and environment protection measures to improve environment of urban areas for all "D" category municipal corporations, towns of regional and district headquarters and the towns of second rank as far as population is concerned. Accordingly, while submitting the drainage projects for sanction during this *Mahaabhiyan*, proper measures should be proposed on the basis of prior study, so as to make available 20 % sewage for reuse after recycling.

5. While, attempts are being made by ULBs for recycling and reuse of minimum 20% of sewage as stated above, it is essential to have recycling and reuse of sewage water on the large residential/ commercial/ industrial projects in the cities vital. For this, regulations should be prepared and made applicable by all ULBs. In this context, for guidance, model regulations will be circulated by the Government to all ULBs separately.

   By order and in the name of Governor of Maharashtra.

Sd/-
(Manu Kumar Shrivastav)
Secretary, UDD

CHAPTER - V
DATA BASE

Agricultural Data
Yield of Crops

5.1. In the tariff proposal 2010-13 (Annexure 4.1), the following irrigated yields of various crops were adopted.

	Crop	Yield (Qtl/Ha)
	Kharif	
(i)	Cereals & Other Kharif	12
(ii)	Groundnut	18
(iii)	Vegetables, Onion	50
(iv)	Paddy	20
	Rabi	
(v)	Vegetables	50
(vi)	Wheat	20
(vii)	Other Rabi (Gram, Oilseeds)	15
	Two Seasonal	
(viii)	Chili, Ginger, Tur	15
(ix)	Cotton	20
	Hot Weather	
(x)	Vegetables	50
(xi)	Groundnut	25
(xii)	Paddy	25
	Perennial	
(xiii)	Sugarcane	800

5.2. A review of the above irrigated yields was done referring to the CWC report 'Water & Related Statistics' (Dec. 2010) where yearly irrigated yields of various crops of Maharashtra from 1999 to 2006 are given. Taking the maximum yield for each crop in any year, the values are presented below along with irrigated yield data from other sources like Mahatma Phule Agricultural University, Rahuri, Report of Commission for Agricultural Costs & Prices (CACP) titled 'Pricing Crisis in Cotton' of Oct. 2011, Dept. of Agriculture & Cooperation, Govt. of India's publication 'Agricultural Statistics at a Glance 2011'.

	Crop	Yield in Qtls/ha (CWC report)	Yield in Qtls/ha (other sources)
	Kharif		
(i)	Cereals & other kharif	12 (bajra)	
(ii)	Groundnut	17	
(iii)	Paddy	24	
	Rabi		
(iv)	Wheat	16	
(v)	Gram	7.4	25 to 30 (as per Agri. University, Rahuri)
	Two Seasonal		
(vi)	Cotton	3.1	5.1 for Punjab for 100% irrigation (CACP report)
(vii)	Tur	-	15-16 (as per Agri. University, Rahuri)
	Perennial		
(viii)	Sugarcane	900	790 (as per Dept. of Agri., GoI)

5.3. It is therefore proposed to adopt following yields for the tariff proposal (2013-16).

	Crop	Yield (Qtl/ha)
(i)	Cereals	12
(ii)	Groundnut	17
(iii)	Paddy	24
(iv)	Wheat	15
(v)	Gram, oilseeds	15
(vi)	Cotton	5
(vii)	Tur	15
(viii)	Sugarcane	800

5.4. For vegetables, data from the various Agricultural Universities in the State shows the following yields for different vegetables. However these yields are in controlled conditions.

	Vegetable	Yield (t/ha.)
(i)	Tomato	50 - 60
(ii)	Onion	15 - 20 in kharif 25 - 30 in rabi
(iii)	Brinjal	25 35
(iv)	Leafy	8

The yield earlier adopted for onion of 5 t/ha per season is being increased to 15 t/ha.

Minimum Support Price (MP)

5.5. In the tariff proposal for 2010-13, the MSP fixed by the Govt. of India for 2010-11 were considered. The support prices for 2011-12 have now become available and are as under

		Rs. /Qtl.
(i)	Kharif cereals (Jowar, Bajra)	1000
(ii)	Paddy	1110
(iii)	Tur	3200
(iv)	Wheat	1170
(v)	Oilseeds	2800
(vi)	Gram	2100
(vii)	Sugarcane	145
(viii)	Cotton	3300

5.6. For other crops where no MSP is fixed like vegetables, horticulture, the market prices at the time of formulating the tariff proposal as per rates of the Agriculture Produce Marketing Committee will be considered.

Irrigation data

5.7. In the tariff proposal for 2010-13 (para 4.1), the following data was presented on irrigation potential, ICA, irrigated and unirrigated area.

Figures in lakh ha

Year	Potential created	ICA (80% of potential)	Irrigated area	Unirrigated area
2008-09	44.86	35.88	27.32	8.56
2009-10	46.46	37.16	27.82	9.34
2010-11	48.21	38.56	28.32	10.24
2011-12	50.24	40.19	28.82	11.87
2012-13	52.84	42.27	29.32	12.85

The projection for 2010-11 to 2012-13 was done at 2 to 2.5 lakh per year for potential creation and 0.5 lakh ha for actual area irrigated.

5.8. For 2009-10 & 2010-11, the Irrigation Status reports have now become available and the data reported in these publications are as under

Figures in lakh ha

Year	Potential creation	Irrigation are
2009-10	46.34	25.43
2010-11	47.37	29.55

5.9. For the period 2013-16, it is therefore proposed to consider an annual increase of 1 lakh ha only in irrigation potential and 0.5 lakh ha in irrigated area over 2012-13 figures.

Volumetric Water Use
Agriculture

5.10. The volumetric use of water (by WUAs) by agriculture during 2008-09 and 2009-10 was as under
2008-09 1818.62 Mm^3 (11.8% of total)
2009-10 919.50 Mm^3 (7.4% of total)

5.11. The total water use for agriculture from 2010-13 in tariff proposal was projected as under
2010-11 18200 Mm^3
2011-12 18600 Mm^3
2012-13 19000 Mm^3

5.12. In the absence of 2010-11 data, for 2013-16, an increase of 400 Mm^3 per year over 2012-13 values is proposed in total use on the basis of earlier assumption and volumetric use will be similarly assumed as 10% of total use.

Domestic & Industry

5.13. The actual domestic water use for 2008-09 and 2009-10 were as under (as per tariff levied by 21 Irrigation Circles)

Figures in Mm^3

Sub category	2008-09	2009-10
Rural / GP	607.06	565.69
ULB (Municipality)	647.88	525.60
Municipal Corporation	2659.64	2953.21
Fishery & others	7.10	0.09
	3921.68	4044.59

5.14. The projected domestic water use for 2010-13 given in tariff proposal was
2010-11 4000 Mm^3
2011-12 4200 Mm^3
2012-13 4400 Mm^3

5.15. The actual industrial water use for 2008-09 and 2009-10 were as under

Figures in Mm^3

Sub category	2008-09	2009-10
Water use as raw material	3.88	4.15
Water use for process	715.48	866.60
Sugar factory, thermal	31.73	11.17
	750.99	881.92

5.16. In the tariff proposal for 2010-13, the industrial use was projected as under
2010-11 725 Mm^3
2011-12 750 Mm^3
2012-13 775 Mm^3

5.17. Circle-wise billing data is for both industrial & domestic use. Although appropriate rates are levied for each category of use, the actual levy shown under domestic or industry is a mixture of both levies. For 2013- 16, it is proposed to combine both uses under a category of nonirrigation use for projection purposes. The basic data to be used for this would be as under.

Year	Non-irrigation use (Mm^3)
2008-09	4672.67
2009-10	4926.41

as per actual use 2010-11 4725.00 2011-12 4950.00 as per tariff proposal 2012-13 5175.00 2010-13

5.18. After non irrigation projection for 2013-16 is done, as discussed in next Chapter, the domestic use would be taken as 85% of the projected non irrigation use and balance 15% for industry.

Establishment Costs

5.19. The actual establishment cost for irrigation management for 2008-09 & 2009-10 were as under

Year	Cost in Rs. Crores
2008-09	400.97
2009-10	544.81

5.20. The projected total establishment cost inclusive of Sixth Pay Commission component for 2010-13 as per tariff proposal 2010-13 was as under

Year	Cost in Rs. Crores
2010-01	555.10
2011-12	655.01
2012-13	772.91

5.21. It is proposed to keep 2010-11 as base year and consider 10% per year increase thereafter to estimate the likely establishment cost for 2013-16. This is against 20 to 25% increase projected earlier which seems to be at higher side. However, this has no impact on earlier tariff rates for 2010-13 as Pay Commission component was not considered at all.

CHAPTER - VI DATA PROJECTIONS FOR 2013-16

Irrigation Data

6.1. As stated in Para 5.7 of Chapter V, the increase in creation of irrigation potential will be assumed as 1 lakh ha per year and increase in irrigated area at 0.5 lakh ha per year both over 2012-13 figures. Accordingly the projected figures will be

in lakh ha.

Year	Potential created	ICA (80% of potential)	Irrigated area	Unirri-gated area
2013-14	53.84	43.07	29.82	13.25
2014-15	54.84	43.87	30.32	13.55
2015-16	55.84	44.67	30.82	13.85

6.2. The revised M&R norms of WALMI (as per Para 3.11 of Chapter III) will be applied on the projected data for 2014-15 to arrive at total M&R requirement.

Establishment Costs

6.3. As discussed in Para 5.19 of Chapter V, the projections of total establishment cost will be done at 10% increase per year over 2010-11 data (Rs. 551.10 crores). The figures would accordingly be

Year	Total Establishment cost (Rs. Crores)
2010-11	555.10
2011-12	610.61
2012-13	671.67
2013-14	738.83
2014-15	812.72
2015-16	894.00

6.4. *M&R Costs*

As discussed in para 3.12 of Chapter III 'Operation & Maintenance Cost of Irrigation Management', the projections of M&R cost for the mid year of the new control period 2013-16, i.e., 2014-15 will be a 10% increase over the M&R norms adopted for 2010-13.

Water Use

Non-irrigation

6.5. 6.5. The data at Para 5.15 of Chapter V of total water use has been plotted at **Graph 6.1** and the projections for the new control period 2013-16 of total non irrigation water use are as under

Year	Total Non-irrigation water use (Mm^3)	Rounding off to nearest of 1000 Mm^3
2013-14	5175	5200
2014-15	5275	5300
2015-16	5360	5400

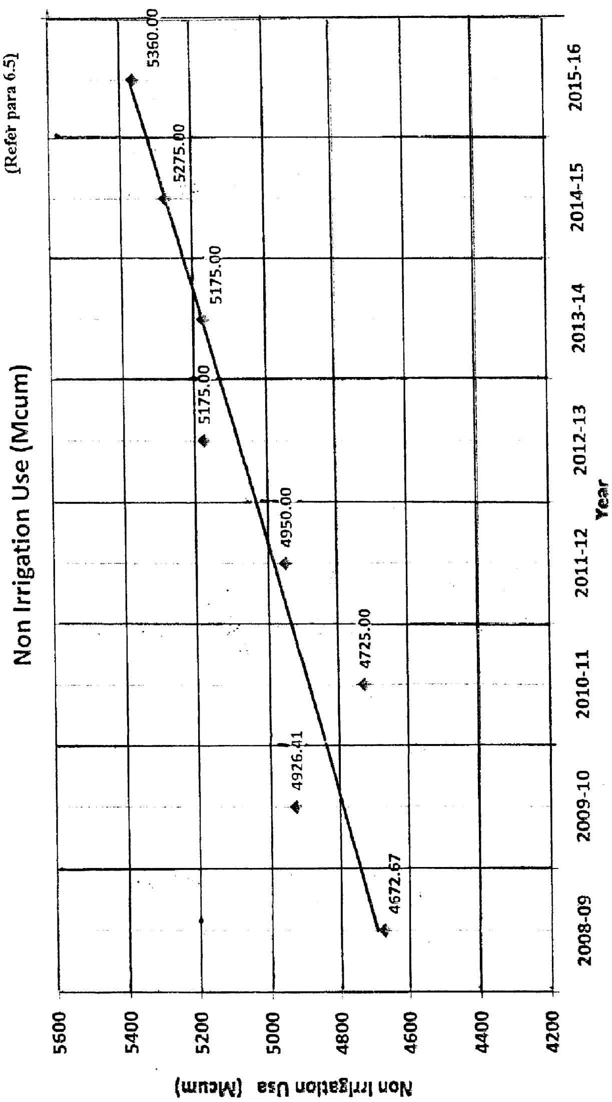
The mid-value of 2014-15 would be considered for tariff purposes with 85% of this as domestic use (4500 Mm^3) and 15% as industrial use (800 Mm^3)

Irrigation

6.6. As stated in Para 5.10 of Chapter V, the total irrigation use and volumetric use projections for the control period 2013-16 are as under

Year	Total irrigation use (Mm^3)	Volumetric use at 10% Mm^3
2013-14	19400	1940
2014-15	19800	1980
2015-16	20200	2020

Graph 6.1
(Refer para 6.5)



CHAPTER - VII
PROPOSED METHODOLOGY FOR WORKING OUT BULK WATER TARIFF (2013-16)

7.1. As per the MWRRA Act, bulk water tariffs in the State are required to recover only the full cost of irrigation management, administration, operation and maintenance of water resources project. Thus tariff cannot recover even a part of the capital cost or the cost of any environmental damage. The users are, however, not absolved from the responsibility of ensuring efficient use of water and discharging, after use, water of a prescribed quality. These objectives are to be enforced through a system of penalties and incentives in the tariff structure.

7.2. In the CBWT (2010-13), the allocation of O&M cost was done considering three parameters viz. Affordability, Accessibility and Quantity & Timeliness. A matrix was constructed by allocating weightages to each of these parameters representing the relative importance of each of these to the three bulk user categories viz. agriculture, domestic and industry. Further, since the main concern of stake holders is ability of farmers to pay and agriculture being the largest user of water, affordability was ascribed a value of 0.6 on a scale of 1 followed by accessibility and quantity, timeliness with 0.2 each.

7.3. Before discussing the actual matrix developed earlier, a brief discussion for sake of recapitulation is made on the three identified parameters and the basis for the weights assigned.

Affordability: as distinct from willingness to pay, affordability is related to consumer's ability to pay. Willingness to pay includes coping costs and is the upper limit of tariff. As per Organisation for Economic Cooperation and Development (OECD) literature, rule of thumb for affordable water service expenditure for households is 3 to 5% of disposable incomes. However, while this could apply directly to domestic water at the retail level, it can be applied only indirectly to agriculture and industry where water is an input to an economic activity. Further, as an input cost, water charge is substantially a higher component of total cost in agriculture than in industry. In agriculture, various Committees in the past have recommended that water tariff should not be more than 3 to 5% of the gross value of produce in case of cereal crops and 8 to 10% in the case of cash crops. For industry, water charges for most industries are less than 1% of the production cost. Keeping these in view, the allocation of weight to affordability was taken as highest for industry (Rs. 75 out of Rs. 100 allocable O&M cost) followed by agriculture Rs. 15 and drinking water Rs. 10.

Accessibility: Like affordability, accessibility is a significant factor which directly impacts pricing. Accessibility is defined here as 'reach' rather than mere availability, or in other words 'ease of access' rather than 'access' itself. Domestic use for drinking is accessed from the storage or distribution canal by lift, transported by pipes and stored in tanks of various sizes. All these costs are borne by the water use entity. The weightage for accessibility for domestic use has to therefore very low. For agriculture, the canal system is already constructed by the State. Unlike domestic use, distances are not great and distribution is among a smaller number of users. Hence weightage for accessibility for agriculture have to be higher than for domestic use. Unlike agriculture & domestic, industry has a choice of selecting location prior to the unit being set up. Industrial estates, SEZs, MIDC establish locations only after a dam come up and water allocation is assured. Hence these parameters will carry a higher weightage for industry. According the allocation of Rs. 100 O&M cost from accessibility consideration was decided as Rs. 45 for industry, Rs. 30 for agriculture and Rs. 25 for domestic.

Quantity & Timeliness: Despite being offshoots of accessibility, these three parameters affect the three categories of users differently. For domestic use, once quantity is decided based on per capita norms, upto this level quantity is important as it is required for survival. However, timeliness in supply is ensured by on-line storages created by the entity. Hence, upto saturation level, domestic use carries lowest weightage. For agriculture, volume is vital but compared to domestic use, it is less acute as irrigation is support to rain water and ground water. Irrigation does not have on-line storages but some time delay in supplies does not affect yields significantly. However, required supplies of right quantity and at the right time will ensure dual cropping, cash cropping and adoption of modern agricultural practices. For industry, both quantity & timeliness are important. All manufacturing processes require water in some form and no industry can survive without this minimum quantity. For industries using water as raw material, quantity at all time will carry a greater weightage. Timeliness is however less importance as industries do have storages or can resort to tanker supplies. Considering quantity and timeliness together, the lowest weightage is for domestic, followed by agriculture and industry. Hence the allocation of Rs. 100 O&M cost was taken as Rs. 45 for industry, Rs. 30 for agriculture and Rs. 25 for domestic.

7.4. Based on the above arguments, the allocable O&M cost of Rs. 100 for each of the three parameters was distributed as under to the three categories of users

Parameter	Agri-culture	Domestic	Industry	Total
Affordability	15	10	75	100
Accessibility	30	25	45	100
Quantity & Timeliness	30	25	45	100

The allocation of O&M with a weightage of 0.6 to affordability and 0.2 each to the other two parameters gave the allocation matrix as under

Parameter	Agriculture	Domestic	Industry
Affordability	15 x 0.6 = 9	10 x 0.6 = 6	75 x 0.6 = 45
Accessibility	30 x 0.2 = 6	25 x 0.2 = 5	45 x 0.2 = 9
Quantity & Timeliness	30 x 0.2 = 6	25 x 0.2 = 5	45 x 0.2 = 9
Total	21	16	63

Thus, the last tariff rates were fixed considering allocation of total O&M cost as 63% to industry, 16% to domestic and 21% to agriculture. Since agriculture included canal flow areas and ground water areas and since ground water was made free of tariff by State govt., the tariff for canal flow was fixed as 16% of O&M cost with 5% being State government subsidy for loss in revenue from ground water use.

Review of Matrix for CBWT 2013-16

7.5. The only suggestion received was that the methodology adopted of assigning weights was subjective and weights could be arbitrarily changed by planners. Hence the Gross State Domestic Produce (GSDP) method was suggested implying that the contribution of each category of use to

GSDP should form the basis. While it cannot be denied that a matrix allocating weightages of this type cannot altogether eliminate the subjective element, the Authority had gone substantially by the views expressed by stakeholders in the public hearings during the earlier tariff exercise. As regards arbitrary changing of weights by Govt./Planner, it is clarified that once the Criteria is determined by the Authority following the procedure laid down in Section 11 (d) of the Act, it becomes final and binding and only the Authority can review the Criteria for the subsequent tariff exercise.

7.6. On a study of the GSDP of the State for 2010-11 (reference Economic Survey of Maharashtra), it is seen that the contributors to the GSDP of Rs. 9,01,330 crores are agriculture and allied activities (10.69%), industry (30.42%) and service sector comprising railways, transport, communications, trade, hotels, banking, insurance, public administration etc. (58.89%). Perhaps the suggestions has been made keeping in view the contribution to GSDP by agriculture is only 10.69% and hence the O&M cost allocation should also be accordingly done.

7.7. Considering GSDP for O&M cost allocation throws up following issues

- (i) GSDP considers all capital costs (cost of dams etc.) which are not to be considered in O&M
- (ii) Domestic water does not contribute to GSDP as it is a social need (life saving) and it follows that it will have to be fully subsidized by State Govt.
- (iii) Service sector, although contributing nearly 60% to GSDP is not a direct bulk consumer except that water use by commercial establishments is treated as industrial use in tariff.

It therefore follows that while agriculture & industry would get substantial tariff relief, the State government subsidy would be nearly 60%. This vitiates the spirit of Section 11 (d).

7.8. This leads to the conclusion that the basic approach decided earlier for allocation of O&M cost still holds water. A number of suggestions were received in the earlier tariff exercise from experts / NGOs and these are worth going over again for the new exercise.

7.9. *(i) Shri Y.R. Jadhav (former Special Invitee to the Authority)*

Agriculture should get lower weightage both for accessibility and quantity & timeliness compared to other two users (20 instead of 30) as agriculture does not get timely and sufficient water. The weights for domestic and industry can be increased to 30 & 50 respectively accordingly.

(ii) SOPPECOM

While the fundamental parameters are agreeable, quality could be added. Farmers are unorganized with no control over market prices. Hence affordability should be on par with drinking (10 each and 80 for industry). Similarly, agriculture depends on earthen channels and subject to theft & losses. Hence accessibility should be 20-20-60 for agriculture, domestic & industry instead of 30-25-45. In quantity & timeliness, agriculture gets water at lower dependability and hence weightage of 25-25-50 would be appropriate instead of 30-25-45 for agriculture, domestic, industry.

(iii) Dr. R.P. Kurulkar

Agriculture should be allocated only 13% considering rate of growth of the sector is less than 4%, low productivity, low per capita income. Considering commercial component in domestic, it can bear 22% of O&M cost.

(iv) Shri R.T. Pokharkar

Allocation for agriculture of O&M cost should be 13% to 15%.

Review of Matrix

7.10. While assigning of weights for Accessibility and Quantity & Timeliness does not call for a review, weights assigned for affordability have been reviewed from the following considerations

(i) 44% of the farmers in the State are marginal farmers having less than 1 ha holding. The small holding size precludes them from going in for higher income cash crops and are thus forced into lower productivity and lower agricultural income (from cereal crops) even after irrigation is made available. The incremental income is not substantial.

(ii) if affordable domestic water is 3 to 5% of disposable income, water charges for cereal crops are also recommended in the earlier Criteria for 2010-13 as 3 to 5% of gross value of produce. Therefore there is a case for narrowing down the disparity in weights assigned to agriculture (15) and domestic (10).

7.11. It is therefore proposed to revise the assignment of weights for Affordability as Agriculture 12, domestic 10 and industry 78. With this revision, the revised allocation matrix will now be Parameter

Parameter	Agriculture	Domestic	Industry
Affordability	12 x 0.6 = 7.2	10 x 0.6 = 6	78 x 0.6 = 46.8
Accessibility	30 x 0.2 = 6	25 x 0.2 = 5	45 x 0.2 = 9
Q & T	30 x 0.2 = 6	25 x 0.2 = 5	45 x 0.2 = 9
Total	19.2	16	64.8
Say	19	16	65

7.12. With 5% subsidy for ground water, the actual allocation of O&M cost to canal users will be 14% (19 - 5) against earlier value of 16%.

Proposed Methodology for fixing of Tariff Non-irrigation

7.13. The methodology earlier discussed in Section 14 of CBWT (2010-13) will undergo a slight change as discussed below (i) for domestic and industrial bulk user entities, the basic volumetric rate will be worked out applying percent cost allocable (16% to domestic and 65% to industry) to the volume of water estimated to be used in 2014-15, i.e., middle year of the 3 year Control Period 2013-16. (ii) Detailed tariff to be estimated for sub categories of users viz. GP, Nagar Parishads & Municipalities in Domestic and process industries (non-polluting and polluting separately) and industries using water as raw material (beverages), depending on source of supply, as already discussed in Chapter IV. (iii) Total revenue realized will be estimated for each category of use and if it is more or less than the O&M cost allocation, the basic rate will be revised downwards or upwards till revenue realized matches with the allocation. (iv) Due to concessions and penalties, there would be loss or gains in revenue to the State govt. At tariff fixing stage, it will be very difficult to assess this realistically. Hence the basic rate will be fixed for matching revenue realized with O&M allocation. Shortfall in revenue due to availing of concessions for water saving will be reckoned as State government subsidy for promoting water use efficiency. In any case, the State government will no doubt earn additional revenue by allocation of saved water to other new users.

7.14. It is hypothetically possible that the revenue earnings in a category of use are more than the allocation due to higher water drawal than estimated or due to realization of penalties which are more than loss in revenue due to concessions. However, it needs to be kept in view that the tariff cycle is 3 years and the total picture from all categories of users needs to be considered, including collection efficiency before jumping to any conclusion that the tariff fixed is higher or lesser than required.

Agriculture

7.15. The principle to be adopted for area based tariff for various crops for agriculture would be the same as in CBWT (2010-13), *viz.*, tariff should not exceed 3 to 5% of the gross value of produce in case of food crops and 8 to 10% of the gross value in case of sugarcane, banana an horticulture. This basic rate will be for rabi. Where the crop nomenclature is same in hot weather or kharif as in rabi, the rate will be 150% or 50% of the rabi crop rate. This norm will be applied also to fix seasonal rates for perennial crops. However, if extended rabi watering is taken for a kharif crop or extended hot weather, watering is taken for a rabi crop, the rates will not be charged to the disadvantage of the farmer. This means that if for a kharif crop, 2 waterings are taken in kharif and 1 in rabi, the area rate for the crop will be charged only at the relevant kharif rate. This clarification was not given in CBWT 2010-13 and was raised by some stakeholders during the capacity building workshops convened by the Authority & WALMI prior to the Entitlement season.

7.16. WRD have suggested that while the norm of 50% of rabi basic rate in kharif and 150% in hot weather could be adopted for volumetric tariff, for area tariff, the hot weather rate should be increased to 200% from 150%. This needs discussion.

7.17. For calculating gross value of produce, the Minimum Support Price for each crop, as fixed by GoI based on the recommendations of the Committee on Agricultural Costs & Prices, for the latest year available will be considered.

7.18. The methodology for calculating volumetric tariff for WUAs at minor level, given in Annex 1 of CBWT 2010-13 has been reviewed. The earlier approach was to work out volumetric rate considering the area rates and volume of water. Suggestions were received that the calculation can be simplified and made easier to understand by reallocating the O&M cost allocation to canal flow between the area users and volumetric users. Since the volumetric supply data is available for each year, the calculation methodology has been revised and is now given in **Annexure 7.1.**

7.19. Since upper level associations (PLA, CLA, DLA) have not been formed in most projects, the maintenance of the system above the minor would continue to vest with the WRD. Budget grants are being provided to WRD for this purpose. The water charges received from WUAs would be returned to them for maintaining the system below the minor, as per norms fixed from time to time by the State government. As and when upper level associations are formed, they would receive budget grants from the State government for system maintenance.

7.20. Since the method of calculating area based tariff for each crop is not linked to O&M cost allocation, unlike in non-irrigation, the total revenue realized after the tariff for each crop is decided has to be estimated based on irrigated area and cropping pattern in the State. This has to match with the O&M allocation made to canal flow areas after excluding the allocation to volumetric areas. In this assessment, the concessions linked to holding size have to be considered as they involve a sizable revenue loss. If the revenue realized is more, then it calls for downward revision in the tariff. Similarly, if the revenue realized is less, then it calls for upward revision in the tariff, subject to the ceilings adopted linking tariff to gross value of produce.

Annexure 7.1
(Refer Para 7.18)

Methodology for Working Out Volumetric Rate for Agriculture for Minor Level WUA

(Calculations to be done with 2014-15 projected data)

1. Assumption - Since system rehabilitation in most projects under Maharashtra Water Sector Improvement Project (MWSIP) will be completed by 2014-15, an overall efficiency of 0.48 is adopted with efficiency of 0.64 upto minor.

2. Let O&M cost allocation to canal irrigation be C

3. Let total volumetric drawal by irrigation be V_1

4. Let total volumetric drawal by minor canal WUAs be V2 (at minor head)

5. Volumetric drawal by WUAs at canal head.

$$= \frac{V_2}{0.64} = V_3$$

6. O&M cost allocable to WUAs

$$= C \times \frac{V_3}{V_1} = C_1$$

7. Unit rate of volumetric supply to WUA

$$= \frac{C_1}{V_3}$$

Note : A concession of 25% in above rate will be considered, if required.

8. This will be rate in rabi. Volumetric rate in kharif is proposed as 50% of this rate and rate in hot weather will be 150%. This actual range will be finalised after discussion.

ECONOMICS OF IRRIGATION IN WATER-SCARCE REGIONS: STUDY OF MAHARASHTRA

N. Rath A.K. Mitra

CHAPTER I
The Problem

1.1Irrigation is crucial to the development of agriculture in India. It is necessary in order to ensure stability in crop production and fuller exploitation of cultivable land in all seasons. It is also necessary in order to derive and sustain benefits from biological improvements in crops, and technological improvements in cropping.

1.2However, available estimates of potential total water resource for India as a whole show that it is in short supply compared to the requirements for irrigation[1] In 1980-81, 49.585 m/ha of crop land, constituting only about 28 per cent of the total crop land (28.61 per cent of the gross cropped area, and 27.66 per cent of the net cropped area) in India was irrigated. The ultimate irrigation potential from all sources, surface and underground, is estimated, in the Seventh Five Year Plan document, to be 113.5 m/ha of gross cropped area. Assuming the 1980-81 intensity of irrigation, this implies that nearly 60.6 per cent of the gross cropped area, or about 63.3 per cent of the net cropped area in the country, can ever be irrigated. (Ref. Table 1.1)

1.3While the all-India figure highlights the overall inadequacy of water for irrigation, the regional picture shows wide differences in this regard. The state-wise data, in Table 1.1, show that in the states of Assam, West Bengal, Bihar, U.P., Haryana and Punjab, covering the Brahmaputra valley and the Indo-Gangetic plains, all the net sown area (or almost all of it) can ultimately be provided with irrigation. On the other hand, in the states of Rajasthan, Gujarat, Maharashtra and Karnataka the ultimate potential net irrigated area is expected to be between 25 and 40 per cent of total net sown area and between 30 and 40 per cent of gross cropped area, presuming the existing intensity of cropping on irrigated land. This percentage is only marginally higher for Madhya Pradesh, around 50 per cent. The states of Tamil Nadu, Andhra Pradesh and Orissa show a still higher percentage, between 60 and 70 per cent. But if the coastal plains of these three states, including the large river deltas, are separated, because of near 100 per cent ultimate irrigation potentiality there (the data are not separately available), then the remaining areas of these states lying in the upland plateau region, would also show percentages similar to those of Karnataka, Maharashtra and Gujarat. The entire plateau region (including the arid regions of Rajasthan) is characterised by rather low and uncertain rainfall and poorer and more uncertain underground sources of water. In fact, between 40 and 45 per cent of the ultimate irrigation potential in these regions is expected to be from minor irrigation sources, mainly from underground, which are known to be more uncertain, and often with poor discharge capacity. The long term perspective of agricultural development in these regions, therefore, acquires a different and more serious dimension. It is obvious that the use of water in these regions has to be most economical if agriculture is to develop and sustain the vast multitudes dependent on it.

Extract from Artha Vijnana March 1989 V 31 N 1, Pp. 1-129.

1.4The position and potentiality of irrigation in the State of Maharashtra well illustrates the problem. In Table 1.2 are given data about the present (i.e., 1982) position of irrigation and the ultimate potential from all state-sector sources of flow irrigation (major, medium and minor), districtwise[2] The percentage figures in the last column show that except the eastern most districts of Bhandara and Chandrapur (including Gadchiroli) and Nagpur, the coastal districts, and the district of Kolhapur, only about 40 per cent or less of the net sown area in the other districts can ever be irrigated. The percentage is 30 or less in six of the nine districts of western Maharashtra in four of the five districts of Marathwada, and in the three western-most districts of the Vidarbha region.

1.5The ultimate irrigation potential in Table 1.1 and 1.2 is calculated on the basis of existing pattern of use of water for different crops, and the existing intensities of irrigation. Therefore, expressed in terms of net or gross cropped area, the figures cannot say anything clearly about the comparable availability of water for irrigation in the different districts. To make such a comparable statement, the Irrigation Department of the State Government has expressed the ultimate irrigation potential in every district in terms of "Rabi Jowar equivalent". It means the number of hectares of Rabi Jowar that can be ultimately irrigated with the quantity of water that is likely to be available in the district from the various flow irrigation sources in the State sector. These data are presented in Table 1.3, Col. 4, and they are expressed as percentage of net sown area of the district in Col. 6. The data show that if irrigation is provided to only a crop of Rabi Jowar, then the water ultimately available will suffice to irrigate 64 per cent of the net sown area of the State. This underlines the gross inadequacy of water for irrigation in the State as a whole. There are eleven districts-five in Western Maharashtra, three in Marathwada, and three in Western Vidarbha - for which this percentage is lower than the State average; in many of these cases it is as low as 30 per cent or less. Since Rabi Jowar requires less irrigation water than other crops, these agricultural regions of Western Maharashtra and Marathwada, and the three western-most districts of Vidarbha, in particular.

1.6From the point of view of the social economy, irrigation water is the factor in shortest supply, shorter than land, in the agriculture of most parts of the State, particularly those located in the relatively low rainfall regions that are also drought prone. Under such factor supply situation, elementary economic logic as well as common sense suggest that maximisation of returns from agriculture would imply maximisation of return per unit of the factor in relatively short supply. In this case it should mean maximisation of net return per hectaremeter of irrigation water, and not per hectare of irrigated land. The Irrigation Commission (1972) has also acknowledged this logic in regard to the relatively water-short regions. It says:

> "In areas other than those with ample water resources, ... our policy should aim at securing the maximum crop production per unit of water.[3]

Table 1.1. Present (1980-81) and Ultimate Potential (Major and Minor Sources) Irrigated Area (Gross and Net) As Percentages of Gross and Net Sown Area

State	1980-81		Ultimate Potential	
	Net Irrig. Area as % of Net Sown area	Gross Irr- ig. Area % of Gross cropped area	Net Irri. area as % of Net sown area	Gross Irrig. Area as % of Gross cropped area
(1)	(2)	(3)	(4)	(5)
Andhra Pradesh	32.24	35.36	68.31	69.35
Assam	21.54	16.60	100.00*	77.48
Bihar	35.51	32.58	100.00*	100.00*
Gujarat	20.92	21.82	42.56	43.03
Haryana	59.24	60.58	81.45	77.08
Himachal Pradesh	16.08	16.49	34.62	32.88
Jammu & Kashmir	42.52	40.25	86.43	74.91
Karnataka	13.75	15.72	37.88	41.09
Kerala	10.92	13.31	60.18	59.88
Madhya Pradesh	12.47	11.46	51.85	46.82
Maharashtra	10.53	12.41	30.55	34.12
Orissa	19.82	19.56	68.35	59.24
Punjab	80.70	85.48	91.43	92.49
Rajasthan	19.54	21.61	26.84	29.20
Tamil Nadu	47.95	50.92	56.77	59.07
Uttar Pradesh	54.89	46.27	100.00*	95.22
West Bengal	26.76	20.22	100.00*	78.60
India	27.66	28.61	63.23	60.62

* indicates that the percentage is more than 100.
Source: Data Relating to 1980-81 are taken from *Indian Agriculture in Brief, 20th edition,* (New Delhi: Ministry of Agriculture and Rural Development), Table 2.6, and the Ultimate Potential data are taken from Seventh Five Year Plan, 1985-90, Vol.II. (Footnote: See next page) Annexures 3-2 and 3-6.

Footnote to Table 1.1

Method of calculation of Ultimate potential Percentages: The Method of calculation for every State is along the lines illustrated for all India in the following:
present (1980-81) and Ultimate Potential Irrigated area (gross and net), as proportion of the estimated total crop area (gross and net) in India.

1.	Gross Cropped Area	(1980-81) 173.324 (M/ha)
2.	Net cropped Area	(1980-81) 140.270 (M/ha)
3.	Gross Irrigated Area	(1980-81) 49.585 (M/ha)
4.	Net Irrigated Area	38.805 (M/ha)
5.	(3) as per cent of (1)	28.61 %
6.	(4) as per cent of (2)	27.66 %
7.	(4) as per cent of (3)	78.26 %
8.	Ultimate Potential Irrigated Area (gross)	113.5 (M/ha)
9.	(8) minus (3)	63.915 (M/ha)
10.	Net irrigated area out of the additional gross irrigated area (9) x (7)	50.020 (M/ha)
11.	Ultimate potential net irrigated area : (4) plus (10)	80.825 (M/ha)
12.	Ultimate potential gross cropped area (1) plus [(9) minus (10)]	187.219 (M/ha)
13.	Potential gross Irrigated area as per cent of total gross cropped area	60.6 %
14.	Potential net Irrigated area as per cent of total net cropped area	63.23%

Note: In estimating potential net and gross cropped area as well as net irrigated area, the existing, i.e., 1980-81 relations of these have been used to estimate the future potential. If a greater intensity of cropping on irrigated land is visualised for the future, the percentage in rows 13 and 14 would be smaller than what is estimated in the table.

Table 1.2. Present (1982) and Additional Potential Irrigated Cropped Area in Maharashtra from State Sector Surface Irrigation Sources

(Area: in '000 ha.)

	District	Irrigation Potential Created (Upto June 1982)	Additional Potential Irrigated crop Area	Total (2+3)	Total irrigated Area as % of Net Sown Area (1978-79)
	(1)	(2)	(3)	(4)	(5)
1.	Greater Bombay	-	-	-	-
2.	Thane	8.39	129.83	138.22	52.14
3.	Raigarh	23.32	138.21	161.53	82.5
4.	Ratnagiri	4.70	139.97	144.67	40.6
	KONKAN	**36.41**	**408.01**	**442.42**	**54.38**
5.	Nashik	113.36	68.23	181.59	20.41
6.	Dhule	64.55	51.47	116.02	16.46
7.	Jalgaon	106.31	232.97	339.28	41.86
8.	Ahmednagar	206.56	126.08	332.64	27.38
9.	Pune	133.86	77.1	210.96	21.07
10.	Satara	97.63	127.77	225.4	38.47
11.	Sangli	75.41	115.48	190.89	30.98
12.	Solapur	142.61	156.03	298.64	26.26
13.	Kolhapur	59.53	192.83	252.36	59.56
	WESTERN MAHARASHTRA	**999.82**	**1147.96**	**2147.78**	**29.09**
14.	Aurangabad	101.69	143.23	244.92	20.17
15.	Parbhani	135.01	150.52	285.53	28.35
16.	Seed	73.23	139.75	212.98	26.31
17.	Nanded	87.56	205.87	293.43	40.31
18.	Osmanabad	69.96	88.51	158.47	14.21
	MARATHWADA	**464.45**	**727.88**	**1192.33**	**24.46**
19.	Buldhana	32.77	65.95	98.72	14.48
20.	Ako]a	43.41	40.25	83.66	10.19
21.	Amravati	14.25	119.76	144.01	19.92
22.	Yavatmal	40.88	291.22	332.1	38.86
23.	Wardha	27.62	155.54	183.16	41.44
24.	Nagpur	68.11	261.52	329.63	58.29
25.	Bhandara	132.56	325.90	458.46	118.06
26.	Chandrapur	79.39	462.13	451.52	78.39
	VIDARBHA	**438.94**	**1722.27**	**21611.2**	**41.83**
	MAHARASHTRRA	**1939.62**	**4006.11**	**5945.74**	**32.59**

Source: Col.2 from Table 7.4; Col.3 calculated on the basis of in Tables 7.4 (Col.2), 7.5 (Col.2) and 7.7 (Cols. 3 & 4); Col.5 is Col.4 expressed as a percentage of data in Col.5 of Table 7.3 of the Report of the *Fact finding committee on* Regional Imbalance in Maharashtra, April, 1984. (Bombay: Department of Planning, Government of Maharashtra)

Table 1.3. Present (1982) and Additional Potential Irrigated Area in Terms of Rabi (Jowar) Equivalent.

(Area: in ’000 ha)

		District	Irrigation Potential under construction and future	Upto June 1982	Total	Net Sown Area (1978-79)
	(1)	(2)	(3)	(4)	(5)	(6)
1.	Greater Bombay				6.60	
2.	Thane	251.52	16.90	278.42	265.10	105.40
3.	Raigarh	283.60	47.85	331.45	195.80	169.28
4.	Ratnagiri	252.24	8.47	260.71	356.30	73.17
	KONKAN	**797.36**	**73.22**	**870.58**	**817.20**	**106.53**
5.	Nashik	113.11	187.93	301.04	889.60	33.84
6.	Dhule	94.21	118.15	212.36	705.00	30.12
7.	Jalgaon	481.55	219.74	701.29	810.50	86.53
8.	Ahmednagar	256.65	420.48	677.13	1214.90	55.74
9.	Pune	165.49	287.34	452.83	1001.00	45.24
10.	Satara	277.05	211.74	488.79	585.90	83.43
11.	Sangli	299.76	195.75	495.51	616.10	80.43
12.	Solapur	345.92	316.17	662.09	1137.40	58.21
13.	Kolhapur	798.28	246.44	1044.72	423.70	246.57
	WESTERN MAHARASHTRA	**2837.79**	**2203.74**	**5041.53**	**3784.10**	**68.28**
14.	Aurangabad	258.89	183.81	442.70	1214.00	36.47
15.	Parbhani	376.35	337.57	713.92	1007.30	70.87
16.	Beed	237.07	124.23	361.30	809.50	44.63
17.	Nanded	424.43	180.52	604.95	727.90	83.11
18.	Osmanabad	144.32	109.18	253.50	1115.00	22.74
	MARATHWADA	**1441.06**	**935.31**	**2376.37**	**4873.70**	**48.75**
19.	Buldhana	130.68	64.93	195.61	681.90	28.69
20.	Akola	80.94	87.30	168.24	820.70	20.50
21.	Amravati	202.38	24.08	226.46	722.90	31.33
22.	Yavatmal	601.82	84.48	686.30	854.60	80.31
23.	Wardha	307.20	54.55	361.75	442.00	81.84
24.	Nagpur	402.21	104.75	509.96	565.50	90.18
25.	Bhandara	420.36	170.98	591.34	388.30	152.29
26.	Chandrapur	547.34	93.97	641.311	690.80	92.84
	VIDARBHA	**2713.90**	**684.74**	**3398.64**	**5166.70**	**65.78**
	MAHARASHTRA	**7790.11**	**3897.01**	**11687.70**	**182411.70**	**64.07**

Source : Tables 7.5 and 7.6 (Table 7.4 for Col.5) of the *Report of the Fact Finding Committee on Regional Imbalance in Maharashtra.*

1.7This logic, of course, holds for individual farms as well as for the society as a whole. If an individual farmer, is faced with a total quantum of water which is relatively short of what the total irrigable land at his disposal would require, then he must try to maximise returns per unit of water. If sometime one finds farmers behaving in a manner that can be interpreted to suggest as if they are trying to maximise return per hectare of irrigated land, it is most likely that they are individually faced with availability of more water than irrigable land, (possibly because of state policy in regard to supply of canal water), despite the overall regional shortage of water for irrigation.[4]

1.8The pattern of canal irrigation that has developed in these relatively dry regions of

Western Maharashtra over the last century has been quite different from that in many other parts of the country. In the first place, the culturable command area (C.C.A.) under a medium or major flow irrigation project is much larger than the area that is planned to be provided with irrigation water in any year, called the irrigable command area (I.C.A.) The I.C.A. is smaller for two main reasons: (i) The inadequacy of the quantity of water available in the reservoir, at 75 per cent dependability, and (ii) the pattern of cropping under irrigation envisaged. Most of the flow irrigation projects were conceived essentially as protective irrigation projects, in view of low and uncertain rainfall in the region. It was, however, found early that the feasible cropping pattern under irrigation would not be able to generate enough income and water revenue to make these projects financially viable. The cropping pattern depended on the prevailing crops and culturable practices and the firm possibilities about it including normally expected yields in years of normal rainfall, the prices of various crops, the changes in land lay out and slope necessary for the purpose, the possibility of raising necessary capital resources, and the worthwhileness of all these. Originally, these systems were designed to irrigate the seasonal crops, like jowar, bajra, cotton, etc., generally grown under rainfed conditions, in order to protect them from impact of adverse rainfall. The earliest canal system of the region was the Nira Canal System. The experience in this and the later canal systems in the region was that farmers made poor use of irrigation water except in years of drought. The reason, as M. Viswesvaraya pointed out at that time, was that while these seasonal crops yielded more under irrigated condition, their costs of production under irrigation were also proportionately higher, leaving no more farm business income than under unirrigated condition in a year of normal rainfall.[5] Because of this disincentive, feature the sugarcane "block" system, with assurance of water to a block of land for six years at a time, was introduced to persuade the farmers to use irrigation water, since this was the only important crop that could not be grown without irrigation, and was profitable. Entrepreneurs were encouraged to start sugar factories so that the farmers feel encouraged to cultivate sugarcane. This stress on sugarcane in the irrigable command areas of irrigation projects resulted in further shrinking of the originally planned I.C.A.

1.9There is reason to believe that the underlying agronomic and economic conditions have undergone change in recent years, particularly the last two decades. New crops, new varieties of seeds of the traditional crops, new agronomic practices as well as different market conditions have emerged. This holds out greater possibility of more economic use of water in farming. If the current sugarcane-centred pattern of use of canal water needs to be changed on such grounds, the question of sugarcane cultivation may be examined with the help of well-irrigation in the command areas, where wells can recycle the inevitably seeping canal water. Indeed, the Maharashtra Irrigation Commission, reporting in 1962, that is, even before the new seeds and crops had been introduced, had stressed this as a policy change, in the interest of wider use of canal water in the essentially drought prone regions of the State.[6]

1.10 Examination of this whole problem requires enquiry into a set of related questions. It is first of all necessary to ascertain the quantity of canal water required and actually used to irrigate individual crops in each of the three seasons. Given this information, it would be possible to examine the types of crops and cropping pattern that would give the best return to society per unit of irrigation water. This requires examination of the levels of physical inputs and outputs of every one of the crops under irrigation, and their valuation at comparable prices. It also requires examination of crop rotations and combinations at the farm level, from the agronomic and economic angles. The exercise has to be based on data not relating to a single year but to a number of years, in order to take account of variations in weather, yields, and prices. Estimates will have to be made taking into account different degrees of risk associated with these elements of farm business.

1.11 If wider coverage of irrigation water, than currently in vogue, is indicated by these exercises, then the additional costs of construction of these channels as well the greater losses of water through seepage have to be taken into account in estimating the final social benefits and costs. These are basically engineering problems.

1.12 This examination will be essentially in terms of the current rates of use of water by farmers for different crops and the current manner of supply of canal water by the irrigation authority. It is, however, possible to think of different rates of use of irrigation water by different crops in the region, aided by a different design and schedule of water distribution. This may lead to greater economy in the use of water and, therefore, further expansion of the irrigable area.

1.13 The purpose of the present study is to examine mainly the first set of questions relating to the most economic utilization of irrigation water in the region. The related question of additional capital cost and cost due to seepage of water involved in drawing the distribution channels longer to cover wider areas, is essentially an engineering problem. We propose to use some study by other agencies to illustrate the problem. The last set of questions arising out of different methods of distribution of water can at present be mainly of a speculative character in the absence of solid ground level experience. We shall refer to these problems at the end, only in a general way.

1.14 It is proposed to examine the pattern of use of irrigation water and the economic alternatives, in the context of two well-established canal systems in this drought prone region, essentially to illustrate the problem. They are: the Pravara Left Bank Canal (PLBC, for short), and the Nira Left Bank Canal (NLBC).

1.20 The system of water distribution in these and other canal systems is specific to the region. The Appendix A to this Chapter gives a brief account of the methods and terms involved, as well as the water rates in force in 1978-79, the year of survey. The second chapter estimates the demand for irrigation water at the distributory head by different crops in the PLBC and NLBC (non-perennial), and then tries to calculate the extent of loss of water in transit in different parts of the distribution system. Chapter three examines the economics of use of canal water for different irrigated crops and crop patterns. Certain uncertainties associated with the yields, prices and quantity and frequency of water supply, associated with the calculations in ^U Chapter three, are examined in Chapter four. The fifth chapter examines the prospects for sugarcane in the State in the light of the policy implications based on the findings of Chapters three and foul including the possibility of sugarcane under well. The sixth chapter makes a reference to the increased capital costs of the alternative pattern of water use suggested, and makes a very brief assessment of the benefit-cost ratio. The final chapter puts down the conclusions arising out of this study.

NOTES

1. The matter is more serious, if requirements of water for domestic use and for industrial purposes, sure to grow at rapid rate, are added to the requirements for irrigation.

2. While comparing the two sets of figures for Maharashtra in Tables 1.1 and 1.2, the following should be kept in mind: The figure in Table 1.1 refers to the ultimate irrigation potential from all sources, while that in Table 1.2 refers to all flow irrigation sources in the state sector, including a significant part of the minor irrigation potential. Secondly, while

the percentages in Table 1.1 refers to net irrigated to net sown areas, the percentages in Table 1.2 refer to gross irrigated to net sown area.

3. *Report of the irrigation Commission, 1972, Volume I.* New Delhi: Ministry of irrigation ana Power, p. 112.

4. The point is also made in Committee to Study the Introduction of Eight Monthly Supply of water on the Irrigation Projects in Maharashtra: *Interim Report,* Bombay: Government of Maharashtra, Feb. 1979, paras 30-32.

5. Ref, *Minutes of Evidence: Bombay Presidency, (of the Indian Irrigation Commission.* Calcutta: Office of Superintendent, Government Printing, 1902; Donald W. Attwood on the History of Deccan Canals in his paper "Irrigation and Imperialism : the causes and consequences of a shift from subsistence to cash cropping", *Journal of Development Studies,* 1986.

6. Ma*harashtra State Irrigation Commission Report,* Bombay: Government of Maharashtra, 1962. Section 5.5.

APPENDIX - A

Present Systems of Distribution of Water

A.1The system of irrigation as is now seen in Western Maharashtra is largely the outcome of physical factors such as topography, soil climatic complex, the nature of water resources, etc. Unlike in other parts of the country the soils in Maharashtra vary greatly from field to field and also water is not plentiful to be supplied to the farmers unrestricted.

A.2The farmer has to decide in advance which crops he would like to irrigate and get the areas of each crop sanctioned by the Irrigation department. As stated in the Maharashtra State Irrigation Commission Report the sanctions are governed by the current irrigation policies such as maximising utilisation in Kharip season, encouraging the growing of foodgrain crops in Rabi season and minimising utilisation in summer season and most important of all the need to restrict the area under perennial crops to prevent large scale damage through waterlogging.

A.3Under the present system of irrigation, sanction is given on seasonal basis in addition to the permanent commitments under the block system. Water is also supplied for casual irrigation on application in form No.7. After getting the areas under individual crops sanctioned, the farmer has to obtain permission at each rotation for irrigating the sanctioned crops. This is done through a system of ‘passes’ issued to farmers for growing crops as sanctioned. Before each rotation the irrigation official enters the date, on which water would be supplied, on the passes, after which the farmers become entitled to get canal water for a particular crop and on the date specified. Sanctions for a variety of crops are given on long term basis, i.e., for six years or some times more. This is the ’block system". The important types of blocks at present in force on the Deccan canals are (i) cane blocks, (ii) fruit blocks, (iii) garden blocks, (iv) garden and seasonal block, (v) two seasonal blocks and (vi) three seasonal blocks.[1]

A.4(i) Cane Block: Cane Blocks are sanctioned in multiples of 1 acre and the basic cane area is restricted to one-third or one-fourth of the total block area depending upon demand of irrigators. This is referred to as ‘one in three’ or ‘one in four cane block’. That means (in case of one-in-four) if a farmer has a 4 acre cane block, he can plant only 1 acre of cane in that 4 acre block, and in the remainder of the block area seasonal crop is allowed to be grown during the Kharif and the rabi seasons, except crops like long staple cotton, lucerne or groundnut in the hot

1. For a brief account of these prevailing methods and terms used in canal water distribution in the State, see P.R. Gandhi, *History and Practice of Management of Irrigation Waters in Maharashtra,* Aurangabad: Water and Land Management Institute, June 1981.

weather. The farmers rotate the cane plot within the block As sugarcane necessarily requires 'overlap', (because 'Adsali' or 18 month sugar-cane must stay in the field for more than a year and 'Suru' or annual sugarcane may have to stand in the field, awaiting harvesting for factory, beyond the stipulated period) additional cane area to the extent of 50 per cent of the basic cane area is allowed to be under sugarcane, but only during the months from July to March or with special sanction even in April but never in May or June. However, permission for 'overlap' has to be obtained separately every time. The normal period for this type of block is six years. The whole idea behind restricting the cane area to one-third or one-fourth area of the cane block is to keep control on the area of standing crop of cane in hot weather season. In the cane block if sugarcane is not planted, permission is given by the irrigation department to plant any seasonal crop whose water requirements are lighter than of sugarcane.

A.5(ii) Fruit Block: In this block fruit trees which stand in the field for a long time, such as, mosambi, orange, mango , etc., are allowed in the entire block area. Usually the contract sanctioned for such block is for 12 years.

A.6(iii) Garden Block: In this block short term fruit trees like papaya, and other light perennials like vegetables and lucerne grass are allowed on 1/3 area. Of the remaining, 1/3 can be under long staple cotton and another 1/3 on any seasonal crops other than those mentioned above. The block is sanctioned for six years. The earlier garden and Seasonal Blocks have been gradually converted into Garden Blocks after 1965.

A.7(iv) Two seasonal Block: In this block, only Kharif and Rabi seasonals are allowed to be grown with 100 per cent of the area of the block can be under irrigation in each of the two seasons. Special sanction is needed for any summer crop in the block. This block is also sanctioned for six years.

A.8(v) Three Seasonal Block: Under this block only one-third of the block area can be put under long staple cotton or groundnut or onion in summer, which may carry over into the next Kharif season. Further, one-third of the area can be put under Kharif seasonal and another one-third under rabi seasonal. Thus one-third of the area of the three-seasonal block remains fallow in Kharif and two-thirds or less of the same remain fallow in rabi.

A.9It is to be noted that no preliminary programme of irrigation is made for the Kharif season. Though the day-cusec of water released and area irrigated for each rotation in kharif season are recorded, these are not scrutinised for examining the efficiency of irrigation. On the 1st of October every year a 'preliminary irrigation programme' is prepared on the basis of the actual available water stored behind the dam, the anticipated overall river gains or losses between the dams and the weirs and the trend of water application in the past. Applications are then invited and these are sanctioned by the 15th of October. A schedule called the 'Shejpali' giving the turns of different irrigators in each rotation is then prepared before irrigation starts from 1st November. The irrigation begins from the tail end and proceeds towards the head as the irrigation progresses. The concerned irrigators are informed about their turns one or two days in advance. This schedule of irrigation can be modified depending upon late demand, sowing periods of different crops and unauthorised use. In practice, however, actual modifications are seldom carried out and actual irrigation often does not proceed in the originally planned manner. This results in low reliability of water supply. Obviously in this system there is a tendency to overdraw water by individual farmers, as time and quantity are not the essence of the sanction, only when an irrigators says he had enough water does the next man get his turn. This makes some others suffer, particularly the tail enders.

A.10 The 'preliminary irrigation programme' contains mainly the following information and data: (i) live storage available, (ii) deduction of tank evaporation losses in rabi and hot weather seasons on the experience of about the latest 10 years, (iii) this 'gives net available quantity of water at canal head, (iv) transit losses in the canal on the basis of the average loss of the last 10 years or so, (v) this gives the quantity of water available at distributory head, and finally (vi) the seasonal duty to estimate the requirement of quantity of water at distributory head. The area of different crops is converted into standard acre of area on sugarcane basis.[2] While preparing the programme the following points are observed. (i) quota for perennial areas for rabi and hot weather is kept aside, (ii) maximum rabi irrigation of wheat, jowar and gram is allowed, and then remaining water is proposed for hot weather seasonals and pre-seasonals of kharif crops.

A.11 As mentioned earlier, the application of the programme begins from 15th of October. The season is generally divided into 7 rotations in Rabi season and 9 rotations in hot weather season. The rotation is of 18 to 20 days in Rabi and about 14 to 15 days in hot weather season. The duration of the rabi season is of around 120 days. The quota of water in each rotation is fixed. If the total quota of water of a particular distributory for Rabi season is 'X' Mcft, the quantity to be drawn in each rotation will be 'X' Mcft divided by 7. However this can not be achieved in each rotation (watering) in practice. Therefore, any extra quantity utilised in the first two rotations is required to be adjusted in the last 3 or 4 rotations by drawing less.

A.12 Once the quota of each distributory originating from the main canal is determined, the flow of water in day-cusec in each distributory is decided as per the water demand statement. Each distributory has got a measuring device called 'Standing wave Flume' where discharge is measured each morning and evening. Also the data of day-cusecs utilised and the progressive total draw off in the rotation along with the approximate area irrigated and the progressive cumulative total of areas irrigated are recorded.

A.13 A number of 'water courses' take off from the 'distributory' or the 'minor' at different points in its course. A concrete structure with a vertical shutter device is installed at the point of take off of a water course to let out water into it from the distributory. There is, however, no water measuring device at this point. The cultivators take water into their fields by making a temporary breach in the bund of the water course separating their fields from the water course. They can also take water to a field when it is away from the water course by designing a field channels through the other farmer's field and breaching the bund of the water course at the head of the field channel.

A.14 From the above account it is clear that the last point in which the measuring device is fixed to measure the volume of water released is at the distributory head, beyond that point there is no provision for any measurement. Under the existing systems the farmers are at liberty to take as much water as they like, or till they are satisfied

2. the conversion rates are as follows: (Ref. Gandhi, op.cit.) Rabi :while the actual sugarcane acre, including the overlap is treated as 1 acre, acre under garden block, fruit block, vegetables or high-yielding variety of wheat is equal to 0.67 acre sugarcane, and other hybrid crops like Hybrid jowar, 0.5 acre sugarcane, and other seasonal crops 0.33 acre sugarcane.
Hot weather: Acre under sugarcane and all hot weather seasonal crops treated on par, only acre under fruit block, garden block or vegetables equal to 0.67 acre of sugarcane.

that the fields are fully irrigated, there is no time limit nor is there any volumetric measure of the water drawn.

WATER RATES

A.15 At present the prime source for the recovery of capital operation and maintenance costs for irrigation works is the charge. Different rates are charged for each crop, roughly corresponding to the amount of water utilised. The following are present rates charged for different crops.

Name of the Crop or Season	Rates (Rs. per hectare) w.e.f. 1-7-75 prevailing during 1978-79)
Sugarcane and Plantations	750
Other perennials	500
Kharif seasonal crops	50
Rabi seasonal crops	75
Hot weather seasonals	150
Hot weather cotton	250
Hot weather groundnuts	250
Pre-seasonal watering	75
Post-seasonal watering to kharif crops in rabi-season	20
Post Seasonal watering to rabi crops in hot weather season	25

A.16 A 20 per cent local cess is levied on the water rates. An Employment Guarantee scheme (EGS) cess is levied at the rate of Rs. 25 per hectare of irrigated land, and an Education cess varied with the crops grown as follows:

Crop	Rates (Rs. per hectare)
Sugarcane (perennials irrigation)	190
Sugarcane (on other lands)	110
Irrigated cotton	40
Hybrid seeds	40-110
Irrigated groundnuts	40
Fruits	80-380
Turmeric	80
Tobacco	130

CHAPTER II

Pattern of Use of Water under Canal Irrigation

2.1 In order to estimate the most economic use of irrigation water, it is necessary, first of all, to ascertain the present pattern of use of canal water for different crops as well as the proper quantity and frequency of application of irrigation to different crops. Unfortunately, there is no information available about the quantity of water applied by farmers to fields growing different crops in the different seasons of the year, under any flow irrigation project in the state. The information available with the irrigation authority is briefly described below.

2.2 The information about the volume of water in the reservoir is available regularly and routinely. Daily information on the volume of water let out of the reservoir into the main canals is also maintained. The difference between the accretion plus depletion of water in the reservoir and its outflow through canals (and through the sluice gates, particularly in the rainy season) gives an estimation of the loss of water through seepage and evaporation. Similarly, for any period - a season or a year - the difference in the volume of water let out through the main canals, and the water let out from the canal to the distributories (as well as given to other users) gives an estimation of the volume and proportion of water lost through seepage and evaporation (mainly the former) in the main canals. The last routine measuring of the volume of water let out is at the distributory head. Beyond this there is no provision to routinely measure the volume of water let out from the distributory at the outlet to water courses, nor is there any direct or indirect measure of the volume of water taken by an irrigator. Therefore, there is no clear measure of the quantity of water lost in transit in the distributory and the water courses and the water actually applied to the field.

2.3 However, in order to supply water to the approved areas under different crops on the fields in a given season indeed during each rotation of water supply, it is necessary for the canal authority to have a clear idea of the amount of water needed per

Table 2.1. Water Requirements of Different Crops at Field Head

(in acre inches per acre)

Irrigation Department*			As per Lift Irrigation Scheme**			As per Agronomists' Specification***		
	Crop	Acre Inches per acre		Crop	Acre Inches per acre		Crop	Acre Inches per acre
	(1)	(2)		(3)	(4)		(5)	(6)
1.	Sugarcane (1 year)	113	1.	Sugarcane (Adsali 18 mths)	139	1.	Sugarcane (1 year)	106.45
2.	Plantains	112	2.	Sugarcane (Surf 1 yr.)	127	2.	Jowar CSH-5 (Kharif)	18.06
3.	Lucerne, E.Grass, Guinca grass	112	3.	Hybrid Jowar (Kharif)	9	3.	Bajra (Kharif)	9.86
4.	Vegetables in succession throughout the	112	4.	Bajra	6	4.	Jowar CSH-1 (Rabi)	14.59
5.	Papaya	87	5.	Groundnut (Kharif)	6	5.	Jowar CSH-8R (Rabi)	15.37
6.	Citrus fruits	76	6.	Rabi Jowar	12	6.	wheat (K.Sona)	15.69
7.	Guava, Pomegranates	60	7.	Hybrid Rabi Jowar	18	7.	wheat (N1-5439)	15.14
8.	Rice (Kharif)	30	8.	Gram	9	8.	gram	11.83
	Rice (Rabi)	10						
9.	Kharif Seasonals	10	9.	Wheat	18	9.	Groundnut (SB-XI)	12.62
10.	Rabi Seasonals	12 to 16	10.	Groundnut (Summer)	36	10.	Sunflower	10.25
11.	Hot weather Seasonals	26	11.	Cotton (Long Staple)	33	11.	Cotton (RHR-253) Hot Weather	35.49
12.	Khapli Wheat	37						
13.	Two Seasonal vegetables	61						

* Gandhi, P.R., *op.cit.*, P.31 ** *A Note on Preparation of Lift Irrigation Schemes*, Bombay: Government of Maharashtra, Irrigation and Power Department, 1970, P.19. *** Obtained from Professor of Agronomy, Mahatma Phule Krishi vidyalaya, Rahuri, Maharashtra.

crop at the field head as well as the proportion of water, let out at the distributory head, that may be lost in transit through seepage, etc. The irrigation authority uses certain norm of water requirement of various irrigated crops at the field head. These are given in Col. 2 of Table 2.1. The seasonal break up of the water requirements for perennials and two seasonals are also worked out. Then, in order to estimate the water requirement at the distributory head, an uniform 10 per cent loss is applied to the seasonal water requirement of each crop. The area under every irrigated crop under the distributory is then converted into equivalent sugarcane area, by using a conversion chart, presumably based on the respective water requirements of various crops at the distributory head. This is illustrated for the Rabi and Hot weather seasons for the Nira Left Bank Canal in Table 2.2.the expected quantity of water that may be available per day of irrigation during the season at the distributory head (based on the experience of the previous 5 years), measured in terms of daycusecs (discharge rate at the distributory head in cubic feet per second multiplied by 24 x 60 x 60 seconds) is then used to divide the sugarcane equivalent planned irrigated area. This ratio, that is, the ratio of area irrigated (AI) to day-cusecs (DC) shows how many acres of sugarcane equivalent area can be irrigated with the discharge at the rate of one cusec water for 24 hours. This AI/DC ratio normally varies from 3.5 to 4, depending upon mixture of crops in the command area of the distributory. It means, provision of water to irrigate about 4 acres of, sugarcane upto a depth of 15 cm or 6 inches of water an acre during a day. The section officer in charge of the distributory can make minor variations in this from season to season, as long as the average AI/DC for the whole season does not exceed the estimated level.

(2.4 to 2.18 not included)

2.19 Variations in demand for water at the distributory head are possible from season to season. Requirement for actual irrigation would vary, from rotation to rotation and even from distributory to distributory, depending upon whether there was rainfall in the area on the eve of the rotation,. as well as on the state of moisture in the soil. This is more likely in the Kharif and the early Rabi seasons. Secondly, certain crops, like sugarcane and Other perennials, need water in every rotation while many seasonal crops need water less frequently. Since there is no uniformity of cropping under irrigation in the area served even by a single water course, not to speak of a distributory, the length of channels that water will have to travel to reach the fields to be irrigated is sure to vary from rotation to rotation and season to season. The longer the channel compared to the quantity of water applied to the field, the greater will be the loss in transit. Appendix Table A.2.1 and A.2.2, showing the area actually irrigated during different rotations in 1978-79, indicate the extent of this fluctuation. Distributory-wise this is even greater. Thirdly, the longer the interval between the two rotations, particularly in summer, more than proportionately greater the application of water in the fields. In the black cotton area, the soil dries and cracks up in a situation of prolonged absence of irrigation in the dry season. When finally water is available, the cultivator per force applies very large quantities of water in order to ensure that the root zone of the crop is fully wetted And more. Indeed, during visit to farmers' fields in summer, we "heard". irrigation water flowing into the field but could not "see" it for quite some time: irrigation water was flowing considerably below the surface, making noise, and could be seen only through the very wide and deep cracks in the groundnut field! Under PLBC, in 1978-79, only four irrigations were provided during the summer, a smaller number than normally necessary; therefore larger water application in the groundnut and cotton fields may be expected. In addition to the normal tendency of farmers to over-irrigate their fields, these abnormal situations lead to very high water application. Fourthly, loss of water in transit is partly due to defective state of the distributories and the Outlets for the water courses. Finally, there is the very real situation of unauthorised and undetected and/or unaccounted use - simply "theft" - of canal water. While checking the irrigation Use, through field visits, under one distributary in the Nira Canal System we came across some land, amounting to about 10 per cent of the total authorised irrigated land, supposedly under well irrigation, that was in fact using canal water unauthorisely for sugarcane. While this had been noticed, it could not be "detected" for what in local parlance are called "political" reasons. Besides these real circumstances on the ground, some of the regression coefficients would not be significant because of very small land area under irrigation during a season or rotation, as the case may be. Thus, the areas under paddy in Kharif and groundnut and cotton in the hot weather were small and scattered under many distributories, and are not likely to yield reliable results for that reason.

(2.20 to 2.21 not included here)

2.22 Since no firm information is available about the actual application of irrigation water by farmers in the field, we propose to use the data put out by the Irrigation Department for the Lift Irrigation Schemes (See Table 2.11, which is the same as in column 3 and 4 of Table 2.1 given separately for Kharif, Rabi and Summer seasons.) Which broadly relate to field level requirement of irrigation, to estimate the loss of water in transit below the distributory head, in the year 1978-79. The method used is as follows: The total irrigation water required in one season at the field level is taken as that given in Table 2.11. But the actual number of irrigations available to a crop in the particular season during 1978-79 in PLBC/NLBC was different from the number of irrigations specified in the Lift Scheme (Table 2.11). We have estimated the water per irrigation for a particular crop in a season to be the total water required for the crop in the Season divided by the number of irrigations actually available. The actual water let out through the distributories and the quantity required for irrigation, calculated in this manner are presented below in Tables 2.12 and 2.13.

2.23 We find that, on the whole, 50 per cent of the water let out into the distributories was necessary for irrigating the standing crops in the fields in PLBC; the remaining 50 per cent was therefore lost in transit. In NLBC (non-perennial section) the use was only about 45 per cent; 55 per cent was lost in transit. The seasonal variation was quite significant. In PLBC the percentage of water used was the lowest in Kharif, 43 per cent, and highest in summer, 72 per cent. In NLBC, it was lust the reverse: 63 per cent in Kharif and 38 per cent in Summer. While concentration of sugarcane area under irrigation in Summer in PLBC may account for the high utilization level in that season, the variations are too much. The factors discussed earlier (para 2.19) surely must be responsible for this.

Table 2.10. Water Requirement of The Crops at Distributory Head as Estimated Through Regression

(Acre inch)

Name of the Crop	Kharif			Rabi			Summer		
	No. of waterings	Quantity per watering	Total	No. of waterings	Quantity per watering	Total	No. of waterings	Quantity per watering	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Sugarcane	5	11.90	59.50	6	7.55	45.30	4	12.16	48.64
Other Perennial	5	6.49	42.25	6	8.04	48.24	4	6.75	27.00
Hybrid Jowar	3	5.97	17.91	-	-	-	-	-	-
Bajra	2	10.63	21.26	-	-	-	-	-	-
Groundnut	3	6.17		-	-	-	2	14.30	26.60
Paddy	4	7.66	29.64	-	-	-	-	-	-
Jowar	-	-	-	3	7.14	21.42	-	-	-
Wheat	-	-	-	4	7.76	31.04	-	-	-
Gram	-	-	-	3	17.41	52.23	-	-	-
Cotton	-	-	-				3	25.98	77.94

NOTE : The canal ran for 5 rotations (watering) in kharif, 6 rotations in rabi and 4 rotations in hot weather season in 1978-79. But, except for sugarcane and other perennials no other crop is necessary Irrigated in all the waterings.

2.24 We noted earlier that nearly 34 per cent of the water let out into the Pravara Left Bank Canal in 1978-79 was lost in transit in the main canal. Of the 66 per cent water let out into the distributories only half was estimated to be used on the field. This means, of the total water let out into the canal, roughly one-third was lost in the main canal, another one-third in the distributories and water courses, and only one third was used by the farmers on their fields.

(2.25 to 2.26 not included here)

Table 2.11. Irrigation Water Requirement of Crops as Prescribed in The Lift Irrigation Schemes, Government of Maharashtra.

(Acre-inch)

Name of the Crop	Kharif			Rabi			Summer		
	No. of waterings	Quantity per watering	Total	No. of waterings	Quantity per watering	Total	No. of waterings	Quantity per watering	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Sugarcane	4	3.0	12.0	12	3.5	42.0	12	4.5	54.0
Other Perennial	4	2.4	10.0	12	2.5	30.0	12	3.0	36.0
Hybrid Jowar	2	3.0	6.0	-	-	-	-	-	-
Bajra	2	3.0	6.0	-	-	-	-	-	-
Groundnut	2	3.0	6.0	-	-	-	12	3.0	36.0
Paddy	2	4.0	8.0	-	-	-	5	4.5	22.5
Jowar	-	-	-	4	3.0	12.0	-	-	-
Wheat	-	-	-	6	3.0	18.0	-	-	-
Gram	-	-	-	3	3.0	9.0	-	-	-
Cotton	2	3.0	6.0	2	3.0	6.0	7	3.0	21.0

Table 2.12. Estimated Utilisation of Water as Proportion to The Actual Amount of Water Released from Distributory Head Under PLBC

Season	Water actually released in the distributories/ minors in acre inches	Estimated utilisation of water at the field level acre inches	Percentage utilisation at field level
(1)	(2)	(3)	(4)
Kharif	291121	123892	42.56
Rabi	497759	236458	47.50
Summer	161830	116290	71.86
Total	950710	426640	50.14

Table 2.13. Estimated Utilisation of Water as Proportion to The Actual Amount of Water Released from Distributory Head Under NLBC (Non-Peremmial Zone).

Season	Water actually released in the distributories/ minors in acre inches	Estimated utilisation of water at the field level acre inches	Percentage utilisation at field level
(1)	(2)	(3)	(4)
Kharif	454546	34330	62.95
Rabi	146106	61972	42.42
Summer	94511	35732	37.81
Total	295163	132034	44.73

NOTES

1. *Maharashtra State Irrigation Commission Report,* 1982, p. 139.

2. *Maharashtra Composite Irrigation Project : Feasibility Report,* New Delhi: Water and Power Development Consultancy Service (India) Ltd., May 1979, Vol.I, pp. 43-45.

3. Ibid.

4. Dhamdhere, H.V. and Padhye, V.S. "Scheduling of Irrigation", published in *National Workshop in Scheduling of Irrigation, Nov. 12-13,1983,* Aurangabad: Water and Land Management Institute, November 1983 (Publication No. 5), p.42.

APPENDIX TABLES

Table A.2.1. Irrigated Area Under Different Crops During Each Rotation, Under PLBC, 1978-79

(Area in Acres)

Season/ Rotation	Sugar Cane	Other Perennials	Hybrid Jowar	Bajra	Groundnut	Paddy	Others	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Kharif:								
1.	985.92	436.58	2585.89	392.64	164.99	85.63	123.50	4774.90
2.	1183.89	473.83	5862.59	1117.65	267.01	189.54	89.46	9583.93
3.	1937.43	465.83	6380.23	1041.52	277.36	205.00	471.14	10778.51
4.	2319.83	471.98	5609.38	924.26	261.11	187.50	409.38	10191.44
5.	1332.73	337.75	3222.14	228.35	172.01	74.25	163.77	5531.00
R.Total	7759.80	2185.97	23660.23	3704.42	1142.48	741.88	1657.25	40859.78

Season/ Rotation	Sugar Cane	Other Perennials	Jowar	Wheat	Gram	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Rabi						
1	1249.12	440.13	6021.03	3992.60	392.24	12094.92
2	1235.23	395.48	3131.51	5145.21	205.64	10121.07
3	1306.21	325.50	3163.14	5474.16	360.76	10629.77
4	1745.69	426.40	5490.86	8096.06	435.13	16194.14
5	1306.65	264.80	1235.18	6972.25	191.70	9970.58
6	1074.52	430.91	1178.47	4991.14	63.00	7738.04
R. Total	7917.42	2283.22	20220.19	34671.42	1648.47	66748.52

Season/ Rotation	Sugar Cane	Other Perennials	Cotton	Groundnut	Others	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Summer						
1	1050.77	428.28	-	44.0	421.89	1900.94
2	1007.03	422.78	22.26	-	1.5	1452.07
3	4425.60	412.78	60.56	64.0	40.5	5003.44
4	5033.01	447.78	43.13	64.0	31.15	5619.07
S. Total	11516.41	1711.62	125.95	172.0	495.04	13975.52

Table A.2.2. Irrigated Area Under Different Crops During Each Rotation, Under NLBC, 1978-79

(Area in acres)

Season/ Rotation	Sugar Cane	Other Perennials	Hybrid Jowar	Bajra	Groundnut	Paddy	Others	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Kharif:								
1	928.00	888.25	956.25	187.00	90.50	140.5	7.5	3198.00
2	1564.5	1615.5	1006.75	699.13	225.00	262.5	8.0	5381.38
3	271.38	428.5	953.5	271.75	207.00	239.0	7.5	2378.63
4	10.00	60.0	28.0	-	-	-		98.00
K.Total	2773.88	2992.25	2944.5	1157.88	522.5	642.0	23.0	11056.01

Rabi	Jowar	Gram	Total
3	2226.38	252.9	2479.28
4	6461.05	359.5	6820.55
5	5790.86	173.4	5964.26
6	208.00	47.0	255.00
R	14686.29	832.8	15519.09

Summer	Cotton	Gr.nut	Total
1	562.00	-	562.00
2	748.88	359.13	1108.01
3	528.75	606.14	1134.89
4	273.00	485.11	758.11
5	772.26	995.88	1768.14
6	793.38	1032.08	1825.46
7	400.00	437.88	837.88
	4078.27	3916.22	7994.49

Note : The first two rotations in Rabi were not given since there was sufficient rainfall at the times.

CHAPTER III

Economics of the Use of Irrigation Water

3.1 Irrigation in the dry, drought prone regions of Maharashtra is mainly sugarcane centered. A little over 10 per cent of the total irrigated area in the State is under sugarcane. However, since sugarcane is a heavy water using crop compared to others, it used between 50 to 60 per cent of the total irrigation water-in the State. Sugarcane is concentrated in the dry, drought prone regions; and, therefore, the percentage of irrigation water used by sugarcane in this region is likely to be even higher.

3.2Does this pattern of use of water give the best return per unit of water? The question is particularly relevant in the context of canal water, which can be used in 'varying amounts and for varying periods during the 8 months after the supply reservoir is filled by the beginning of October every year. The same approach would not work for wells, though given his endowments of land and water, the irrigator with a well may also be expected to maximise return per unit of the factor in relatively short supply. In order to estimate the net returns to the farmer per unit of water under canal irrigation, it is necessary first of, all to find out the net returns per acre of different irrigated crops. Then the returns per unit of irrigation water used in different crops/crop rotations can be calculated and compared.

3.3For this purpose two different sources of data are sought to be used. The first is a survey into the costs and returns of ,a sample of farmers selected from the command areas of 'PLBC and NLBC (non-perennial zone), relating to the year 1978-79. The sec-pond is the data extracted from the enquiries into costs of production of farm products, conducted by the Ministry of Agriculture of the Government of India, in all regions since 1972-73. We have used the data relating to the irrigated crops in the samples drawn [from regions in or near which our selected command areas are located- We present below brief accounts of the composition of the sample farms and the costs and returns relating to different crops from these two sources.

3.8Only one-third of the total operated land of the cultivators under the PLBC command, was irrigated by the canal. Another 42 per cent of their land was irrigated by wells in or near the command area. One-fourth (24.67 per cent) of their land was without any irrigation facility. Size-wise the smallest cultivators had the maximum, i.e., 51.68 per cent of their land irrigated by the canal, the largest had only 29 per cent of their land under canal. Incidence of well-irrigation however was less uneven: the smallest had 36.23 per cent well irrigated land while the largest had 40.22 per cent; only the middle farmers had about 50 per cent of their land under wells. Therefore, the unirrigated lands with the smallest sized farmers was only 12 per cent while in case of the largest it was nearly 31 per cent.

3.9In the non-perennial zone under NLBC, on the other hand, much smaller per cent of the total operated area of the cultivators in the command area, 18.58 per cent only, was under canal irrigation. Land under wells accounted for another 20 per cent, leaving more than 61 per cent of the total operated area of the farmers unirrigated. Here also the smallest farmers had nearly half their land irrigated by canals, the medium about 30 per cent, while the large farms only 13 per cent. The extent of well irrigation did not vary significantly among the three size-classes. Greater irrigation facility has, all along in India, been associated with small average size of land holding. That again appears to be borne out by the difference between PLBC and NLBC (non-perennial) regions, observed here. Another point worth noting in the context of these two regions is that larger the proportion of operated area of farmers covered by canal water, the larger the extent of well irrigation. This is plausible, since the wells are able to tap and recycle seeped canal water, and greater the coverage under canals, greater this possibility of tapping underground water.

3.10 The cropping pattern of the sample farms is presented in Appendix Tables A.3.5, A.3.6, A.3.7 and A.3.8 for the two regions separately. Under PLBC, only 5 per cent of the gross cropped area, canal irrigated, was under sugarcane. This is broadly in keeping with the sugarcane block area mentioned earlier. However, nearly four times as much sugarcane land, normally irrigated by wells were provided with 2/3 irrigations from the canal in summer. If we add this area as well as the sugarcane area which was an overlap of 1977-78 year and took water pending harvest, mainly in the Kharif and early Rabi seasons, to the gross cropped area under canal as well as to area under sugarcane, we find that nearly 24 per cent of the gross cropped area under canal was under sugarcane. Cereal crops, millets and wheat accounted for the bulk of the canal irrigated land. As against this, not only was the total area under well irrigation under PLBC higher, but the area under sugarcane was nearly 28 per cent of the gross irrigated area under wells. If we add the sugarcane overlap area to the total as well as to the sugarcane area, sugarcane accounts for nearly 40 per cent of the gross irrigated area under wells. The area under well-irrigated millets was just about as large as the area under sugarcane. Wheat was another important cereal. Long staple cotton was grown mainly under well irrigation in summer, while it was very little under canal. Besides, a wide range of seasonal crops as well as fodder and lucerne were grown mainly under well irrigation. In the unirrigated portion of the land holdings of the sample farmers the main crops grow were local variety of jowar in the Rabi season (nearly 70 per cent of the gross cropped area), bajra and a variety of pulses in the kharif season.

3.11 the distribution of the total gross cropped area (irrigated plus unirrigated), according to the size class of land holdings, is presented in Appendix Tables A.3.7 and A.3.8. An interesting fact to note in this context is that while the small farmers had more than half their land irrigated by canal and nearly, 88 per cent of their total land irrigated from either source, the area under sugarcane constituted just about 10 per cent of their gross cropped area. What is more, most of this sugarcane was under wells; the sugarcane area under canal in their case was very small, constituting less than 1 per cent of their net irrigated area under canal. (Data not separately presented.) Out of the total sugarcane area under canal (excluding overlap area), 60 per cent was with the large farmers, over 38 per cent with the medium, and only about 2 per cent with the small farmers, while they occupied 53, 26 and 21 per cents respectively of the total canal irrigated land. Even if we include the overlap sugarcane areas, the distribution amongst the size classes remains broadly unchanged. This shows that, under the block system of giving canal water to sugarcane land, the small farmers had little place; the blocks were mainly with the medium and large farmers, more so with the latter. The small farmers were recipients of canal water for seasonal crops (presumably under Form VII which is given after the available water has been apportioned to the various block areas). We shall return to this inequality of distribution of sugarcane blocks among farmers of different size holdings in a later chapter.

3.12 In the non-perennial zone of NLBC the canal irrigated lands was devoted to mainly 3 crops: Rabi jowar, Kharif and Summer groundnut and long staple cotton in summer. Under well irrigation, about 10 per cent of the gross cropped area was under sugarcane. Wheat, maize and cotton were the other important crops, besides Rabi jowar. Here too, like under wells in PLBC command area, a number of other seasonal crops were grown in the kharif and Rabi seasons, a phenomenon much less visible in the lands irrigated by the canals. On the unirrigated lands, which formed the bulk of the total cultivated area, Rabi jowar and Kharif pulses were the only two crops being grown.

NET INCOME FROM IRRIGATED CROPS

3.13 Detailed data on inputs, costs and outputs, cropwise, were collected from the sample farmers. These were valued at the prevailing prices paid or received by the farmers during the year. The net income per acre was calculated for the various crops grown by the farmer under canal and well irrigation, as well as under rainfed condition. The net income was calculated by valuing the main product plus the by-product, if any, of a crop and deducting from this the values of all material inputs, whether purchased or home-supplied, including feed, fodder etc., expenses of bullocks or cost of hiring bullocks, irrigation costs and the wages paid to casual or annual farm workers hired for operations on the crop and imputed wages of family labour. The average per acre costs and returns for a number of irrigated crops are presented in Tables 3.1 and 3.2 for PLBC and NLBC, respectively.

3.14 We examined such data separately for farmers in the three different size classes of land holdings (data not presented here), but did not find any significant differences among these. Difference between canal and well irrigation, in terms of inputs and outputs were not noticeable in case of many crops, like jowar, bajra, groundnut, etc. But in case of three crops, namely sugar- pane,' wheat and long staple cotton, the inputs, mainly fertilizer application, were somewhat higher on the well irrigated lands and so was the output per acre. As against this the labour cost per acre was higher on canal irrigated lands, particularly for sugarcane, and the cost of irrigation was higher under well irrigation. The relatively higher fertilizer application on these crops, irrigated by wells, was possibly due to the greater control over water supply, particularly in terms of frequency and timeliness. Fertilizer is applied on the eve of water application, and there is longer interval and greater uncertainty associated with canal irrigation. The higher labour charge is presumably due to the practice of contracting out of a number of operations on the sugarcane field, particularly by the large and even some medium farmers who alone were having canal water for sugarcane, while the small farmers who had almost entirely well irrigation used less of hired labour and there too less contracting out of work to labour gangs. Because of these higher and lower costs and returns in regard to these three crops, the net income per acre in these cases was only marginally higher on well-irrigated lands. We have, therefore, chosen to take the weighted averages of the per acre costs, outputs and net incomes of these as well as the other crops grown under canals and wells. This means that in using these net income data to compare the net incomes per unit of irrigation water used in different crops under canal irrigation, we are somewhat over stating the case for sugarcane in particular. Is This does not matter. Hopefully, improved management of canals, now being slowly started, would lead to this difference being wiped out. In any case, the other set of data relating to farm costs and returns over a number of years which we also propose to use for our exercise, does not permit us meaningful separation of canal and well irrigated crop lands, due to smallness of the Samples. For all these reasons, the data in Tables 3.1 and 3.2 give the weighted average per acre costs, returns and net income of a number of crops under irrigation in the sampled farms during 1978-79.

3.l5 The data show that the net income *per acre* under irrigation is the highest for sugarcane. Indeed, it is more than 50 per cent higher than the next highest net income yielding crops, onion and lucern grass. It was 9 times that of irrigated Bajra, 5 times that of irrigated Rabi jowar and 4 times that of hybrid Kharif jowar; and so on. It is not surprising that given ample supply of irrigation water compared to this total land holding, a farmer in this region would prefer to grow sugarcane, except to the extent required by rotational requirements of good agronomic practice

NET RETURNS BASED ON FARM COST ENQUIRIES

3.16 The farm costs and return data presented above related to r the PLBC and NLBC areas, for a particular year. Year to year variations in costs and returns are not unreasonable to expect, even under irrigated conditions, not only due to variations in weather, but also variations in frequency and quantum of water supply as well market conditions. The data collected by the field survey relating to a single year cannot help take care of this. Moreover, these data were collected by a quick survey of the sample farms. There is possibility of errors arising out of inaccuracy in recollection by the respondents. Greater reliability can be ensured if daily accounts could be kept by the farmers or for him, for the entire agricultural year. But this would have proved very expensive and time consuming.

3.17 Fortunately, such data were (and are) available for the irrigated crops in the region for a number of years. Since 1973 the Union Ministry of Agriculture has been conducting, with the help of Agricultural Universities and other institutions, a comprehensive scheme for collection of data on costs of cultivation of different crops in the country. For each crop, called the main crop, a systematic multistage sample is drawn for the region(s) of the State predominantly growing that crop. The information from the main sample, and, after a few years, of a sub-sample, is collected continuously for a certain number of years. For Maharashtra, we copied out, with the permission of the Economic and Statistical Adviser to the Ministry of Agriculture, detailed information relating to 3 main crop samples, sugarcane, jowar and bajra. Under the scheme the talukas in each district are selected where the particular crop is grown as main crop. From each taluka (cluster) five villages are selected and from each village two, farms growing the crop as main crop are selected, keeping in view different sizes of holdings. In addition two progressive farms are also selected from these villages. Thus, in each cluster twelve farms are selected for the particular crop. Detailed information from these farmers relating to land holding, land revenue, imputed rent on own land as well as rent paid for leased in land (plotwise), particulars of attached farm servants, material inputs and irrigation charges (cropwise) record of production (cropwise), running and maintenance expenses of farm machinery and implements is collected periodically. In addition, records of daily operations, plotwise for each crop are also kept by the cost-accounting method. Data on the above items are recorded not only for the main crops but also for the other crops grown by the selected farmers.

3.18 We obtained data for 5 districts , viz., Nashik, Ahmednagar, Pune, Satara and Solapur, for our purpose. For the sugarcane main sample, data are available for the years 1973-74, 1974-75, 1975-76, 1976-77 and 1977-78. For jowar main sample, data are available for 1973-74, 1974-75, 1975-76 and 1977-78, and for bajra main sample, data are available for only 1976-77. In all, data for 61 clusters were available and collected; as mentioned earlier, on the basis of 12 farmers per cluster, it works out to 723 farmers, for whom the data on the above-mentioned variables were available.

3.19 It may be mentioned here that so far as sugarcane, jowar and bajra are concerned, the input-output analysis is based only on the data from each of the respective main sample clusters; for instance, for sugarcane the data are processed only for sugarcane grown in the main sample sugarcane cluster and not for sugarcane grown in jowar and bajra clusters. Similarly, for jowar and bajra data are processed only from their main sample clusters. It is only in the case of other crops (other than sugarcane, jowar and bajra) that the data from all the main sample clusters are pooled together for the individual crops separately for further processing and analysis. Other than sugarcane, jowar and bajra, only those crops are considered which show a sizeable area under cultivation in the sample farms, and not all crops that are reported to be grown by the sample farmers.

3.20 Making use of the data of the sample farms mentioned above we have computed the amount of each of the physical inputs used and output realised per unit (acre) of land for different crops. Before we go into the results of the physical input coefficients of different crops estimated, it is necessary to take note of a few things.

3.21 First of all, scrutiny of the recorded data shows that size groupwise break-up of the input-output data, cropwise, leaves the sample size for each crop in each size-group so small, in terms of area under the crop, that estimating average input coefficient from such a small sample does not seem to be very meaningful. In those cases, however, where area under given crop was found to be substantial in each size-group, the estimates of input coefficients for different inputs did not show any marked variation from one size group to the other except for fertilizer in some cases. While estimating input coefficient, therefore, we have pooled the data for all the size-groups together. So the estimates of inputs coefficients are in the nature of averages for all farms, irrespective of size.

3.22 Secondly, the input-output data for each crop are recorded separately for that grown under well irrigation, canal irrigation and under dry condition. Again, if we considered the case of a crop grown on well and canal separately, the sample size (area under the crop) would be very small. Further, estimated input coefficients for a given crop grown on well and on canal did not show any marked variation from each other. In view of this our estimated input coefficients are in the nature of averages for irrigated crops, irrespective of source of irrigation.

3.23 Thirdly, the year to year variation in input coefficients is also not found to be significant, in other words, there is no marked variation from one year to other in the use of basic inputs, like seed, human labour, farm yard manure, irrigation, etc. As per the annual Season and Crop Report of the State Government, the year 1973-74, 1974-75, 1975-76, 1976-77 and 1977-78, for which we have the data recorded for most of the major crops grown, have been more or less normal years in terms of rainfall and its distribution, except 1974-75, when the rainfall and its distribution was less than normal. But even for 1974-75, most of the basic inputs were not significantly different from those of other years. In view of this, the input estimates are not presented for each year separately, but only the average of the years. Since the PLBC command area, located in Ahmednagar district is the subject of study, the data from the cost of production survey in Ahmednagar district alone is used here. The estimated input coefficients are presented in Table 3.3.

3.24 An interesting aspect relating to the use of inputs, particularly fertilizers and insecticides, in different crops, as seen from these data, may be noted here. It is seen that only in case of five crop - sugarcane, groundnut, cotton, onion and wheat - was there any significant application of fertilizers. There was little of it in case of all the other irrigated crops, not to mention the dry ones. Sugarcane recorded the highest amount per acre, but it was quite below the doses recommended by the extension agency. In case of the other four crops, it was even lesser. Similar was the picture in regard to farm yard manure. Insecticides/pesticides were reportedly used only on irrigated cotton fields, and to a lesser extent on wheat. In regard to all other crops, neither provision of irrigation nor use of improved seeds appeared to have led to any noticeable use of chemical fertilizers, insecticides, etc.

3.25 There was considerable variation in the rates of yield of most crops from year to year as well from farm to farm in the same year. This was largely due to differences in local soil, climate conditions and cultural practices besides the weather. Therefore, the average of yield rates over the years and sectors have been calculated and are given in Table 3.3. The problems arising out of the variations noticed will be discussed in the next chapter.

3.26 The physical inputs and outputs, which are average of the observed figures for a number of years, are valued at 1978-79 prices, as in case of the special sample survey farmers, presented earlier. The problems arising out of the variations in the relative prices of various outputs as well as inputs will be taken, up in the next chapter.

3.27 The gross value of output per acre includes the value of by-products as well as the main product. The costs (inputs) taken, into account include costs of all materials used, whether purchased or home supplied, costs of bullock labour hired, purchased or farm supplied, the labour charges, both hired as well as the imputed value of family labour. Since the interest is in estimating the net income due to a unit of canal water, the costs due to machine hours and diesel oil used, essentially in irrigation from wells, presented in rows 8 to 9 of Table 3.3, are excluded in calculating the total cost given in row 10.

3.28 The comparative picture *per acre* of net return of various crops under irrigation, given in Table 3.4, is very similar to what was seen earlier under the sample survey of PLBC and NLBC farmers. Sugarcane, whether 'Adsali' (18-20 months) or 'Suru' (annual), gives the highest net income per acre under irrigation. The next highest irrigated crop, onion, gives only two-thirds of the income from 'Adsali' sugarcane, but was not far below the annual sugarcane. The irrigated cereals, like wheat (HYV), Hybrid Jowar and Hybrid Bajra gave less than one-third of the income of 'Adsali' sugarcane. But, this is not the proper way to compare the data. In the first place, 'Adsali' sugarcane stands for 18 to 20 months on the field before harvest, and 'Suru' for about 12 months. Most seasonal crops stand for about $4\frac{1}{2}$ months, so that at least two seasonal crops can be grown in a year and more than 3 in 18-20 months on the same land. Moreover, the requirements of water of these crops are quite different. Therefore, the proper way to compare these returns is to calculate the net return per unit of irrigation water from every crop.

Table 3.3 Per Acre Inputs and Outputs in Physical and in Value Terms for the Principal Crops (Ahmednagar District)

		Name of the Crop							
		Cotton (HYV)	Groundnut (HYV)Kh. Irrigated	Groundnut (HYV) Kh.Dry	Groundnut (Local) Kh.Irri.	Groundnut (Local) Kh.Dry	Maize (Irri-gated)	Onion (Irri-gated)	Lucern (Irri-gated) Fodder
(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Area under the crop (Acres)		7.41	18.41	18.88	10.83	25.02	4.42	4.67	8.21
1) Seed	Q. (Kg)	2	35	28	40	39	10	4	11
	V.(Rs.)	40	175		160	171	25	180	25
2) F.Y.M.	Q. (Kg)	1000	500	200	500	450	2000	1500	1000
	V.(Rs.)	35	20	5	15	15	70	55	35
3) Fertilizer	Q. (Kg)	100	50	--	25	--	50	150	-?
	V.(Rs.)	50	75	--	40	--	75	225	-?
4) Pesticide	Q. (Kg)	--	--	--	--	--	--	--	-?
	V.(Rs.)	100	--	--	--	--	--	75	-?
5) Irrigation charges									
(Canal)	V.(Rs.)	50	30	--	30	--	30	50	300
6) Human labour days	Q.	70	45	30	30	20	30	90	20
	V.(Rs.)	280	180	120	120	80	120	360	80
7) Animal labour days	Q.	8	8	6	8	6	10	8	4
	V.(Rs.)	96	95	70	95	70	120	95	48
8) Machine hours	Q.	134	22	--	24	--	25	100	38
	V.(Rs.)	94	20	--	18	--	19	100	21
9) Diesel Oil	Q.	150	80	--	70	--	--	100	--
Ltrs.(Irrg)	V.(Rs.)	375	200	--	175	--	--	250	-?
10) Total Cost Excl.									
Cls. 8 & 9	V.(Rs.)	751	650	3411	460	336	440	1040	488
11) Main Product	Q.	3.5	4.5	2	3	2	5.5	60	70
	V.(Rs.)	1400	1125	500	750	500	825	2100	1050
12) By-product (quintal)	Q.	-	6	2.5	4	2	6	-	-
	V.(Rs..)	-	50	30	50	25	50	-	_

(Contd.)

Table 3.3. (Contd.)

		Name of the Crop							
		Jowar (HYV) (Irri-gated)	Jowar (Local) Irrigated	Jowar (Local)Dry	Bajra (Hy.) Irrigated	Bajra (Local) (Irri.)	Bajra (Local) (Dry)	Wheat (Hy.) (Irri.)	Wheat (Local) (Irri.)
(1)		(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Area under crop (Acres)		16.83	57.53	162.90	17.62	18.90	59.23	180.66	85.90
1)	Q. (Kg)	3.0	4.0	4.0	2.5	2.0	2.5	37	35
	V.(Rs.)	35.0	8.0	8.0	25.0	4.0	5.0	88	77
2)	Q. (Kg)	1500	1000	100	1500	1200	200	1000	700
	V.(Rs.)	50	35	5	50	40	7	35	25
3)	Q. (Kg)	30	15	--	20	15	--	100	50
	V.(Rs.)	50	20	--	30	25	--	50	75
4)	Q. (Kg)	3	--	--	--	--	--	--	-?
	V.(Rs.)	20	--	--	--	--	--	--	-?
5)	V.(Rs.)	30	30	--	30	30	--	30	30
6)	Q.(days)	40	25	15	40	30	15	36	30
	V. (Rs.)	160	100	60	160	120	60	145	120
7)	Q.(days)	7	7	4	7	7	5	8	7
	v. (Rs.)	80	80	48	84	80	60	95	80
8)	Q.(Hrs.)	4	10	--	14	13	--	42	29
	v. (Rs.)	1	3	--	12	11	--	19	24
9)	Q.(Ltrs)	40	20	--	35	15	--	75	50
	V. (Rs.)	100	50	--	85	35	--	185	125
10)	v. (Rs.)	425	273	121	379	299	132	543	407
11)	Q.	8	4	1.5	6	4	2	6.5	4
	v. (Rs.)	840	500	187	750	500	250	975	600
12)	Q.	15	18	6	13	8	6	7	7
	V. (Rs.)	70	90	35	70	50	36	60	50

(Contd.)

Table 3.3. (Contd.)

		Name of the Crop						
		Wheat (Local)	Gram Irrigated	Gram Dry	Cotton (Hy.)Hot Weather	Groundnut (Hy.)Hot weather	Sugarcane (Adsali)	Sugarcane (Suru)
(1)		(18)	(19)	(20)	(21)	(22)	(23)	(24)
Area under crop (Acres)		34.79	54.51	79.43			62.64	13.75
1)	Q. (Kg)	27	21	19	2	30	13,500	13,000
	V.(Rs.)	54	46	38	70	130	600	600
2)	Q. (Kg)	100	115	--	1500	1000	5000	4160
	V.(Rs.)ı	5	6	--	55	35	175	145
3)	Q. (Kg)	--	25	--	150	100	600	480
	V.(Rs.)	--	40	--	225	50	900	700
4)	Q. (Kg)	--	--	--	--	--	--	-?
	V.(Rs.)	--	--	--	100	--	--	-?
5)	V.(Rs.)	--	30	--	150	100	550	400
6)	Q.(days)	15	22	15	80	45	140	120
	V. (Rs.)	60	88	60	320	180	700	600
7)	Q.(days)	5	6	4	10	8	20	20
	V. (Rs.)	60	70	48	120	95	240	240
8	Q.(Hrs.)	--	12	--	--	--	350	280
	V. (Rs.)	--	8	--	--	--	350	280
9)	Q.(Ltrs)	--	25	--	--	--	350	280
	V. (Rs.)	--	60	--	--	--	875	700
10)	V. (Rs.)	179	280	146	1040	690	3165	2705
11)	Q.	2	3	1.5	4.5	4.5	360	300
	V. (Rs.)	300	540	270	1800	1125	4680	3900
12)	Q.	3	3	1	--	6	--	-?
	V. (Rs.)	20	30	10	--	50	--	--

NOTES: 1) Physical coefficients of inputs are based on averages for the year 1973-74 to 1975-76 in the case of jowar, for the year 1976-77 in the case of Bajra, for the year 1973-74 to 1977-78 in the case of Sugarcane and all other crops.

2) Irrigation charges shown in the computation of total cost per acre are for canal irrigation only. In the case of lift irrigation, instead of canal irrigation charges, cost of machine hours and either of diesel oil or of electricity need by considered assuming that the entire machine hours is for irrigation only.

Table 3.4. Cost and Return Per Acre of Principal Crops (Irrigated) from Cost of Production Survey

(Ahmednagar District)

Name of the Crop (all Irrigated)	Avg. cost of cultivation	Avg. Production per acre		Value of Production per acre		Total	Net Income (per acre)
		Main product (Quintal)	By-product (Quintal)	Main product (Rs.)	By-product (Rs.)	(Rs.)	(7)-(2)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sugarcane (Adsali)	3,165	360.0	--	4,680		4,680	1,515
Sugarcane (Suru)	2,705	300	--	3,900	--	3,900	1,195
Hybrid Jowar-Kharif	425	8	15	840	70	910	485
Jowar (local) Rabi	273	4	18	500	90	590	317
Bajra (HYV)	379	6	13	750	70	820	441
Bajra (local)	299	4	8	500	50	550	251
Wheat (HYV)	543	6.5	7	975	60	1,035	492
Wheat (local)	407	4	7	600	50	650	243
Groundnut (HYV)-Kh.	650	4.5	6	1,125	50	1,175	525
Groundnut (local) Kh.	460	3	4	750	50	800	340
Cotton (HYV)- Kharif	751	3.5	--	1,400	--	1,400	649
Gram (local)	280	3	3	540	30	570	290
Maize (local)	440	5.5	6	825	50	875	435
Lucern (Fodder)	488	70	--	1,050	--	1,050	562
Onion	1,040	60	--	2,100	--	2,100	1,060
Cotton (HYV) HW	1,040	4.5	--	1,800	--	1,800	760
Groundnut (HYV) HW	690	4.5	6	1,125	50	1,175	485

Table 3.5. Irrigation Water Requirement of Crops at Distributor Head and the Net Value of Product per Unit of Water Used (1978-79)

Name of the Crop	Water requirement (acre inch)	Area that can be irrigated per Mcft. of water (acres)	Net profit per acre (Rs.)	Net Value of produce per Mcft.
(1)	(2)	(3)	(4)	(5)
1. Sugarcane (Adsali)	175	1.55	1,515	2,348
2. Sugarcane (Suru)	136	2.00	1,195	2,390
3. Bajra (HYV-Kharif)	20	13.80	441	6,086
4. Bajra (local)	20	13.80	251	3,464
5. Groundnut (HYV-Kharif)	24	11.50	525	6,038
6. Groundnut (Local-Kharif)	24	11.50	340	3,910
7. Cotton (HYV-Kharif)	24	11.50	649	7,463
8. Maize (local kharif)	20	13.80	435	6,003
9. Hybrid Jowar (Kh.)	15	18.40	485	8,924
10. Jowar (Local-rabi)	22	12.50	317	3,962
10a.Jowar (Hy-Rabi)	22	12.50	485	6,063
11. Wheat (HYV)	30	9.20	492	4,526
12. Wheat (Local)	30	9.20	243	2,235
13. Onion (R.abi)	36	7.65	1,060	8,109
14. Gram (Local)	18	15.30	290	4,437
15. Onion (Hot weather)	42	6.55	1,060	6,943
16. Maize (Hot weather)	36	7.65	435	3,328
17. Cotton L.S. (hot weather)	42	6.55	760	4,978
18. Groundnut (hot weather)	36	7.65	485	3,710

NET RETURN PER UNIT OF IRRIGATION WATER

3.29 In order to calculate the net return per unit of water from different crops, we should have the data on total irrigation water requirement of different crops. For this purpose we propose to use our estimate of demand from different crops at the distributory head, presented in Table 2.10, after some adjustments made on the basis of other relevant data. These are given in Table 3.5. It is useful to use the estimated water requirements of different crops at the distributory head rather than at the field head in order to take account of the loss in transit. This is also how the irrigation department estimates irrigation requirements as well as allocation of water to crops in a season. This leaves the possibility of improvement in the water distribution system that can further reduce the demand of various crops at the distributory head open. Now, given a discharge of one million cubic feet (Mcft), of water at the distributory head we calculate the area of a crop that can be irrigated with that quantity of water the command area below the distributory. These are also given in Table 3.5. Given the area of a crop that can be irrigated, the net income generated by that area of the crop is estimated by multiplying it with the net income per acre in Table 3.4. The last column of Table 3.5 gives this. A similar set of data, based on the per acre costs and returns of different irrigated crops, derived from the special survey in PLBC command, (Table 3.1) are also presented in Table 3.6. Since the two tables show similar results, we propose to use the information in Table 3.5 for discussion and further use.

Table 3.6. Economics of Alternative Crops in Terms of Net Income Per Unit (Mcft) of Water

Crop	Per acre water requirements in acre inches	Area that can be irrigated per Mcft of water in acres	*Net value of produce per Mcft of water in Rs.
(1)	(2)	(3)	(4)
Sugarcane	175	1.60	2336
Hybrid jowar	15	18.40	6955
Bajra	20	13.80	2139
Groundnut (Kharif)	24	11.50	5980
Jowar	22	12.50	3650
Wheat	31	9.20	3606
Gram	18	15.30	2295
Cotton (Summer)	42	6.60	4059

* Net income per acre of irrigated land taken from Table 5.1.

3.30 The net income per Mcft of irrigation water, generated from different crops reverses the ranking of crops seen on a per acre basis earlier. Sugarcane turns out to be the crop that generates the lowest income per Mcft of water, at the given level of prices of the inputs and outputs. All the cereals crops show a higher net income per Mcft of water; hybrid jowar in particular shows comparatively very high net income. Among the cash crops, cotton onion and groundnut show very high incomes. All this happens be cause though the net income generated per acre of the irrigate; seasonal crops is lower than that from sugarcane, many more acre of the seasonal crops can be irrigated with an Mcft of water. It is clear that in situation like in the drought prone dry agricultural regions of Maharashtra, where irrigation water is potentially in short supply and where therefore the question of choice an-crop or crops for irrigation arises, use of the water for sugarcane turns out to be economically least efficient.

3.31 the matter can be examined from a somewhat broader social angle as well. The calculations above have been in terms of the net income generated, per acre or acre-inch of water. The measure of net income used is relevant for the farmer in deciding the choice of crops for the use of scarce water. The matter can be looked at from the social point of view, where it would be useful to find out what addition to the gross national product can be the use of a given quantum of water make in agriculture of the region. The approximate gross national product or gross value added per acre of the different irrigated crops are arrived at by deducting the cost of all material inputs from the gross value of output. In our calculation in Table 3.3, the only item that will not be taken into account is the cost of human labour, both family and hired. The gross value added per acre of different irrigated crops is presented in Appendix Table A.3.9. The picture is very similar to that relating to net income per acre. The gross value added per Mcft of water also shows a similar relative position as net income per acre inch of water. It is clear that under prevailing conditions use of irrigation water for sugarcane adds the least to social income. Most other crops are much better placed in that regard.

3.32 It was noted earlier (Chapter I) that cultivators in the past were reluctant to use water for irrigating seasonal crops, except in years of abnormally low rainfall. M. Vishweswaraya had mentioned that while irrigating a seasonal cereal crop gave greater yield, its cost was also higher, leaving no greater net income than what the unirrigated crop would give in a year of normal rainfall. This picture appears to have changed. The net incomes per acre of irrigated jowar and bajra are higher than that of unirrigated ones. What is more, the new hybrids give a distinctly higher net income. There is no reason to think that farmers would be reluctant to irrigate hybrid jowar or bajra crops even in a year of good rainfall in these drought prone regions. Newer varieties, stabler and higher yielding, are gradually being introduced; these and better extension would lead to greater use of plant nutrients leading to higher net incomes from these seasonal crops. The developments are likely to further improve the efficiency of irrigation water in all such crops.

3.33 While most other irrigated crops give a higher net income compared to sugarcane, one cannot expect farmers to grow any one of these crops exclusively. Normally, farmers follow certain crop rotations, depending on soil condition, agronomic requirements labour supply position, besides market condition. A number of such crop rotations, as alternatives to (i) Adsali sugarcane, which stands on the field for 18-20 months (July to February) and (ii) Suru sugarcane which stands on the field for 12 months (November to November) are proposed in Table 3.7. These rotations have been finalised in consultation with and on the advice of the Professor of Agronomy at the Water and Land Management Institute at Aurangabad.

3.34 On the basis of these crop rotations, the total water requirement of the entire rotation can be estimated and the number of acres on which every one of these rotations can be practised with one Mcft of irrigation can be worked out. This gives a basis for estimating the net income from every one these crop rotations from one Mcft of water, which can then be compared with the net income from the corresponding area under Adsali or Suru sugarcane, as the case may be. This is attempted in Table 3.8.

3.35 The exercises show that every alternative crop rotation generates greater total net income than sugarcane, in all cases more than two times that of sugarcane. Further, if any of the alternative crop rotations is followed on a single plot of land (on which the alternative is sugarcane), then the alternatives to *Adsali* sugarcane can irrigated 30 to 60 per cent more net sown area, and the alternatives to Suru, 50 to 100 per cent more net sown area, depending upon the alternative crop rotation.

3.36 This point of view has acquired growing acceptance and support from informed irrigation engineers, scholars and knowledgeable public men. In the *Interim Report of the Committee* (set up by the Government of Maharashtra) *to study the Introduction of Eight monthly supply of water on the Irrigation Projects in Maharashtra* this point of view has been very strongly advocated. In fact, this Committee for a comparatively smaller irrigation project on the same Pravara river (Mahaldevi Project) shows (Table 8 of the Report) difference among returns to per acre-inch of water from different crops, similar to those calculated here in this study. Indeed, in the serious water scarce regions, the Committee advocates extensive irrigation, covering one-fourth of the total cultivated area of the cultivator in the Kharif season and another one-fourth in the Rabi season, thus covering 50 per cent of the command area with irrigation. Our crop rotations above are in the nature of intensive irrigated farming on the same piece of land, three crops being grown in the three seasons of the year. If this is relaxed and farmers are persuaded or permitted to take water of only a given amount, without any specification of crop rotation on a given piece of land, a much wider area can be irrigated for at least one, possibly two crops during the year. This, of course, would not affect the net income generation, estimated earlier. We shall turn to these and other related questions in chapter V. But before that it is necessary to raise and answer some questions relating to the basis of our calculations in this chapter, and the farmers' attitudes in the matter, to which we now turn.

Table A.3.8. Cropping Pattern of The Sample Farmers on their Total Operated Holdings Neera Left Bank (Non-Perennial Zone)

(Area in acres)

Size group of operational holding	Sugarcane	Pulses	Maize	Vege-tables	Wheat	Rabi jowar	Cotton (Mainly hot weather)	Groundnut (Mainly hot weather)	Others	Total Gross cropped area
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1. Upto 5.00 acres	0.75 (0.35)	3.50 (1.66)	7.75 (3.67)	1.25 (0.59)	5.20 (2.46)	154.38 (73.05)	15.00 (7.10)	19.50 (9.23)	4.00 (1.89)	211.33 (100.00)
2. Above 5.00 acres and upto 10.00 acres	15.23 (2.72)	32.05 (5.73)	21.56 (3.86)	3.38 (0.60)	37.89 (6.78)	354.03 (63.31)	44.25 (7.91)	28.00 (5.01)	22.84 (4.08)	559.23 (100.00)
3. Above 10 acres	63.84 (3.06)	285.83 (13.70)	72.00 (3.45)	26.00 (1.25)	82.49 (3.95)	1293.87 (62.00)	94.30 (4.52)	79.70 (3.82)	88.70 (4.25)	2086.73 (100.00)
All sizes	79.82 (2.79)	321.38 (11.25)	101.31 (3.55)	30.63 (1.07)	125.58 (4.40)	1802.28 (63.08)	153.55 (5.37)	127.20 (4.45)	115.54 (4.04)	2857.29 (100.00)

Note: Figures in the parentheses indicate percentages to total gross cropped area.

A.3.9. Gross Value Added by Different Crops Per Mcft of Irrigation Water

Crops	Gross Value Added per acre (Rs.)	No. of acres irrigable with Mcft (acres)	Total Value Added (2 x 3) (Rs.)
(1)	(2)	(3)	(4)
Irrigated Crops			
1. Sugarcane (Adsali)	2 215	1.55	3,433
2. Sugarcane (Suru)	1,795	2.00	3,590
3. Cotton	929	11.50	10,683
4. Groundnut (HYV-Kh)	705	11.50	8,108
5. Groundnut - HYV Sum.	665	7.65	5,087
6. Cotton - HYV-Summer	1,080	6.55	7,074
7. Maize - Kharif	555	13.80	7,659
8. Onion - Summer	1,420	7.65	10,863
9. Jowar - Hybrid	645	18.40	11,868
10.Jowar - Local Rabi	417	12.50	5,212
11. Bajra - Hybrid	601	13.80	8,294
12.Bajra - Local	371	13.80	5,120
13. Wheat - HYV	637	9.20	5,860
14. Wheat - Local	363	9.20	3,340
15. Gram	378	15.30	5,783
Unirrigated			
18. Groundnut - HYV Kh.	309	-	-
19. Groundnut - Local	269	-	-
20. Jowar - Local	161	-	-
21. Bajra - Local	214	-	-
22. Wheat - Local	201	-	-
23. Gram	194	-	-

CHAPTER IV

Returns to Irrigation Water under Uncertainties

4.1In the preceding chapter, the superiority of different combinations of seasonal crops over a sugarcane based irrigation system, in terms of net returns per unit of water, was established. Despite this, most farmers, given an opportunity, appear to go in for sugarcane in preference to seasonal crops under irrigation water: if the state is willing to supply unlimited water to farmers for growing sugarcane in specified areas, the farmers have no reason to refuse. But there are other considerations besides this. During the field survey, discussion with many farmers brought out their acceptance of the greater returns from irrigated seasonal crops than from sugarcane, for a given quantity of water. But they mentioned a number of other reasons that, in their opinion, make the farmers prefer sugarcane to seasonal crops. These may be summarised below:

(i) The minimum price of sugarcane is not only fixed (by government), but it is more than supported by the co-operative sugar factories. As against this, the prices of seasonal crops fluctuate highly from year to year and there is no effective check on this in the market.

(ii) Sugarcane is largely free from pests and diseases, and fluctuations in weather have the minimal impact on yield of sugarcane. On the other hand, the seasonal crops are subject to many diseases and pests and, even when irrigated, are affected by changes in temperature and rainfall.

(iii) Canal irrigation is not very regular and reliable despite the formal rules laid down by the irrigation department. Sugarcane can stand the stress arising out of this; most seasonal crops cannot, and therefore suffer in yield. Hence the preference for sugarcane.

(iv) Seasonal crops demand labour at different times, the operations are fixed and time specific and, therefore, cannot, be postponed. Sugarcane is just the opposite, with the requirement of labour after planting being essentially for irrigation and application of fertilizers which can stand postponement to a greater extent. And, finally, sugarcane does not demand as much of routine attention and care from the farmer as the seasonal crops do.

These various considerations are sought to be examined in what follows.

FLUCTUATION IN PRICES

4.2In the exercises in Chapter III, the prices of outputs and inputs used were those for the year 1978-9, prevailing in the PLBC area. However, it is necessary to examine how the relative prices have behaved over the years, in order to be reasonably assured that these prices are not of an exceptional type. For this purpose, the relative prices of a number of relevant crops were examined for a period of 16 years preceding 1978-79. Monthly average price data were collected from the *Statistical Abstract of Maharashtra State*, published by the Directorate of Economics and Statistics of the Government of Maharashtra, for 16 years, beginning 1960, for some selected primary market centres in the drought prone region, viz., Ahmednagar, Srirampur, Pune, Barsi. The annual average prices were calculated as simple averages of the relevant monthly prices. The annual average price of every other commodity in a year was expressed as a percentage of that year's price of Bajra, which was used as the base crop for the purpose. The years or centres for which Bajra prices were not available systematically, the price of Jowar was used as the base price. The relative prices of different crops, calculated in this manner, for years 1960 to 1976, for the four market centres, are given in Appendix Tables A.4.1 to A.4.4.

4.3A perusal of the relative prices shows that except for groundnut and pulses, the relative prices of other crops show no particular trend, though, of course, there are fluctuations from year to year.

4.4Similarly, independent studies[1] show that the relative value of wage rates in agriculture in Maharashtra, that is, the money wage rates deflated by the prices of farm products entering into the consumption of the labourers, show no upward or downward trend over long years. On the other hand, the relative prices of the two other major inputs, fertilizers and diesel oil, had shown a rising trend after 1973.

4.5It is useful to ask the question how low can the relative price of any of the seasonal crops-relative to sugarcane - can go before the net income per Mcft. of water from that crop becomes lower than that of sugarcane? In order to estimate this limit, We have tried to estimate the gross value of output, per Mcft. of water, from every one of the seasonal crops which will give he same level of net income as annual (Suru) sugarcane. Compared to the observed gross value for the year 1978-79, it indicates upto what extent, given the observed yield rate and the costs of inputs, the price of the seasonal crops can go down before

1. B. Santra, Agricultural Wages in India, 1979, unpublished Ph.D. thesis, in the Libraries of the Gokhale Institute of Politics and Economics, and the University of Poona, Pune.

sugarcane becomes more economical. Alternatively, the same percentage can be interpreted as the extent to which the per acre physical yield of the seasonal crops can go down, given the prices and costs of all crops (at 1978-79 level) before sugarcane becomes more economical in the use of irrigation water. The figures below indicate these percentages for various crops:

1.	Jowar - Hybrid-Kharif -	48%
2.	Bajra - Hybrid-Kharif -	36%
3.	Onion - Rabi and Summer -	33.3%
4.	Cotton - HYV-Summer -	33.3%
5.	Cotton - HYV-Kharif -	32%
6.	Groundnut - HYV-Kharif -	28%
7.	Maize - Kharif & Summer -	26%
8.	Jowar - Local-Rabi -	26%
9.	Wheat - HYV -	24%
10.	Gram - Local -	24%
11.	Bajra - Local -	16%
12.	Groundnut - Summer -	16%
13.	Groundnut - Local-Kharif -	16%

4.6The above table shows that the price of most crops had to fall by 25 per cent relative to the price of sugarcane, and in case of crops like cotton, onion and hybrid bajra by one-third and in case of hybrid jowar in the kharif season by nearly half, compared to the price of annual (Suru) sugarcane before these crops would yield a lower net income per mcft. of water let out at the distributory head, than sugarcane. Comparison with *Adsali* sugarcane would make these percentages somewhat higher.

4.7In point of fact, in most of the years since 1960-61, and particularly since 1968-69, the prices of the first 10 crops listed above compared to sugarcane had not fallen lower than the percentages indicated. Only the price of wheat compared to sugarcane had fallen by about 32 per cent in 20 per cent of the years and the price of jowar by nearly 50 per cent for nearly one-third of the time. One important reason for the price of jowar having remained low compared to the price of sugarcane or bajra for some years, was the policy of monopoly procurement of jowar by the State Government. Since this was given up, the relative price has not gone down to the extent estimated.

4.8All this goes to suggest that even with very considerable lowering of the relative prices of the irrigated seasonal crops, these crops continue to show greater return per Mcft. of irrigation water than sugarcane. The cultivator's fears do not appear to be borne out, except the fact that fluctuations in the prices of these crops results in fluctuation in net income from these irrigated crops, while this is less so in the case of sugarcane. This may give rise to the feeling of the farmers noted in the beginning of this chapter.

4.9Another factor responsible for this feeling is the variation in the prices of seasonal crops within a year. This variation, while not uniform from year to year, is sometimes quite high. This can cause genuine feeling of loss to the grower of seasonal crop(s) compared to sugarcane, which exhibits no such post-harvest price fluctuations. One important policy measure to reduce such fluctuations is the formulation and implementation of a minimum support price for the seasonal crops. While the Agricultural Price Commission (now called the Commission on Agricultural Costs and Prices) has been recommending and the Government announcing support prices for most of these crops, for more than two decades now, there is often no purchasing agency available at the primary 'market level to purchase at the announced support price, in most parts of the country excepting the wheat-rice belt in northern and north-western ,India, and a few pockets elsewhere. For millets (jowar and bajra) and gram and oilseeds there is no such effective agency in the field; for onions, NAFED has been carrying out this operation irregularly. Cotton is now under monopoly state marketing in Maharashtra. A proper mechanism to enforce support prices would go a long way in erasing this uncertainty relating to price of seasonal crops from the minds of the farmers.

4.10 A related exercise in the context of changing relative prices has also been carried out by using the prices prevailing in the year 1981-82. During this year the price of sugarcane doubled (from Rs. 130 a tonne to Rs. 260), while that of the seasonal crops went up to a much smaller extent: local jowar and bajra Rs. 180 (Rs. 125); hybrid jowar Rs. 140 (Rs. 105); wheat Rs. 220 (Rs. 150); groundnut Rs. 350 (Rs. 250); maize Rs. 180 (Rs. 150); gram Rs. 200 (Rs. 180); onion Rs. 60 (Rs. 35); cotton Rs. 500 (Rs. 400). Similarly prices of many inputs also rose. The net income per Mcft. of irrigation water separately for all these crops, by using the 1981-82 prices, but the same physical inputs and outputs as before, are given in Table 4.1. Table 4.2 gives the income from the different crops rotations mentioned in Chapter III.

4.11 The data show that despite a very high increase in the relative price of sugarcane - more than 50 per cent compared to other crops - the other crops, that is, all high yielding varieties an hybrids as well as onion, show a higher net income per Mcft. of water than sugarcane. Therefore, some crop rotations with these crops in particular, are still seen to be comparable to sugarcane.

GOVERNMENT OF MAHARASHTRA
MAHARASHTRA WATER & IRRIGATION COMMISSION REPORT
Volume I APPROACH (June 1999)

PREFACE
VOLUME I

The Maharashtra Water and Irrigation Commission had been constituted by the Government of Maharashtra in Irrigation Department through Resolution (Marathi) No. MIC 1095/224/IM (Policy), dated 5-12-1995 for recommending a perspective plan of action for sustainable development and management of water resources of the State. The Commission had formally commenced its activities on 25th January 1996. The Secretariat of the Commission started functioning in WALMI premises. Drafting of the Report continued till 30.6.1999 and it was finally submitted to the Government on 1.10,1999. It comprises 5 volumes covering about 2000 pages and 100 maps (forming bulk of Vol. IV and V).

A Compact Disk of this version is also being released alongwith that of Volumes II & III.

Aurangabad
April 2002

(S.A.Nagre)
Chief Engineer & Secretary
Maharashtra Water & Irrigation Commission

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No. MWIC/TS/F-1/2450 Date: 30th September 1999

To,
Hon’ble Chief Minister,
Maharashtra State, Mantralaya,
MUMBAI-400 032

Subject: Maharashtra Water & Irrigation Commission - Report

The Commission is pleased to present the Report of Maharashtra Water & Irrigation Commission. The Report of the Commission has been approved during its meeting in June 1999. However, the elections of the Legislative Assembly were declared thereafter and as communicated by the Government through letter No. MIC/1098/366/(70/98) IC., dated 23.7.99, the Commission has to wait before submitting the Report. The Report is brought out unanimously.

The Commission has been constituted through Government (I.D.) Resolution No.MIC/1095/244/I.M.(Policy), dated 5.12.95. After having taken into consideration the scope of the Terms of Reference, the name of the Commission has been changed to the Maharashtra Water & Irrigation Commission in pursuance to the Govt. (I.D.) Resolution No. MIC/71360/19-I.C.Cell, dated 20.10.97.

The Commission is grateful to the Government for offering a valuable opportunity for undertaking a study pertinent to an important subject which is related to the development of Maharashtra; and putting before the Government its findings.

Sd/-
M.A. Chitale
Chairman

Sd/- S.B.Kadrekar Member	Sd/- Bhujangrao Kulkarni Member	Sd/- Devram Gorade Member
Sd/- Bhavarlal Jain Member	Sd/- Sarjerao Thombre Member	Sd/- S.A. Deshpane Member
Sd/- B.B.Pujari Member	Sd/- U.M. Phadake Member	Sd/- S.B. Varade Member
Sd/- Balasaheb Wagh Member	Sd/- V.P. Shimpi Member	Sd/- D.M. More Secretary

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Ex-Secretary General
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Ex-Vice Chancellor,
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ABBREVIATIONS

AMS	Aggregate Measurement Support
BSI	Bureau of Indian Standards
CADA	Command Area Development Authority
CAPART	Council for Advancement for Peoples' Action and Rural Technology
CCA	Culturable Command Area
CDO	Central Designs Organisation
CGWD	Central Groundwater Board
CIR	Completed Irrigation Report
cm	Centimetre
CWC	Central Water Commission
CWPRS	Central Water & Power Research Station
DDP	District Domestic Product
DIRD	Directorate of Irrigation Research & Development
DISNET	Distribution net work
DRDA	District Rural Development Agency
DSO	Dam Safety Organisation
EEC	Europian Economic Community
EGS	Employment Guarantee Scheme
ESC	Engineering Staff College
ESP	Exchange Sodium Percentage
FIDC	Fishery Industry Development Corporation
FYP	Five Year Plan
GOI	Government of India
GSDA	Groundwater Surveys & Development Agency
GWDT	Godavari Water Dispute Tribunal
ICA	Irrigable Command Area
ICAR	Indian Council of Agricultural Research
ICOLD	International Commission on Large Dams

IMD	India Meteorological Department
IS	Indian Standard
ISCB	Inter State Control Board
JAICA	Japan International Cooperation Agency
km	Kilometre
KWDT	Krishna Water Dispute Tribunal
M & R	maintenance & repairs
MEDA	Maharashtra Energy Development Agency
MERC	Maharashtra Electricity Regulation Commission
MERI	Maharashtra Engineering Research Institute
Mld	Million litre per day
MLA	Member of Legislative Assembly
MNES	Ministry of Non-conventional Energy Sources
MOEF	Ministry of Environment & Forest
MOWR	Ministry of Water Resources
MSA&RDC (Bank)	Maharashtra State Agricultural & Rural Development Cooperative (Bank)
MSEB	Maharashtra State Electricity Board
MSRTC	Maharashtra State Road Transport Corporation
NA	Not available
NGO	Non Governmental Organisation
NHP	National Hydrology Project
NSDP	Net State Domestic Product
NWDA	National Water Development Agency
NWDPRA	National Watershed Development Project of Rainfed Area
NWDT	Narmada Water Dispute Tribunal
NWP	National Water Policy
O & M	operation & maintenance
OM & R	operation, maintenance & repairs
PBR	Plant Breeder Right
PIP	Preliminary Irrigation Programme
FWD	Public Works Department
R&D	Research and Development
RIDF	Rural Infrastructure Development Fund
SD	Standard Deviation
SOPPECOM	Society for Promoting Parcipative Ecosystem Management
SQA	Statistical Quality Analysis
UNO	United Nations Organisation
WALMI	Water and Land Management Institute
WMO	World Meteorological Organisation
WTO	World Trade Organisation
YASHADA	Yashwant Chavan Academy Development Administration

Conversion Factors

1	1 Mm^3	35.32 Mft^3
2	1 TMC	28.31 Mm^3
3	1 km^2	100 hectares
4	1 TCM	1000 m^3
5	1 BCM	1000 million m^3
6	1 $mile^2$	2.59 km^2
7	1 Mcft	1 Million ft^3
8	1 cumec	35.32 cusec

Chapter 1
PREFACE

Subsequent to the formation of the Maharashtra State, the First Irrigation Commission had been constituted in 1960 under the Chairmanship of late S. G. Barve for undertaking study of various issues pertinent to irrigation development and suggesting long term policy of irrigation *vis-à-vis* the working methodology. The Commission reported to the Government in 1962. The planning of water and irrigation during the last 35-36 years is being pursued in consonance with the recommendations it offered. The Commission had made around 200 recommendations which among others include the availability of surface water in major basins of the State, its use, planning of irrigation projects, development of irrigation area, financial aspects of irrigation, irrigation water distribution system, etc. Most of the recommendations were accepted in full and few partly, and implementation has been underway accordingly.

2. Enormous growth in population during the intervening period, changing standard of living and the industrialisation have led to increase the overall demand for water. Water for domestic consumption, industrial use and hydroelectric generation is required to be reserved. The all-out demand for water had made it imperative to prioritise requirements for diverse purposes such as domestic use, irrigation, industrialisation, etc. Health and environment-consciousness have led to heightened expectations about the quality of water and attested its importance in the water management. Growing awareness regarding development of various regions of Maharashtra *vis-à-vis* issues pertinent to imbalance and backlog in development, relentless and uncontrolled draft of groundwater increased with the pace of development, pollution of water sources as a result of municipal and industrial use culminating into pollution of both surface and subsurface reservoirs are some of the newly emerging issues which are assuming a serious proportion rendering the management of Water resources development increasingly difficult and complex.

3. Based on this premise and in view of the changed scenario, the Government of Maharashtra constituted the MAHARASHTRA SECOND IRRIGATION COMMISSION in December 1995 (Appendix - 1) in order to undertake an uptodate study of issues pertinent to irrigation and water resources development in the State and to report the Government. The transactions of the Commission commenced formally in January 1996. The Commission's Office was then opened at Aurangabad in the Water and Land Management Institute (WALMI) premises. The deliberations held in the Commission in pursuance of guidance offered by the then Honourable Chief Minister Shri Manoharrao Joshi in his inaugural speech and also that by the then Honourable Irrigation Minister Shri Mahadeorao Shivankar (in his capacity as the Convenor of the Commission) through the prolonged discussions he had had with the Commission in its beginning meet, when considered in conjunction with the Commission's formal Terms of Reference (TOR) revealed that the different parts of Maharashtra are finding difficult to reconcile the growing need of irrigation in the State with the increasing requirement of rural & urban water supply and that of industrialisation. It is therefore, considered essential to go in for an integrated consideration of all - irrigation, rural & urban Water supply and water for industrial needs - in the context of water that is grossly available instead of viewing through an isolated consideration of irrigation management alone. It was appreciated that the name of the Commission be changed to 'Maharashtra Water and Irrigation Commission' instead of allowing it formally to remain as 'Irrigation Commission' merely in order to enable it to undertake the study from that perspective and pave way for holding discussions with thinkers and scholars of the society. A request to that effect was extended to Government in March 1997. In

response to this, the Government changed the name of the Commission by issuing formal order in October 1997 (Appendix-2).

4. The composition of the Commission also underwent few changes during its tenure. Dr. S.B. Kadrekar, Ex-Vice Chancellor, Konkan Agricultural University, Dapoli was inducted as a member of the Commission - to represent Konkan Region in June 1997. Shri Munjajirao Kadam made a request to the Government in July 1998 to relieve him from the Commission's obligations on personal grounds (by tendering his resignation which was accepted by the Government subsequently).

Outline of the Report

23. The Report of the Maharashtra Water and Irrigation Commission has been brought out in 5 volumes the scheme of which is as per the following:

Volume I: This is the core of the Report. It contains topicwise approach alongwith of which numerous recommendations are scattered here and there. Moreover, a brief resume of key recommendations is presented at the end of the Volume as Chapter 14. Running through pages, the exposition of the Volume is divided into 12 chapters and which in turn encompass 109 topics.

Volume II: This outlines sub-basin specific 'The Planning Perspective' of sub-basinwise planning and management. The Volume contains one independent chapter on planning and management of each of the sub-basins or basin/sub-basin groups as delineated by the Commission. The Maharashtra is divided by the Commission into 25 sub-basins (basin/sub-basin groups) for the sake of water management. The indications as to the manner in which the principles and recommendations contained in Volume I will sub-basinwise be made applicable to these sub-basins are exemplified in the chapters throughout this Volume.

Volume III: All appendices and statements are presented in a consolidated manner in this Volume. The information and analysis thereof on the basis of which the exposition in Volume -I is presented, are included in these appendices and statements. In all, 41 such appendices and 62 statements are incorporated. Personal acknowledgements to all those who had had interaction with and those personnel and organisations who rendered assistance to the Commission in this respect are included in the very appendices of this Volume.

Volume IV: This contains maps of Maharashtra. Topical maps of the State - 22 in number - forming base of the approach as elucidated in Volume I are incorporated.

Volume V: Detailed sub-basinwise maps are presented in this Volume. Sub-basinwise information supplementary to the sub-basinwise exposition of Volume II compressed in 2 maps for every sub-basin is incorporated in this Volume for reference. Having amalgamated a few small sub-basins with the adjoining larger ones such maps, in all, number 44.

24. Paragraphs in the Commission's Report are numbered employing decimal system in preference to numbering serially. According to the system the first digit indicates the serial number of the Chapter. The topic is indicated by the second digit and the third digit refers to the paragraph under the topic. Sub-paragraphs are not numbered. Annexes, graphs, diagrams and maps which are illustrative of exposition and with which the chapters are teemed follow the text of respective chapters as they appear in Volume I whereas other references and analysed data are attached as appendices and statements in Volume-III and are compiled chapterwise.

Expounding the Subject

25. Fortunately Maharashtra is bestowed with an age-long tradition of water management and irrigation from prehistoric times. The **Phad** System on weirs across Panzara and Mosam Rivers in Tapi Basin or thousands of irrigation tanks belonging to Gond Era in Wainganga Basin are still extant. They are testimony to the irrigation development attained locally in the recent historical past. Clues to the social tenets and finer details as to the climate and land - which are key factors in local management -are replete throughout this developmental systems. That is why the Commission's Report starts with a brief resume of the historical past of water - related developments in Maharashtra under the caption of 'Maharashtra and Water Resources' as its Chapter 2. The expansion of irrigation achieved in recent past thereafter and the brain storming that ensued thereof have found expression through the reports of various commissions and committees which preceded this Commission. The Chapter 2 of this Report initially undertakes an overview of that also at the outset. Many such principles applicable to the current situation are found to be deliberated upon even in these reports, take for example, that of distributing limitedly available water over an extensive area.

26. The basic objective of irrigation development has been to effect substantial 8 increase in agricultural productivity leading thereby to prosperity of rural area. In view of this, it was considered necessary to have an appraisal of the present status of rural area. A review of economic condition of various districts was, therefore, undertaken; the data in regard to average gross annual income *vis-à-vis* the status of literacy was analysed. The outcome has been presented in Chapter 2. While deciding priorities of future irrigation programmes to be undertaken, the districts of Dhule, Jalna, Buldhana, Gadchiroli - which have remained backward in economic development - deserve special priority in taking up water resources development and irrigation expansion programmes here-in-after. Clear indication in respect of this is found in the exercise of analysis conducted in the very Chapter 2.

27. It has, so far, not been possible to assess availability of water in different sub-basins on an equal footing. As such, the sub-basinwise details presented in this Report serve only a limited purpose namely that of indicating the comparative status of the sub-basins. It is necessary to undertake such studies of sub-basins in much more details based on the state-of-art of Hydrology. At the outset of the Report in Chapter 2 itself, the Commission has recommended taking up such studies on priority. Especially total availability and the interrelation between surface and groundwater have, it appears, not been spelt out concretely. As per the river tribunal awards in respect of rivers like Krishna, Godavari and Narmada there is a full freedom to the states to use groundwater within their respective territories. This, therefore, necessitates to have concrete estimations of groundwater potential of different sub-basins. For the present, the total availability of water in a sub-basin is assessed on the basis of estimation of average annual surface runoff. Based on this, the sub-basins in the entire State are grouped under 5 categories in Chapter 3 titled 'Basinwise Water Planning And Management'. They are; highly deficit, deficit, normal, surplus and abundant in tune with the availability of water for the purpose of planning and management.

28. Priority in respect of diversion of water to various uses is going to be different in different sub-basins in accordance with the current status of development, natural availability of water and conditions favourable to irrigation or other water - dependent activities in respective sub-basins. An attempt is made to offer tips in regard to this in individual chapters of sub-basins in Volume II of the Report.

29. It is essential to go in for a detailed consideration as to the way in which the best possible use of water in Konkan Region is achieved where 42 percent of the water that is available in Maharashtra is extant. It is a water - abundant region. Nevertheless, the Barve Commission assumed a stand that technically there is the least scope to dam building activity and creating water impoundments in Konkan. The experience over the last 3 decades, however, shows that even the large dams are quite efficient functionally as well as from the safety point of view provided they are designed and built with due care. As on today, there are over 130 large dams in Konkan. Therefore, the question now remains not of successfully undertaking dam building programme and creating storages but that of evolving the best methods of water distribution and streamlining its use. Quite peculiar topography and climatic conditions of Konkan demand a very different approach in developing methods of water distribution than the rest. That is why, the Approach laid down in Volume-I is not expected to be fittingly applicable to Konkan in many respects as it is to other parts. The pertinent issues are, therefore, separately discussed in the respective chapters pertaining to Konkan in Volume-II.

30. It will be appropriate to determine inter-se priority amongst various programmes by provoking more comprehensive sub-basinspecific interaction in an open forum in the respective sub-basin for accomplishing a detailed planning for their development. It is not proper to assign priority to the same type of programme or campaign throughout the State as is being practised currently. It is necessary to interlink the developmental needs of the respective sub-basins appropriately with the water availability and geographical configuration.

31. Irrigation facility is a factor which provokes disparity in rural life. It is necessary to distribute the limitedly available water over as large an agricultural area as is possible so as to lend, in the minimum, an economic stability to the agriculture in drought prone area by virtue of irrigation and at the same time to minimise disparity. Distinct criteria for implementing the measures for deficit and highly deficit sub-basins are proposed for that in the Report. On similar lines, it is essential to generate employment potential in rural areas - which is not dependent on agriculture - on a large scale through the processing enterprises of agricultural produce and other productive activities & service facilities. From this viewpoint, a review of marketing, processing enterprises and industries has been taken in Chapter 4 devoted to the topic of ‘Agriculture and Irrigation.’

32. Anyhow, the irrigation system is now being realigned through social and economic transformation towards the overall economic upliftment of rural area from that of the system initial objective of which merely was that of providing for protection of foodgrain production. The people voluntarily of their own are inclined to a shift in cropping pattern on account of the economic variants, paucity of water and market rates. For example, there is an increasing trend towards growing grapes in lieu of that of sugarcane. On a similar line fruit gardens, vegetables, floriculture are going to play a dominant role here-in-after in irrigation management. An overview of needs therefor and export potential of irrigated produce has, therefore, been covered in Chapter 4. The increasing trend of globalisation in marketing is going to cause, it appears, countless important changes in demand of agricultural produce in Maharashtra. The change over in the irrigated cropping pattern in accordance with that is therefore inevitable.

33. In order to arrest the influx to urban life from that of rural, it is essential to convert more and more rainfed tracts into multi-seasonal irrigated area by extending irrigation facilities. But, the agricultural set up is not going to bring about the transformation to perennial irrigation in view of the deficient water scenario in a good number of sub-basins. Despite this, a farmer be enabled to sustain himself with an adequate dignity in the new economic set up with the support of culturable land he owns and to accrue agricultural production in at least two seasons from all the culturable land in his possession will have to be the main objective of agriculture here-in-after. The *kharif* crop should mainly be sustainable on rains with bare minimum support of irrigation only when that is necessary; one more assured independent crop mainly supported on irrigation in rabi thereafter, however, be desired. With the objective of effecting planning of such sub-basins by establishing such a two-seasons-cropped system in irrigated areas is suggested. In most of the years such two crops could be grown. During drought years at least one crop be ensured in such areas. On the contrary, the irrigation management system is to cater to enable accrual of one more, i.e., the third seasonal crop additionally during years of excessive rains (around 20% in number) in which water is available in plenty. The changes in cropping pattern will have to be effected 10 in accordance with the yearly rains on account of the year-to-year variability as to the water availability. In order to achieve this with least difficulty, going in for a mixed cropping system will be beneficial in benefited areas and the Commission has advocated its adoption in irrigation management.

34. The earlier planning of dams and canals has been accomplished from the viewpoint of placing the agricultural activity on a safe footing by lending a relief basically to drought prone area during the British period prior to independence. Therefore, the main thrust of field investigations and formulation of projects had long been remained of determining where and how the storage reservoirs, weirs and gravity canals be located. Now the planning of project is instead desired to tread upon the line of increase in agricultural productivity and multifaceted rapid economic development of irrigated zone in its wake. On that count numerous changes in project formulation and creation are warranted. A discussion to that effect is included in Chapter 5 titled "Project Planning and Construction" of the Report. The issue of acquisition of land in possession of the Forest Department has long been remained beseeching and lent a tenseness to the project construction. This is highly regrettable. Especially the progress of Vidarbha in water resources here-in-after is going to rest on the policy as to the acquisition of land in possession of the Forest Department. A discussion at length in regard to that also has, therefore, being made to form a part of Chapter 5.

35. The agricultural productivity in irrigated areas is not going to increase unless skills in irrigation technology are improved. Canal management is one intricate issue in the very irrigation management. It is clearly apparent that the larger most irrigated area in Maharashtra is going to be that on canals despite adoption of various alternatives for achieving irrigation. Therefore, distribution of canal water and its management will here-inafter be a matter of more concern. Various aspects in this respect are duly weighed upon in Chapter 6 of this Volume. Productivity through every drop of water is required to be increased in water deficit areas. Irrigation methods enabling highly economic use of water such as drip etc. are, therefore, required to be specially pursued in irrigated areas. Detailed exposition of this is also incorporated in the same Chapter.

36. As the initial 25 years of the planned development were passing by, i.e., around 1975, a more critical evaluation of performance of irrigation projects completed till that, utilisation of irrigation potential created and productivity potential of command areas attained till that started taking place. A comprehensive concept of Command Area Development transcending beyond the project formulation and its execution has come to the fore. The committee of Irrigation

Ministers appointed by the Central Government under the chairmanship of the Ex-Chief Minister of Maharashtra late Vasantdada Patil gave impetus to this new conception. This led to the creation of CAD authorities which necessitated paying attention to adoption and operationalising interdisciplinary management system in the field of irrigation. Besides instituting logistic support organisations such as MERI, ESC, CDO, DIRD merely for imbuing quality in engineering practices, it became imperative to create interdisciplinary organisations like WALMI and CAD authorities. It was expected to evolve an agricultural productivity - oriented irrigation set up along the lines suggested in the report of the National Irrigation Commission of 1972 by streamlining this new set up of interdisciplinary agriculture based system during the last 25 years. However, that didn't materialise. Therefore, a detailed exposition of the state of affairs and needs thereof is 11 undertaken in Chapter 7 titled 'Command Area Development'.

37. The Commission noticed that the Government of Maharashtra has from time to time issued several basic directives and guidelines in respect of water use and irrigation in keeping with changing needs of the society and managerial requirements. For want of any clear legal status, however, the rigorous implementation of the same was found to be beset with difficulties. Besides, there seems to be a want of enough consistency in their follow up. An exposition is presented separately in Chapter 8 of the Volume regarding the manner in which the forthcoming requirements of legal provisions are to be fulfilled by undertaking a review of the existing provisions in the acts pertinent to water and irrigation.

38. Requirement of water for non-irrigation use exhibits an increasing trend. Owing to the growing urbanisation and industrialisation , it is now required to divert water in systems meant earlier for irrigation to non-irrigation uses. Coordination in this regard is, here-in-after, going to remain the crux of water management. But, for that it will be continually necessary to undertake a thorough review of the diverse uses of water. Therefore, a critique of those requirements is carried out in Chapter 10 on 'Non-irrigation Uses of Water'. One of the effective uses of water is for hydropower generation, which seems to have been overlooked during the intervening period. It is necessary to rejuvenate this again on top priority to cater to the peak load demands in electricity supply. A special emphasis on this count is, therefore, also included in this Chapter.

39. The Commission, altogether decided to look at the overall irrigation needs on a broader perspective. Various modes of irrigation such as canal irrigation, lift irrigation, irrigation in watersheds, irrigation on groundwater and also costs thereof *vis-à-vis* institutional requirements have been deeply dwelled into. Though the present name of the Department, i.e., Irrigation Department with which the responsibility of irrigation currently devolved upon is indicative of its limited functional ambit that is to deal with canal irrigation systems exclusively, the Commission realised the necessity of clearly grasping the conjunctive nature of irrigation being managed in future through diverse modalities such as wells, drip, reuse of water, etc. in view of the overall need of Maharashtra in respect of irrigation. A separate analysis is also, therefore, incorporated to throw light on other alternatives. Detailed expounding in regard to this is presented in Chapter 11 on the subject 'Watershed Development' and in Chapter 12 on 'Groundwater Development.' Watershed development is a boon to the areas which are deprived of irrigation through conventional systems. Nevertheless, the confounding situation is going to attain an increasing trend in case planning and regulation of groundwater in those areas is not carried out in a scientific manner or extraction of groundwater is allowed to continue relentlessly. This subject is, therefore, required to be paid due attention here-in-after with more diligence. Especially, a scientifically alert viewpoint is required to be inculcated all over in regard to groundwater recharge, its availability, storage limitations thereof etc. Misunderstandings in this respect are evident in many quarters even now.

40. A good degree of unequivocality is clearly evident in different schools of thought with regard to the definition of drought prone area. More facilities are kept at the disposal for the sake of development if an area is brought under the precincts of 'drought prone zone'. Therefore, various types of criteria are used to be suggested so as to get one's working arena included within the ambit of drought prone area. Once it is categorised under drought prone area, the 12 regulatory planning of water compatible to such area, is however, it seems, never accepted as such. The planning of water to be resorted to for drought prone area, as a consequence, properly belongs to the deficit and highly deficit sub-basins. An effort is, therefore, made in the Volume to suggest different criteria of regulation necessarily to be achieved in respect of such sub-basins. Which area is precisely regarded as drought prone has since long been remained an unanswered issue, conceptually at least, to date. Instead of going into its complexity, a pertinent discussion is incorporated in this Volume keeping mainly in view the sub-basins which clearly exhibit deficit and highly deficit characters governed by availability of water. Besides, an elaborate discussion in regard to drought prone area is also presented independently in Chapter 11 in the context of watershed development.

41. In order to comply with an evergrowing need of people's participation and necessity of seeking benefit of guidance from experienced thinkers it is utmost necessary to convert the mode of working into what is amenable to collective wisdom instead of merely leaving it to the discretion of an individual official in a Governmental set up. Accordingly, restructuring of the whole set up has been suggested through the exposition in various chapters and especially in Chapter 13 titled 'Restructuring of the Department'.

42. During the first phase of development, when investigation and construction were of special significance, the irrigation sector obviously lent importance to civil engineering based activities. Thereafter, during the Command Area Development Phase, more and more agricultural orientation warranted in accordance with the indications offered in the report of the National Irrigation Commission of 1972. In view of the growing needs of water and necessity of undertaking co-ordinated planning of river basins /sub-basins necessitated as a result of more and more stress being put on water an increasing need is now going to be experienced of special types of skilled experts who are well-versed in the science of Hydrology, managerial skills and are capable of achieving interdisciplinary coordination *vis-à-vis* that of an executive machinery compatible thereto. The Irrigation Department of Maharashtra which is the bulk user of water in the State be converted into the Water Resources Department in consonance with the change already accepted by the states of Gujrath, Madhya Pradesh, etc., in pursuance of the suggestion of the Central Government. The Chapter 13 presents a detailed exposition as a follow up to that as to the manner in which such transformation is to be effected which will be compatible to the new set up of compositions of various institutes and organisations of the Department. So far a meagre attempt has been made to evolve experts in Hydrology from amongst the civil engineering graduates of the Irrigation Department. The number of such experts will here-inafter be required to increase on a far larger scale. In addition to civil engineering experts, the number of knowledgeable and trained personnel in Hydrology will have to be increased largely even by inducting geologists and hydrogeologists, experts in Climatology and other physical sciences including that of Chemistry too. From the environmental management point of view also, the need of such experts is going to be felt on an increasing scale. Restructuring of the existing investigation organ of the Irrigation Department even is proposed therefor.

43. Diverse issues of integrated and comprehensive planning of available water will be required to be handled in times to come owing to the rapidly taking place development of Maharashtra. The water management needs have newly emerged within the broader context such as conjunctive use of surface and sub-surface water, the most proper apportionment of 13 water for diverse uses, year-to-year changes in water availability status, etc. The Commission realised that before reaping the expected benefits from the Command Area Development Programme - which had been the second phase of irrigation development - the pressure of social needs forced us to land into the more complex third phase of water planning. Having considered these new needs, the Commission has presented in the Report its findings as to how basinwise/sub-basinwise co-ordinated management of water is required to be considered. The Commission also realised the need of setting up of a new type of system by incorporating some significant changes in the water and irrigation management system in pursuance thereof. Suggestions as to the manner in which that new system be set up are offered by the Commission through various Chapters of the Report in general and in the last one on the Administrative Restructuring in particular.

44. While landing into the third phase of the water resources development in social and technical context on one hand, even the initial phases of project investigation and construction are not yet completed in its entirety in many of the sub-basins. A need of different modality of working and an urgency of capital mobilisation is, it seems, being experienced by the Government in order to impart a special momentum to construction activities in such laggard basins /sub-basins. Therefore, independent development corporations for various basins have, of late, been constituted by acts of Legislative Assembly. Having elaborately considered the forthcoming needs and transactional mode, the Commission (on the basis of maxims implied in these acts) has put forth in Chapter 13 its views on the modality of working of these corporations.

The Government had expressed a desire through a separate formal letter to put forth some suggestions by the Commission as to the raising of funds for irrigation development. Needs pertinent to that are examined at length in Chapter 9. In this context, an exposition as to how far and in what manner the transformation of Governmental systems into cooperative, corporate or privatised systems be effected during the forthcoming 30 years is presented in Chapter 9 which undertakes discussion on ‘Financial Aspects’.

45. The ultimate irrigation potential likely to be created in an average year through various sources (surface as well as sub-surface) in all the sub-basins in the State is, it appears, probably to touch the mark of 126 lakh ha. It is based on the study undertaken on the basis of information and statistics made available. The gross area likely to be brought under irrigation management will be more than this, i.e., 140 lakh ha. Out of this, all the area, however, may not be irrigated every year because of the system of annual rotation. Irrigation in an average year will form about 60% of the total cultivable area of Maharashtra, (i.e., 225.42 lakh ha). Barring the area that so far been brought under irrigation management (56.75 lakh ha) a capital of about Rs.67000 crores (1999 price level) will be required for the remaining area (69.25 lakh ha). Out of this, Rs.37000 crores through the Government’s budgetary provisions whereas Rs.30000 crores will have to be raised through the beneficiaries’, (e.g., corporations, industrial groups, irrigation beneficiaries organisations and so forth) contribution; and through the assistance from financial institutions. The Chapter 9 contains an involved exposition on this aspect.

46. Even if the annual rate of economic development continually remains at least 6 percent during the forthcoming three decades, the ensuring 30 years will see the societal prosperity enhanced by 5 times in the least. It appears in future India will strive to maintain an annual economic 14 growth rate of 7 percent in the minimum. With this, even greater rise in economic prosperity is expected to be in the offing in three decades to come. This, in turn, will boost up the capital raising in private and co-operative sectors and also the pace of formation of autonomous voluntary organisations. Instead of merely relying on the works carried out through the Government's budgetary allocations, the construction of irrigation distributory network and the individual farm development works could, it appears, be accomplished with the joint financial support partly managed through cooperative basis and partly through that obtained from financial institutions. Even as treatment to waste water emerging from all the cities cannot be undertaken at once, it is believed, the coming decade can even see such works accomplished by the municipalities and corporations on their own standings as a spadework to that. Priorities of implementation are proposed assessing possibilities of such favourable undertakings which are likely to be taken up in coming future.

47. Water management *vis-à-vis* irrigation development is not an exclusive concern of the Government. The pyramid of development is going to be realisable through mutually complementary and joint efforts of all- such as universities acting as think tanks directed to achieve progress in that and pursuing research activities, private industries providing modern managerial skills and fetching the capital investment necessary, various kinds of voluntary organisations capable of invoking public awareness, mass organisation and people's participation and so on. While discussing various topics in the Report, the subject therefore is not expounded by keeping in view merely the functional organisation of the Government but also suggestions are offered so as to distinctly spell out the probable functions of various other constituents of the society along with those of Government machination, the issue being of concern of the whole society.

48. A number of personnel and organisations raised diverse issues while deliberating on various topics with and offering suggestions to the Commission regarding specific projects and schemes which are in planning stage, are under construction or have already been brought within the purview of management. The Commission was also requested to opine on those. Nevertheless the Commission, following the footsteps laid down in this regard by the Barve Commission (1962) and the National Irrigation Commission (1972), decided to refrain from going in for examination of any particular scheme or project for its own sake. Instead, it chose to give a comprehensive consideration only to those fundamental issues and principles in regard to the overall planning which will be brought to the fore through such discussions and only these are to be made the subject of exposition of the Commission's Report. No views, however, be decidedly expressed pertinent to any specific programme or a project. Whereas the Commission thought it not proper to offer suggestions at length regarding particular projects, it did, however, discuss in the Report by solely drawing on the premise of principles of causes behind demands put forth in particular as to some specific impediments of particular areas, *talukas*, villages, and probable direction of remedying those. The Commission has not gone into discussion as to any specific problematic issue a village or a *taluka* is subjected to face. Having accepted the principles and issues upheld by the Commission, it is hoped that in course of time the concerned departments will independently embark on various programmes and undertake necessary revised project planning and reforms in field programmes pursuant thereof.

49. While undertaking past review of water use and irrigation, the Commission 15 came to know that no systematic pattern as to the water use and irrigation development had since then been developed anywhere in Maharashtra in pre-independence period barring some tracts. The Barve Commission had therefore been led to offer suggestions for future programme only on the basis of the limited experience and gross information then available. While assessing gross water resources that are available, no isolated estimation of groundwater had even been possible. Even sufficient experience in respect of irrigation projects in Vidarbha, Konkan and Marathwada had been wanting at that time. The commission was, therefore, required to mainly concentrate on the bringing up of new projects and the necessity of implementing agencies within the Irrigation Department needed for accomplishment of those projects. During the development phase of the initial 25 years after independence, creation of new projects and setting up organisations required for the fulfilment of that had broadly been the sole activities of focus all over India. Nevertheless, the Maharashtra Water and Irrigation Commission had, now, been called upon to initiate thinking in a manner more comprehensive and transcending far beyond the trodden path.

50. The Terms of Reference of the Commission had been got framed at the very inception of the Commission. Nevertheless, it was asked to go in for thinking over such other pertinent matters along with that also which are necessary for paving way for economic development and overall prosperity. The Commission, therefore, attempted along that line to pursue other pertinent issues such as marketing facilities for agricultural produce and processing industries. Its findings and recommendations in this respect have been presented in the Report. The relevant chapters and the manner of compliance of the very terms which are laid down in the TOR of the Commission are succinctly indicated in the ANNEX appended to this preface. It contains a consolidated list of terms in the TOR of the Commission *vis-à-vis* the various chapters and topics in the Volume touching thereupon. It presents a glimpse of the manner in which the various topics contained in the TOR have been tackled. A sort of repetition will appear in respect of some issues in different chapters and in the context of different topics in the Volume. Nonetheless that type of presentation is found to be more helpful at the respective points in the context of discussion so conducted. The repeatedly occurring matter is, therefore, accepted as it is instead of merely relying on the sole reference of the main pertinent paragraph of the Volume.

51. No clear indication as to any particular year in future had been there in the TOR upto which the study of issues suggested therein keeping in view the needs of Maharashtra by that time the Commission was called upon to undertake. However, it is difficult though not impossible to cast current data by peeping into far distant future. Keeping this limitation in view, the Commission decided to submit its findings by considering only those likely changes and needs which are in the offing during the forthcoming 3 decades. While offering suggestions on various topics from that standpoint, compliance of implementation is proposed to be realised in 3 phases periodwise, i.e., the implementation of recommendations in the Volume is to be effected by keeping in view the probable objectives to be achieved during the first, second and third decades. Matters which, of necessity, are to be implemented forthwith are clearly mentioned likewise at respective places in the Report and are so indicated in Chapter 14 which contains the listing of important recommendations. It is expected that the implementation in those cases be carried out on priority during the ensuing 2-3 years.

52. As in fact the mode of write-up of the whole Volume is basically of recommendatory nature a concise compilation of only selected and important recommendations will be found in the listing of Chapter 14. Even apart from that also, the exposition in the Volume is replete with numerous useful suggestions. The Commission hopes that a comprehensive consideration will be given to all of them by those concerned and be implemented in a fitting manner. It is not expected that no action similarly be initiated at all during the first decade in respect of those recommendations the implementation priority of which is shown to be either during the second or third decades. Contrary to that, follow-up action in their case will have to be initiated though it is merely meant that the completion will either be going to take longer time or it will also do if more time elapses before it is completed.

53. It requires a good deal of spadework to bring out fundamentally important changes in agricultural sector and irrigation management. The social and administrative systems are also required to be favourably disposed. Considering the difficulties encountered and the experience gained in customarising the new patterns especially like that of CADA, the ensuing changes and restructuring, though deemed to be essential, are not all likely to be materialised with the urgency desired. A stress is, therefore, laid in the Commission's Report to bring out these transformations by accomplishing a suitable spadework in a planned manner. Creating social awareness and condition conducive to accomplish that will firstly have to be taken up. It is not that all the reforms and restructurings will have to be carried out on priority during the coming 30 years, nor is it possible even. Nevertheless, it is worthwhile to have a beginning in that direction.

Indicated Terms of Reference of the Commission and pertinent Chapters/Topics of Importance

Sr. No.	TOR		Chapter/Topic
1	To assess the available surface and groundwater potential; to formulate a report on the utilisation of water resources for irrigation, hydropower, industrial and domestic use etc. with optimum and judicious distribution among them. While preparing the report, the possibilities of interbasin transfer of water for various purposes need be considered	2.8	Surface Water Resources
		2.9	Groundwater
		3.2	Sub-basinwise Approach to the Development
		3.4	Management of a Sub-basin
		3.5	Interstate River Water Allocations
		3.6	Interstate Projects: Planning & Management
		3.7	Interbasin Water Transfer
		8.1	Equity in Water Distribution
		10.1	Domestic Water supply
		10.3	Water for Industries
		10.5	Hydro-electricity
		12.0	Groundwater Development
2	To draw a plan to make good the backlog of different regions of the State while distributing the available waters as above for various purposes	3.3	Sub-basinwise Planning & Related Strategies
		5.7	Completion of Incomplete Projects
		9.7	Regional Backlog

(Contd.)

Sr. No.	TOR		Chapter/Topic
3	To prepare a report suggesting the types of measures to be adopted to make available the irrigation facilities to drought prone areas of the State	3.3 3.7 11.4	Sub-basinwise planning & related strategies Interbasin Water Transfer Drought Prone Area
4	To recommend plan for creation of irrigation potential after reviewing the status of projects which are completed, under construction and planned in future	5.1 5.7 9.1 9.3 9.5	Project Layout Completion of Incomplete Projects Ultimate Irrigation Potential Funding Needs of Irrigation Development Capital Mobilisation for Irrigation
5	To consider problems in the command area of irrigation projects in regard to:-		
	i) Type of crops	4.2	Cropping Pattern under Irrigation
	ii) Cropping pattern and crop planning	4.3 6.1	Role of Irrigation in Agricultural Production Operation & Maintenance of Projects
	iii) Policy formulation for eightmonthly or perennial canal irrigation	6.5 6.6 6.9	Modern Methods of Irrigation Conjunctive Use of Water Evaluation of Distributionnetwork
	iv) Waterlogging and drainage	7.3	Utilisation of Irrigation Potential
	v) Water distribution & water management and proposing changes for simplification of procedures thereof	7.4 8.5	Water Logged and Salt Affected Lands Changes Required (to be brought about) in Irrigation Act
	To decide policies for fixing water rates and compulsory irrigation cess and introduction of new irrigation techniques (e.g. sprinkler, drip etc.) and their application	9.9	Assessment and Recovery (of irrigation charges)
6	To make recommendations in formulating guidelines in respect of carrying out repairs to the old projects	7.5	Renovation and Modernisation of Old Projects
	(*ex-malgujari* and other tanks/ projects) and expediting completion of lingering projects.	7.6	Restructuring of Ex-Malguzari Tanks
7	To decide policy of capital mobilisation for building storages to meet the water demands of growing urbanisation and industrialisation and to recommend remedial measures to mitigate the effect, if any, on irrigation as a result thereof	10.2 10.4 10.6 10.7	Drinking Water supply and People's Participation Water for Thermal Power Generation Reuse of Water Water for Non-Irrigation use and its Impact on Irrigation
8	Presently, the CAD works are being undertaken on a few certain projects. The policy of extending this facility to all the completed irrigation projects considered.	7.1 7.2	(CADA) Concept (CADA) Organisation
9	To make recommendations as to formulate policy for evolving guidelines for promoting participatory irrigation management and the manner in which the transfer of Irrigation distribution network be effected.	7.8 8.5	Participatory Irrigation Management Changes Required (to be brought about) in Irrigation Act

(Contd.)

Sr. No.	TOR		Chapter/Topic
10	To offer recommendations regarding the policy of examining the ongoing irrigation works from the view point of financial returns, policy of exacting betterment levy and economic & financial criteria pertinent to annual maintenance & repairs	9.2	Economics of Irrigation Projects
		9.3	Funding Needs of Irrigation Development
		9.8	Expenditure on O&M
		9.9	Assessment & Recovery (of irrigation charges)
		9.10	Betterment Levy
		9.11	Allied Income from Reservoirs
11	To consider other pertinent issues necessary to bring about economic development and overall prosperity in irrigated areas of Maharashtra	3.1	National Water Policy and Related Strategies
		3.2	Sub-basinwise Approach to Development
		4.9	Agrobased Industries in Irrigation Sector
		10.10	Fishery
		11.0	Watershed Development
		13.0	Restructuring of the Irrigation Department
12	To offer recommendations on subjects found necessary by the Hon'ble Chief Minister and Hon'ble Irrigation Minister apart from those enlisted in the foregoing by incorporating the same in the TOR	13.4	Mainline Services
		9.5	Capital Mobilisation for Irrigation.

Notes: 1) All the topics covered in the Report are not included in the aforesaid list. Only those topics are indicated which have a direct and important bearing on the TOR.
2) All the appendixes referred to are incorporated in the Volume III.

CHAPTER 2
MAHARASHTRA AND ITS WATER RESOURCES

2.1 History of Water Resources Development

2.1.1 Agriculture in India is dependent on the vagaries of monsoon. In order to overcome this, various schemes envisaging water supply to irrigation had been in operation since the time immemorial. The centres of Sawalda, Prakashe in Tapi Valley and Inamgaon in Bhima Valley are contemporaneous to the Indus Valley Civilisation. The excavations at Inamgaon have brought to the fore some evidences which throw light on the then prevailing agricultural practices. It had incorporated construction of a weir across river gorge to facilitate water supply to agriculture. Nighantu in its commentary on the Vedas has given details of 14 types of wells. In, Yajurveda, we come across references to canals and dams. In the literature of Smritis also, a mention to lakes and tanks appears. The composers of all the Smritis have appealed that human being should routinely undertake *ishtapoorta karya* (philanthropic work) which are of public utility like digging wells, creating lakes, drawing canals.

Brihaspati - one of the Smriti composers - had given an extraordinary importance to the repairs of old dams & construction of new ones and stated that noble men in the state should undertake such meritorious works of their own. Like Smriti literature, the Sutra literature has also given much more importance to the irrigated agriculture being practised on canals. In Kaushik Sutra, we come across description of a very interesting ceremony to be performed at the time of creation of canals. Dhammapad, a well known treatise on Buddhism, dates back to the Mouryan period where details of various irrigation systems in vogue during those days have been described. The provincial representatives of Chandragupta Mourya constructed a beautiful lake named 'Sudarshan' at Girnar. Chandragupta had had a department of irrigation which used to look after construction of canals & darn and maintenance and irrigation management. The contemporary inscriptions contained a mention to that effect.

2.1.2 Koutilya was also of the opinion that agricultural area should not solely depend on monsoon but should have a support of irrigation. While quoting an example of a well-governed state. Koutilya went on saying that the state which remains increasingly dependent on irrigation instead of rains for its agricultural production is more prone to prosperity. Water was also used to be lifted from rivers, lakes etc. by means of wind mills by deploying bullock power or by making use of water wheel. Suggestions as to constructing collectively aqueducts while establishing new colonies and invoking participation of all in such endeavours, penalising those who would entail loss of water or cause harm to the construction of canals etc. appeared to have been offered in the Artha Shastra of Koutilya.

The Artha Shastra also went on advocating a different tax structure for construction of tanks. recovering water charges, protecting irrigation systems, deciding cropping patterns, cultivating pastures, keeping rainfall records and desilting tanks etc. Koutilya has come out with detailed suggestions in this respect. For example, who lift water from his own tank for farming should pay 1/5 of his produce as water charges, that who lift by means of bullocks to pay 1/4, who lift with the water wheel to pay 1/3 and who lift water from wells in river courses and tanks should pay 1/4. It has also been commented by Koutilya that 'growing of food grains is the best practice of all, then follows vegetables and lastly the sugarcane'. 'Because the latter consumes more water and there are risks in cultivating it.' Koutilya also recommends in his treatise to grow watermelons in coarse soils near river bed, grapes and sugar-cane in deep fertile soils further on river banks, vegetables near wells and green grass be grown on tank embankments and in farms surrounding crops.

2.1.3 Medhatithi Parashar Rishi wk we known. The treatise Krishi Parashar is famous after him. It provides a special exposition regarding main canal, distributaries, minors and control thereof while explaining details about irrigation. The concept of water wheel has been put forth by him only. The concept is basically of Indian origin. It is observed that such water wheels have been in use in Maharashtra since time immemorial. In course of time, it is Migrated to Persia. With the arrival of Persians, it remigrated to India under the name 'Persian Wheel'. The treatise lays emphasis on special maintenance of irrigation-dependent land. He coined the term *palibandhan* for constructing dams. Dams and canals are discussed in the Vishnu Dharmottar Puran, the dam is stated to be rather more useful than canals there.

Based on this very premise, Hemadri Pandit has given special exposition on irrigation in his work Daankhand. There he elaborately explains the terms *pali, vipali, koop, wapi, pal,* etc. By and large, it appears, the societal frame of mind was clear in ancient times about irrigation and irrigation-related concepts. The maxim of achieving state prosperity through adoption of assured irrigation than relying on vagaries of monsoon seems to be in acceptance. The Indian literature and inscriptions proliferated during the period 4th century B. C. to the 17th century are more often replete with contemporary irrigation methods.

In the scenario of Indian water management practices projected through the Archeological Survey, the contribution made by Devgiri complex is especially remarkable. Whatever caves are there in Maharashtra, an equal number of forts, hill forts etc. are there. Near the caves as well as in every fort, there had been constructed holy cisterns, *kunds,* tanks, etc. The images of Ganga, Yamuna, Sindhu, Saraswati are found to be engraved in their vicinity. A mention to that effect is available for reading inscriptions there. An excellent mention of such a *kund* of water and reservoir comes across in inscriptions at Ajantha Caves.

This inscription has been carved during the 8th year of reign of king Sri Pulumavini of Satvahan dynasty. It makes a mention of Samba - a *griha-pati* - as the constructor of this tank.

The triplet 'Achintya, Ajint Jaya and Ajantha' which are brought home by the ancient Budhist literature of Achintya Rajsutra, Mahamayur, Poonavadan and the inscriptions at Nagarjun-konda is reflected in one Ahirani folk tale. A ballad based on this folk tale known as Panchakalyani Tarana goes on telling the tale of creation of Ajantha Caves situated near the seat of Goddess Kalankini. The tale of king and queen, viz. Achintya and Ajint Jaya in this episode is quite a telling one. According to this tradition, the couple Achintya and Ajint Jaya hailing from the royal dynasty of Paithan in the ancient Maha-rashtra had set up this kingdom the borders of which, it is said, had been transcending from the Khaibar Pass to the Nagarjunkonda embracing the three seas. Also, it has been described there that this couple had constructed numerous ghats, kunds, canals, tanks, channels in their kingdom. It is like this: *"Ubhaytanni bandhale hote ghat kund nana Jodooniya tali ghat kiti panhalyanna Bahut dis rajya kiyo rani aani rana."*

2.1.4 It is said that a dam has been constructed across a stream flowing near the village Hisse-borala 10 km away from Washim Town in Vidarbha. In the story of the dam it has been said that during the 5th Century A.D., a lake named 'Sudarshan' had been built there. Merely a few masonry markings of the embankment behind which the lake was formed are extant today. No trace of this lake other than this existed at that place at any other time. In an inscription, how-ever, there is a mention of having built up a lake named Sudarshan during the 5Th Century A.D. In the inscription, there has been expressed a desire to the effect. "For the well being of all people; till the time all the four eras also elapse and as long as the Sun, the Moon and the Earth exist , this philanthropic deed meant for the God may last long for the enjoyment of all people".

In one inscription which was arranged to be engraved by an officer named Kalmegha from the period of the Krishnaraj - III who belonged to the Rashtrakut dynasty and known by the title Kandhapoorvaradhishwar elaborately describes the lake by the name 'Jagatung' in Kandhar Town and the water management system existing thereat. There has been a mention of creation of in all 5 water bodies in the area. In the vicinity Jagatung Lake, there were constructed *prapas* (wells) which were interconnected by five chan-nels supplying water to people in the corridors of structures such as Royal Palace, the Yaksha Gate, *makar toran,* a monastery, etc. Also, it is clear from the inscriptions that there had been an arrangement for supplying fodder and water to the farm animals. At all such five places there had been excavated cold water channels to provide shelter from heat in the monastery. The wells, which were used to be filled up through channel water, had been constructed. In crowded localities at these very spots, a system of water cisterns and fodder depots had been constructed to enable the animals to quench their thirst to their hearts content. The details of daily expenditure being incurred at respective places has also been given in the inscriptions.

After passage of 16 centuries, the Jagatung Lake is supplying water for drinking and irriga-tion to the existing *taluka* place near Kandhar. The earth embankment and three carved masonry outlets of ancient times are still extant there standing strongly. Therefore, the town of Kand-har never experiences shortage of drinking water. It may not be wrong if it is said to he a symbol of a system created for use in ancient times and for bringing prosperity.

The ancient literature is full of detailed expositions made in different contexts as regards to the insistence of constructing embankments for impounding water, a continual emphasis on renovation of irrigation systems, details as to the reasons which lead to the distress in embankment and how to strengthen it, discussions on ways and means to redress the difficulties resulting from natural calamities inflicted on canals, how to maintain the bank work of reservoirs for centuries together, how to invoke involvement of parties which were local beneficiaries, how to form committees for ensuring maintenance, the necessity of mutual cooperation among the rich, philanthropic organisations and the king in the state in this regard and so on. The Paithan Town had been internationally known at that time. Though precisely how old is the ancient history of Maharashtra cannot definitively be asserted; the literature and archaeological means are replete with the evidences as to the existence of habitats at these places during the Mourya period. It is said that the empire of Nand Mourya had been spread upto Nanded and therefore the habitats such as *moolak, ashmak and kuntal* had been set up in this part during the ancient times. Paithan was the seat of *moolaks* habitat, Bodhan was that of the ashmaks whereas Latur was of *kuntalas.* The name Kunthalgiri, therefore, sounds indicative. It has been counted among the great habitats of India.

2.1.5 The reliable civil history of Maharashtra commences from the Satvahan period. The period of Satvahan is regarded from 230 B. C. to 230 A. D. This dynasty has reigned over. Maharashtra for 460 years. It is the only royal dynasty which continuously reigned over Maharashtra for a period over 450 years. The 500 caves carved out during that period is the telling example of their prosperity. The prosperous life of Satvahanas is manifested in the treatise Gahasattasai written by Halla. The Vakatakas ruled the empire of this region subsequent to the Satvahanas. The Vakatakas have ruled from 250 to 550 A. D. Numerous inscriptions and copper plates of Vakatakas are extant which testify that they had promoted the prevailing irrigated agriculture. The contemporary literature and physical evidence make it clear that the Vakatakas had created tank water projects in their states. Their prosperous life is reflected in the coloured paintings of Ajantha. Through the eyes of Maharashtra, the period of Satvahanas is regarded as the golden age. The references to wells, flower gardens, honey groves, streams, lakes, tanks, etc. found in the inscriptions are of extreme importance. The Satvahanas had constructed a huge ‘Rajtadag’ in the vicinity of Aurangabad for the public use. It instill recognised as the Harsool Tank and it is still functional. The name Rajtadag might have been coined from the very tank constructed by the Satvahan Royal dynasty of Paithan during the first - second century. The tank of Aamkhas at the Aamkhas Ground of Aurangabad, it appears, might have been a part of this very Rajtadag. Moreover an important note recorded in the inscriptions Of Satvahanas is that of ‘Watermen’ community (an industrial community of the then society). There is a mention of donations offered by this watermen community. The watermen community means a community which operationalises the irrigation system. The requisite technology of water supply had been possessed by them.

2.1.6 The entire Maharashtra had been under the domination of Chalukyas of Badami during the post-Vakataka period. They had created tanks as well as *warivahas /baravas.* They had allowed the farmers to go in for full irrigation so as to use these baravas for irrigation. A nominal tax was used to be levied therefor. Income being accrued from the tanks was itself being used for carrying out repairs to the tanks. For that, *panchayats* were formed which assumed the responsibility of carrying out maintenance of tanks and irrigation in the area. The Rastrakutas lent high priority to the ’creation of tanks and development of irrigation area’ in Maharashtra. The ‘Jagtunga Sagar’ of

Kandhar is one of them. Though it has rendered into disuse today, the irrigation system in vogue during the Rashtrakutas' period at Kandhar is still functional. Besides this, they had created big tanks in areas of Dharur, Mannikhed. Latur etc. After the Rashtrakutas, the Yadavas had popularised *baravas* like temples on a large scale. During this period hundreds of temples, *baravas*, tanks had been created. The Yadavas had given special priority to the tank creation. They were more inclined to use tank water for agriculture than for drinking purpose. Ordinarily, very large *barava* or a huge tank used to be created as a philanthropic work where no water supply from a river or major *nalla*, had been possible. The stone quarry wherefrom rubble was used to be extracted for the construction of temple would be converted into a *'barava'* for storing water further. A *barava* is a speciously stepped well use of which was used to be made mainly for drinking water supply. Water was used to be drawn from the baravas with the help of a water wheel. This water was used to be fetched to gardens and to some extent for irrigation.

The majority of constructions of *baravas* in Maharashtra, it is felt, had been accomplished after the eighth and nineth centuries only. The baravas are provided with three to seven landing stages. The *'baravas'* with five landing stages are popular. The kings and the local heads had accomplished the construction of *baravas* for the facility of people and the people too had preserved them properly by undertaking their maintenance. Such *baravas* are observed even today in Marathwada and North Maharashtra Regions. Such well-maintained baravas may number over 150. At most of the places they are still in use and they are in good condition too for the, last 700-800 years.

A system of drinking water seems to be implemented at Devgiri Fort and the area from the Yadav period (1100 A. D.) The hilly plateau presently known as Khultabad was once upon a time a part of Katak Devgiri. This part on west of Devgiri Fort used to be known as Shoolibhanjan. A series of tanks appears to have been constructed in that plateau area during the Yadava period. In a single gorge, approximately within a 3 to 4 km distance, emnants of 10-12 tanks are still being observed. Among them Suryakund, Chandrakund, Dharmatalav, Bhadratalav ferry tank, House-a-qutlak at Mousala and the massive mountainous gorge leaning from Mousala towards the Devgiri Fort and the constructed tank therein was a water treasure. All the water bodies had remained to be the base of water and irrigation around the Devgiri Fort.

2.1.7 Mohamad Tughlak tried to shift capital from Delhi to Devgiri, i.e., Daultabad. Special efforts appear to have been made by them in Devgiri area as to how irrigation area would be increased by increasing capacities of tanks constructed during Yadav Period. However, thereafter they were required to lend priority to the sole item of war owing to the continued struggle for domination among the fragments of Bahamani. Therefore, the development of water and irrigation had remained neglected. Malik Ambar - the last Prime Minister of Nizamshahi of Ahmadnagar had tried his best to accomplish development of water resources. But his schemes do not appear to have achieved general success. Nevertheless, his emphasis had mainly been on water supply to palaces, capitals, forts and army. He constructed 1 m high wall and roughly 2 km long wall at the foot of Sultan Hill opposite the Devgiri Fort from the toe of latter upto the middle of the former. By tapping all the rainwater he managed to divert that water in the fort through a syphon. In another scheme, attempt has been made to draw canals by creating a series of tanks at different levels in the gorge adjoining to the same mountain and supplying water to the fort through ceramic pipes (1605 to 1627). Similar type of schemes appear to have been implemented at Aurangabad, Ausa, Kandhar, Naldurg, etc. The *'malgujari'* type of tanks appear to have been constructed on a large scale in some parts of Nanded. Parbhani, Latur and Osmanabad whereas in Beed, Aurangabad and Jalna area on a small scale.

2.1.8. In Aurangabad City, a water supply system had been established envisaging supply through channels and pipes (during 17 Th and 18 Th centuries) to 52 localities in the city by gathering groundwater from the feet of adjoining hills. Evidences corroborating this are still extant. A few of the systems (Thatte *Nahar*, Baijipura *Nahar*, Kiradpura *Nahar*, Cantonment *Nahar*. *Nahar* - a - Ambar, Shahanoor Miya *Nahar*, Panchakki *Nahar*) are still functional - though in a dilapidated state. Use of water brought from distance through a pipe line appears to have been made to run a wheel in Aurangabad City. Use of water had not been made only for drinking and irrigation but also for generating mechanical energy. A system fetching water to tanks in towns through channels excavated in rocks, ducts and thereafter through ceramic pipes appears to have been set up at Chandwad and Sinnar also. A permanent water supply facility through a *mot* had been created in the Naldurg Fort by diverting river Bori by way of constructing a high masonry dam for impounding a large reservoir for the Naldurg Village and Fort. By channellising water into the moat around the fort, its safety had also been ensured alongwith water supply system. The water palace constructed exactly midway between the Naldurg Fort and the structure of Ran Mandal is the key attraction of Naldurg.

***Phad* System**

2.1.9 Sugarcane, banana, cotton and rice are amply produced in Khandesh. Implemented traditionally for hundreds of years in that part, the *Phad* irrigation system is instrumental for that. The *Phad* system on canals has been implemented since the medieval period on Panzra, Girna, Mosam and Burai Rivers flowing through Nashik and Dhule Districts by diverting water by way of constructing *bandharas* across those rivers. Rising at the foot of Sahyadri, these rivers first flow eastward and then join the west-flowing Tapi. A peculiar geographical setting causes the rocks to percolate and as these rivers flow through this region they used to be almost perennial earlier. Exploiting this favourable situation, the technique of constructing *bandharas* across these perennially percolating rivers and bringing agriculture under the existence of *Phad* irrigation by diverting water had been inculcated since the ancient times. It is surmised that the existence of *Phad* irrigation system has been in practice since the time Mouryas ruled over Khandesh (300 BC). The Yadavas came to power in Khandesh around 1000 years back. A history testifies that the Yadava kings encouraged the construction of *bandharas.* Therefore, the possibility of the *Phad* system finding its inception in the Yadava period gains more ground.

The historical references attest to the fact that by the mid-sixteenth century this part had reached its climax of abundance in growing cotton and rice because of this irrigation system. During the seventeenth and eighteenth centuries further, the *Phad* system had received patronage in the tenure of Queen Ahillyabai Holkar and it appears that the true development of equitable water distribution had taken place in this period. This system envisages construction of *bandharas* across rivers and diverting the water so impounded to irrigation through canals. The area under irrigation used to be divided into four parts and each was recognised as to be a *phad*. Several beneficiaries belong to a single *phad*. None the less, a sole type of crop used to be harvested in the same *phad*. They used to cultivate perennial crops in the first *phad,* two seasonals in the second, seasonals in the third whereas a crop would he grown in the fourth in case water had been available. A distribution of this sort had been practised. After every four years, a facility of growing perennials in the same *phad* had used to be availed there. Another characteristic of this system is that no soils in that part had ever been rendered saline or waterlogged because of this irrigation system practised for thousands of years as a crop in a *phad* used to be rotated every year. One *phad* body for accomplishing irrigation management used to be there in a village where *phad* system was in vogue. All the farmers who possessed land under irrigation used to be the members of this body. All these members could not come together for day to day work. Therefore, they used to appoint one *panch* committee. For that, all the irrigators within the premise of the *bandhara* used to be invited for a meeting by arranging drum beating once in a year (on the New Year's Day, i.e., *Gudhi Padva* as per the Hindu Calendar/*Akshay Tritiya*). An experienced and capable person was used to be appointed as the head for this meet and four-five *panchas* were used to be selected. No remuneration on count of this work was used to be paid to them. This system was made customary.

The following functionaries were used to be appointed for the irrigation system: (1) *Havaldar* (to keep a watch on the *bandhara* and distributaries; to ascertain whether water is tendered as per the *Shejpali* system) (2) *Patkari* (to distribute water in the canal, etc.) and (3) *Barekari* (to fill the farms by *shejpali;* to arrange watch and ward till the crop is harvested, etc.). Besides the foregoing works, these workers were required to remove silt in the canals too. The remuneration therefor was used to be generally paid to them in the form of grains. It is far from objectionable if it is said that this had been an ideal system of irrigation practised for thousands of years through public participation. This system is still surviving at some places. By drawing the very principle of *phad* system Sir Visvesvara a had tried to enforce the block system on Mula, Neera, Pravara and Godavari Projects in Maharashtra during the British period. An irrigation system fares successful only if it be implemented collectively and with a participatory approach. As the seeds to that effect have been geminated in the minds of masses in t is part, we see the network (in Godavari Basin belonging to Nashik District) of 'water users' associations' spreading on a large scale in this part during the recent 10 years.

Malgujari Tanks

2.1.10 The tenure of Gond kings saw the creation of a series of tanks in Vidarbha. It is given to understand that nearly 10000 tanks had been constructed nearly 300-350 years back in the districts of Chandrapur, Gadchiroli, Bhandara and Nagpur in Wainganga Basin through the entirely private enterprise of the Kohali community, that is, by deploying their own money and efforts. *Bavdis* (wells) too were constructed downstream of such tanks. While undertaking creation of a series of tanks, all the four sides of a village have been covered. A care also appears to have been taken to keep the crest level of waste weir below the village. Therefore, the village is made immune from the danger of flood water. The technique of using the water from a tank again and again by making it to flow from one tank into another, and from there to the next one without entailing any wastage of water has been employed. It appears, these tanks have been constructed to have a protective system of supplying water in case rains are not in time for the crop of paddy, by constructing storages underground and to produce jaggery by growing the sugarcane. Alongwith the cultivation of paddy and sugarcane, the facility of fishiculture had also been provided with the support of those tanks.

The district Bhandara is recognised as the District of Tanks and a 'Godown of Grains' The development of tanks could take place rapidly owing to the patronage it received during the tenure of a Gond king. This king had brought the people of Kohali community from the North India (Banaras). It is given to understand that the King Hareshaha of Chandrapur had even declared "Whosoever will cleanse forest and cultivate fields will be bestowed with that much land; and whosoever will construct a tank will be awarded that much land as Khudkastakar (self-cultivating the land) which can e brought under irrigation under that tank.

One committee of beneficiaries used to be there for managing water distribution. It used to fix the quota of everyone by ascertaining the availability of water in the tank. The works of maintenance and repairs of the tank were used to be carried out on behalf of the committee through the cooperation of beneficiaries. Patkaris were used to be appointed to enforce the decision of the committee. This patkari used to be among the landless people. Whosoever was in need of silt in the tank was allowed to carry the same to his farms. The committee used to keep a watch on the system of tanks and pertinent system and the same used to fetch every year revenue to the king in commensurate with the water availability.

When the Britishers took over the reign of the country (19 Th century) the right of recovering revenue on account of these *malgujari* tanks was entrusted to a few reputed citizens in that part and they were recognised as *malgujars.* A definite share was used to be remitted to the Government by these *malgujars* from the revenue so collected from beneficiaries. The works of water distribution, maintenance, repairs, silt removal etc. were, however, used to be managed by the beneficiaries only. These tanks were used to be recognised as *malgujari* tanks as their ownership changed hands for the sake of convenience of revenue collection from cultivators to the *malgujars* during the British regime. Nevertheless, in pursuance of the enactment of the then Madhya Pradesh Government, the *malgujari* had been abrogated after the year 1950 and the Government took possession of the tanks. The public participation diminished as the control of the system has been taken over by the Government. A few tanks now appear to have become extinct on account of want of maintenance and repairs. Presently, around 7000 tanks are extant and area under irrigation thereof appears to be nearly 1.25 lakh hectare. One excellent system which remained functional through participatory management apperas to have come to a standstill owing to diminishing public participation and the consequent dependence on the Government. Presently all these tanks are being used to provide protective irrigation to the *kharif* paddy crop. Second crop in *kharif* and perennial crops like sugarcane have altogether vanished.

A similar network of tanks appears to be existing at Biloli *Taluka*, Nanded District in East Marathwada. Even more than 100 old minor tanks are functional even today in this part. In practice, they are also recognized as *malgujari* tanks only. Irrigation management thereon is still being practiced through participatory management only. In east part of Latur (Tambal) /- two *malgujari* tanks (Red Tank and Black Tank) are even today found to be providing facility of irrigation and drinking water to the surrounding area for several years. In Marathwada part signs in testimony of village tanks are found at numerous places but in course of time actual tanks have become extinct.

***Khajana* Well**

2.1.11 One more old excellent system of irrigation appears to be functional even today in the form of *'Khajana'* well near the Beed City in Marathwada. This system had been created to bring under irrigation 212 ha agricultural land in the year 1572. This well is excavated on south of the Beed City roughly at a distance of 6-7 km at the right bank of Bindusara River and at the foot of Balaghat ranges. Approximately 20 m in diameter, this well is constructed with ashlar masonry. By excavating 2.5 km long underground tunnels from the Bindusara River course to collect groundwater in the well and making them cross the gorge underneath it, water is taken through earthen pipes via outlets so as to bring under irrigation area on its left bank upto the Beed City through canals. In recent times the growth of

Beed City seems to have led the irrigation area under the well to shrink. It is informed that 11 gates on canal and the distribution network used to make the irrigation possible. Maintenance & repairs of canals / distributaries were used to be carried out by the beneficiaries only of their own. The Water charges were used to be recovered by the Revenue Department in accordance with the *Kayamdhara* (Permanent Settlement) System. Water was used to be released through these 11 gates for a predetermined period and from tail to head. These distributaries were named after the days of week, viz. Monday, Tuesday, etc. It is given to understand that each distributary used to run on a certain day of the week. The Government has also taken over this system further and a good system implemented through farmers' participation came to a halt.

2.1.12 Old examples of an irrigation system in the form of storing water and conveying the same through distributaries via outlets also appear to have been practised under the tanks famous by the names 'Moti Tank' and 'Chandani Tank' at Sindkhedraja in Buldana District. It seems these tanks might have been constructed by the Jadhav family (Lakhujirao Jadhav). during the 17th century. Water is being supplied for irrigation through this system even today. These systems have presently been taken over by the Government. The village Sindkhedraja comes under the influence of both these tanks. Large *barav* wells are also extant in this very village. It seems the wells were used for drinking water and irrigation as well.

A contemporary system of similar type appears to have been provided through 'Moti Tank' situated on west of Jalna City. It appears the tank might be used Mainly for facilitating drinking water supply to the city. Terracotta pipes have been used for conveying water. Existence of these schemes is found to be manifested even today. This tank might be used for irrigation as well (through a well). The growth of Jalna City has caused to set up urban colonies in this irrigated area and the system is left to become defunct. Generally, during the very period, drinking water supply systems for Ahmadnagar, Junnar had been provided by laying a pipeline - a fact easily found to be corroborated by their very existence. In a similar manner a water supply system for the city of Pune was also provided during the Peshwas' period by laying underground pipes even through the Katraj Pass near Pune.

2.1.13 Konkan is characterised by high rainfall and extremely steep gradients. Comparatively, it is an unsuitable terrain to store water through tanks. It was, therefore, given to understand that a Patsinchan system was used to be practised earlier to provide irrigation facility to coconut, areca nut and paddy cultivation in Konkan by adopting a similar type of irrigation. Cash crops like coconut, areca nut, kokam, etc. are being grown even today on nearly 120 ha in Ratnagiri District. The facility of such a farming on streams fetches j benefits to around 2100 farmers even today. By letting the stream water to join the pats (by carrying over a distance of 200 to 1500 m), the undertaking of using water for irrigation might he in practice from ancient times in Ratnagiri and Sindhudurg Districts.

The percolating streams through the mountainous joints are the main source of water. Water was used to be made available to crops by tapping this percolated water by constructing masonry bunds of suitable heights and conveying water by drawing pats along contours below the bunds. The porous lateritic rock found in this part is the main base of these streams. The incident rains in Konkan which is ample in proportion is led to the subsurface strata through these porous rocks which gets transformed into groundwater. It proves supportive to the irrigation when it flows through streams so as to make available through *pats*. The presently found remnants of this system lead to think that roughly 5 litre per second discharge might he flowing which is equally sizeable as that of the groundwater flowing through the pats traversing these excessively steep slopes. All these systems Were used to be practised by the farmers on a cooperative basis. The water turns were used to be decided by the farmers with mutual counsel.

Reference as to the existence of hundreds of tanks in Thane area of North Konkan are, however, replete. It is informed that in sole Shajapur *Taluka* of this district several tanks had been extant. At the time of advent of British regime, information for the then first gazetteer was compiled which contained data pertinent to these tanks. Having neglected in course of time, these small and big tanks appear to have now been deserted.

2.1.14 At the turn of 19th century (in the ear 1883) Mahatma Jyotiba Phule appears to have offered suggestions to the then British Government in his famous book *'Shetkaryacha Aasood'* regarding implementation of soil and water conservation schemes to improve the condition of farmers, providing a facility of irrigating farms through wells, preventing erosion of soil by employing land development works, etc. He has also suggested to get such type of benevolent works to be carried out by the Government through the army and peons in the Police Department.

Thereafter, efforts were made to use initially the flowing water in *nallas* and rivers and the rainwater through the small tanks and diversion *bandharas* during the early British period. Some *bandharas* forming part of an irrigation system from the then period had been in use till now. They were converted into new projects later in post-independence period. Among them were the projects: Khodshi Canals on Krishna River, Krishna Canals in Satara District. Shahada Canals in Dhule District, Lakh Canals in Ahmadnagar District, Jamda Canals on Girna River in Jalgaon District. The Khadakwasla Canals on Mutha River near Pune are from the early British period. Some of the irrigation works of earlier times were, however, devoid of participatory approach right from inception; it had been a Government-run system.

2.1.15 The 'People's King' Chhatrapati Shahu Maharaj constructed the 'Radhanagari Dam' across the river Bhogavati during the early 20th century. By this act, he successfully tried to enlarge me command area along t e river by releasing reservoir water into the river by constructing a series of *bandharas* along it. A power generation facility (on water being released through the dam) was also provided. Nevertheless, irrigation development had been accomplished along both the banks of the Panchaganga River by lifting water impounded behind the *bandharas* mainly through *mots* as power was not made available then. The system of lifting water through *mots* was used to be practiced collectively through people's cooperation and this collective irrigation system also used to be referred to as '*Phad'* system. The system of employing pumps in a line to lift water to higher elevation, which is prevalent now had also been practiced to convey water to a distance by lifting through *mots* in a line irrigation used to be practiced through cooperation by getting distributed water amongst themselves by collectively taking water to higher elevation. The today's success of cooperative movement in that part is an evolution of the participatory approach the seeds of which were germinated in the similar system practiced during the period of Shahu Maharaj.

The state of affairs in Marathwada had been one of status quo. Only policy the Nizam adopted had been to prevent the society from getting aroused and to deprive the Britishers of the opportunity of interference. Therefore, though the *malgujari* tanks were created as stated, earlier no irrigation development based on *malgujari* tanks could, however, take place. As development of whatsoever type in agriculture as well as irrigation could not take place in Marathwada, it relegated to backwardness as far as development policy was concerned.

All that has been expounded in the foregoing leads to think that a long tradition of irrigation - which invoked public participation such as *phad* system in Khandesh, *malgujari* tanks in Vidarbha, old *malgujari* tanks in Nanded area of Marathwada, Khajana well, the network of *barav* wells stream irrigation in South Konkan, tanks in North Konkan and lift irrigation from *bandharas* in Panchaganga Basin - which is altogether different than the Government-controlled system prevalent during the British period has been germinated since ancient times by different ways in various parts of Maharashtra. Several examples of storing water by constructing a series of tanks on surface to find ways and means to overcome variability in nature and to overcome its vagaries, and to use water so stored for irrigation and drinking during the remaining period are found at several places in Maharashtra since ancient, times. The process of storing water in a tank, withdrawing the groundwater through wells and going in for double and perennial cropping thereon to achieve prosperity has germinated in this land since thousands of years. Irrigated agriculture is not new to Maharashtra, seeds of which are found to be sown thousand years earlier even to the period of Kautilya. Along with the development of science and technology the developed from in modern times of this in recent period is no other than the system of large reservoirs, canals and net work of distributaries off-taking therefrom, lifting water to a height by pumping, etc.

2.1.16 This is, as such, a brief and a running resume of the long and ancient irrigation tradition of Maharashtra. Want of adequate research and compilation of detailed information have prevented to bring forth all finer points pertinent to the characteristics of irrigation patterns, rules of cropping system, methods of revenue collection and management set-Up prevailing during that period. Nevertheless, such a long tradition is itself an important heritage and much can be learnt from that It is going to be exceedingly useful hereafter to have a standing set-up in Maharashtra which will undertake compilation of such type of information and a continual analysis thereof. An independent programme is it appears, required to be undertaken to facilitate dissemination of detailed information in this regard to all by conducting an in-depth overview of the commendable ancient irrigation tradition that was in vogue in Maharashtra through joint efforts of departments of History, Civil (Hydraulics) and agriculture in an university.

The retrospection of these ancient and historically long experiences of Maharashtra reveals that there had been a diversity compatible to the nature and conducive to local geographical and climatic conditions in patterns of crops, irrigation and water supply in different parts of Maharashtra. The water distribution methods had also been of different types dictated by the patterns of crops, climate and water supply system. Nevertheless, the common thread being manifested through all these was that the irrigation development had been given a good degree of encouragement and assistance by the local kings without any kind of interference in the day to day management of irrigation system. Maintenance and management systems were entirely left to the people.

Modern technology cropped in the physical set-up of irrigation during the British period: the scope of irrigation projects was enlarged. But along with it came governmental proneness. The ill-effects of enactments carried out during the period of dependance have still left its mark on all the system.

The merits and demerits in the Maharashtra's present irrigation system should be viewed on this long backdrop. Several new works of modern times were executed in Maharashtra region of the Mumbai Province which had been under the domination of Britishers. During that very period of 100 years (1848 to 1948) no new works of worth mention had been carried out in Marathwada and Vidarbha however. On the contrary, the thrust of public participation which had been rampant there by virtue of tradition, went on diminishing gradually to render the collectively-managed 'irrigation system and survived through the ancient tradition debilitated.

The disparity being experienced in different regions of Maharashtra due to the status of irrigation has as such a long causative tradition. The further set- up and management system will have to be established with adoption of the principles gathered through experiences from ancient historical & modern periods by properly grasping them that are likely to prove favourable in times ahead and discarding the drawbacks infused in it in course of time in the project formulation, cropping pattern and social structure.

2.2 Irrigation Development in Retrospect

2.2.1 Highly undulating terrain and vary low flows in rivers during periods other than monsoon have led to accomplishment of no major irrigation works in Maharashtra prior to the advent of British rule. During this very period several irrigation development works appear to have been accomplished in low lying area of Ganga Basin and the delta area on the east coast owing to lowly situated land and round-the-year flows in rivers.

During the period 1858 to 1868, the British Government entrusted the responsibility of executing irrigation projects to the East India Irrigation Company and Madras Irrigation company by assuring them 5% profit on the capital investment. However, both the Companies proved unsuccessful in accomplishing the works which led the Government to withdraw from them the works in a partly carried out state.

2.2.2 After 1867, the Government established an independent department for irrigation and formed one construction organization. In 1869, comprehensive irrigation development plan of 10 years had been evolved. A scheme involving $150 million expenditure was contemplated. The next 10 years subsequent to the year 1867 saw expending $52.85 million on this scheme. As the project works undertaken by the Government and the capital investment made therein in this new system proved satisfactory and worthy of use, a policy of undertaking further irrigation projects at the Government expense and through governmental organization was implemented. It can be said that the presently practiced Government system and methodology find their roots in this very step.

2.2.3 The concluding years of the nineteenth century saw a horrible famine. This has forced the British Government to undertake at least protective irrigation schemes, though out of reluctance. The first such major irrigation work could be cited as the Krishna Canal which started in 1870; The water of Krishna River has been used through a canal by constructing across it a weir at 'Khodshi'. The area to be irrigated on downstream used to be in proportion to the water available in the river course. Seeing that area being irrigated on canals was got affected after diminution in flow that occurred in post-monsoon period, it became clear that unless there had been a sizeable storage in Maharashtra, no systematic irrigation could be possible. Inception of canals off-taking from water storages came in the form of 'Khadakwasla' Dam constructed across the Mutha River and canals taking off therefrom. This work had been completed in 1875. Vihar (1860), Powai & Tulshi (1876) and Tansa (1883) Projects (drinking and industrial water supply for Mumbai) were completed in that order. Thereafter, the Neera Left

Bank Canal was commissioned by completing the Bhatghar Dam in 1885. The Union Irrigation Department had conducted one survey in 1902 to assess the water availability. This survey was the sequel of the Hydrographic and Hydrological Survey Report of H. F. Beale which saw the light of day in 1901. The following schemes had been envisaged therein Neera (Left Bank), Mutha Extension Canal, Girna, Mula Canal, Bhima, Kukadi, Ghod, Meena, Koyna, Mukane, Tapi (Hatnoor) and so on.

2.2.4 The irrigation development has always remained associated with political and social conditions prevailing in the country. The modern history of irrigation projects commences from the British era. During the British regime (in the years 1854, 1867), government construction works and development thereof were undertaken. The policy of mobilising loans to meet expenditure being incurred on construction has even gained the ground. The need of determining as o which criteria was to be applied for a particular work to be undertaken by raising a loan arose as a result of this policy. The pros and cons of this issue had been discussed by one special committee appointed in 1879 at the behest of the House of Commons. The main recommendation that has been offered by this committee is: "Only those schemes that would prove economical were to be undertaken which would fetch an annual interest equal to that which otherwise would have been accrued on the capital so invested Since the work commenced by raising loans and undertaken with the responsibility of the Government." Before 1-2 years of the submission of report of the committee, the Government of India had incepted one Famine Insurance Fund in pursuance of the recommendation of the Famine Relief Commission. One of its objectives had been that some public works should be undertaken which would provide a permanent relief in the eventuality of famines so that a saving would be entailed in the expenditure required to be incurred on future famine relief. The construction of Mangi Tank in Karmala *Taluka* was started in 1887 and could be completed only after independence in 1955 in phases during the famine years of 1899, 1906 and 1921. The report of the National Irrigation Commission of 1901-1903 contains the following information as to the manner in which irrigation works used to be classified during early 20th century and capital used to be mobilised therefor.

The irrigation works can basically be classified into two main streams - those executed mainly through raising loans and other works cost of which is met from revenue like that is being managed in case of construction of roads or Government buildings. The first (type of works is known as 'viable' works while the other type of works as 'minor' works. But when famine relief fund was instituted, a new intermediary class of work called 'protective works' has been created. In case some money out of that accumulated every year in the fund remained balance for want of necessity of expending for famine planning, it was planned to be used for expending on works such as constructing rail routes and irrigation works which were intended for ensuring permanent relief from famine and the rest of the part be used for repayment of loans or minimising the need of borrowing loans. As the famine relief fund is raised through the current tax recovery, the expenditure on count of protective works was used to be met from tax recovery like that for minor works. None the less, it had some element of difference namely the expenditure on count of protective works was being managed through a grant earmarked for famine relief protection and insurance. In case these works are not taken up, the funds are utilised either for repayment of loans or minimising the need of borrowing loans. Elsely, if it was to be expressed in different terms, it was used to be reserved for incurring expenditure on future famine relief. However, if a particular irrigation work was he accomplished as a 'viable one' by raising funds, it had been made obligatory to fulfil the following conditions so as to get the Secretary of the State convinced about its viability, viz., at least a net income equal to the interest accurable on the capital outlay inclusive of deficit, if any, experienced subsequent to 10 years after completion of the construction till that time must have been derived therefrom. 'Capital outlay inclusive of deficit' means total direct and indirect capital costs plus the additional income accruable to that date over and above the net income. Protective and economically viable works are bound to differ because of the ways of mobilising capital and the criteria of cost-effectiveness. Besides differentiation was also used to be made in respect of the manner in which irrigation management was ought to be practised from the viewpoint of providing irrigation to standing crops. The differentiation was necessitated on account of 'providing protection' being the objective of protective works. The area under the crops like sugarcane, other water intensive crops or perennials was used to be limited at the beginning of a year owing to this very objective. The intent was to enable fulfilling fully the water requirement of rainfed crops in case scanty rains are received during the fag end of the year.

Even from the viewpoint that the crops will have to be protected, the commission had been sceptical about any benefit the Government practice was indeed going to achieve. The commission has stated.

'It is of no significance on the part of Deccan area to merely increase area under foodgrains like that happened in 1877-78. It is not that much difficult to supply foodgrains to scarcity-hit provinces in years of drought. What is really necessary is that the farmers be in a position to seek an agro-related employment which would be productive enough. If at all this is going to be possible through irrigation works, it is immaterial whether the employment is sought in the production of foodgrains or that of cotton or sugarcane.'

The commission even went on suggesting that no distinction be made between protective and productive works as far as ways and means of raising capital are concerned. It was of the opinion that if at all it proved imminent to undertake protective works for reasons other than the mode of capital raising, one need not require to wait till the same was Managed from the famine relief fund. The commission went on recommending that all major works be accomplished by raising loans only.

The opinion expressed by the Bombay Irrigation Inquiry Committee of 1938 is:

"The best protection that a canal give is afforded when the supply is used from year to year as profitably as it can he to obtain crops of the maximum value. It is with a view to secure this important advantage that a redistribution of irrigation facilities computed on rational line is advocated in this report."

Irrigation Inquiry Committee (P-59).

2.2.5 Canals from Godavari were drawn by accomplishing completion of Darna Reservoir in 1916. By constructing Chanakapur Dam across the Girna River in 1918 canals were commissioned. The reservoir at Bhandardara provided in 1920 the canal network off-taking from Pravara River and year 1930 saw the commissioning of Neera Right Bank Canal as an extension of the already existing Bhatghar Dam. Irrigation commenced at Ramtek, Ghorazari Asolamendha and Naleshwar in Vidarbha in the years 1909, 1910, 1911 and 1920 respectively.

2.2.6 During this period, lack of flawless engineering techniques prevented from going in for high earth dams. Therefore masonry dams had been constructed. The engineering of masonry dams, too, had also not been sufficiently developed.

As such the pre-independence period could boast of creation of (1) Godavari (Nandur-Madhameshwar) (2) Pravara (Ozar) (3) Neera (Veer) (4) Mutha (Khadakwasla) (5) Krishna (Khodshi) and (6) Girna - all major projects and 15 medium projects - in all 21 reservoirs. Irrigation potential of 2.74 lakh hectare has been created therefrom the details of which are as per the following:

Sr. No.	Project	Created irrigation potential (lakh ha)	Total expenditure (Rs crore)
1.	Major Projects	1.72	}
2.	Medium projects	1.80	} 16.60
3.	Minor projects	0.22	}
	Total	2.74	16.60

Irrigation Development during Post-independence Period

2.2.7 India attained independence in the year 1947 and the Maharashtra State as of today came into being in 1960. The Plan periods commenced from 1951. No irrigation work of worth the name had been completed in Marathwada till 1954. No new major irrigation work had been taken up in the State during the 25 years since 1930 till the commissioning of Gangapur Reservoir in 1954. The increasing population was facing shortage of foodgrains. This has led to the need of increasing agricultural production. The condition was not conducive to take up major dams, nor had there been the slightest experience of constructing high dams. No data considered a pre-requisite to project formulation such as rainfall data, geological data, etc., was at hand. Ignorance as to how much water will be required for crops which crops would prove to be beneficial was rampant. Knowledge of flood forecasting hydraulics of canals and related hydrology had also been wanting.

Under such unfavourable circumstances, the cropping pattern in respect of projects was decided initially mainly to overcome the shortage of foodgrains. The engineering of earth dams was brought from abroad and, to start with, the Gangapur Earth Dam was constructed by applying that engineering. The experience gained thereafter had led to undertake the work of major dams such as Girna, Mula, Panshet, Dina, Ithiadoh, Bor, Manar. In case of masonry dams however, the earlier experience had come to help to undertake the work of dams viz. Koyna, Veer, Yeldari, Siddheshwar and so on. By lending priority to agricultural development in this work, attempt has been made to achieve a broader irrigation development in a planned manner.

2.2.8 After the formation Maharashtra State in 1960, the Maharashtra Irrigation Commission was appointed under the chairmanship of the then Irrigation Minister and Economist S.G. Barve to chalk out the course and frame the policy of future irrigation. The Commission brought out its report in 1962. The period 1955-1980 saw a radical change in the science Agronomy by way of invention of hybrid varieties of crops. A large scale use of pesticides and chemical fertilisers also started taking place. The evolution of engineering from earth and masonry dams had also been made possible out of experience. Deployment of heavy construction machinery has since then proved to be the key element. Obviously, 'construction of projects had been undertaken in the State on a large scale.

In view of the geographical setting of Maharashtra, it has become incumbent to take up irrigation development on a large scale. In comparison with the other states, this state of affairs will have to be called as simply unfavourable.

By expending Rs. 3342 crores (as per the 1995 current price) on the extensive programme of irrigation projects till the period ending 1980. Nearly 15 lakh ha irrigation potential has been added thereby.

Irrigation Development Subsequent to 1980

2.2.9 An attempt has been made to effect improvements in irrigation management alongwith the construction of dams / projects during this period. The thought of taking up maintenance and repairs of completed projects and appropriate use of water came to the fore. Consciousness as to top priority of water is aroused in farmers in different parts of the State. A demand for non-irrigation uses like drinking water, industrial supply, etc., has come forth alongwith this.

The disparity between the created irrigation potential and utilisation thereof may be attributed to the following main reasons:

1. Underutilisation during *kharif* season.
2. Changes in Cropping pattern,
3. Reduction in yield at dam sites,
4. Non-irrigation uses,
5. Poor-maintenance & repairs of canals and distribution system,
6. Fragmentation of land / non-preparation of farms for irrigation

Influence Area

2.2.10 As the experience goes, the influence area of a project is far larger than its command. While this is being ascertained in case of a few projects, this ratio appeared to be 2-3. This influence area includes the following irrigated areas:

* Lifts from reservoir
* Lifts from wells along the reservoir periphery
* Lifts from rivers / *nallas* in canal
* Lifts from wells in command
* Lifts from wells on off-canal side
* Area irrigated in adjoining sub-basin through a pipeline taken from wells in command.

It is being experienced that all this irrigation is indirectly attributed to the very project only. The statistics of irrigation area compiled by the Department does not account for the foregoing elements. Of late, data as to the irrigation areas under wells in command is being gathered by the Department. But there appears to be some confusion as to account for this area in the utilization of irrigation potential or not. The scenario will certainly appear to be different if reality based on influence area concept is appreciated.

2.2.11 Participation of water users' organization is being evoked in irrigation management pursuant to the current Government policy. The pace with which this is being implemented is, however, quite slow. Farmers are also not coming forward. The present scenario is like this:

* Operationalised WUAs	206
* Area transferred to these WUAs	78356 hectare
* Registered WUAs	250

Outlays during Plan Period and Created Irrigation Potential

2.2.12 It appears, roughly Rs. 95 crore have been actually expended by the end of Eighth Five Year Plan, i.e., March 1997 which facilitated to create 32 lakh ha irrigation area. This amounts to 15% of the cultivable area of the State.

As recommended by the Barve Commission, an investment of Rs. 1130 crore had then been expected to accomplish creation of 52.91 lakh ha ultimate irrigation potential. Rs. 20625 crore were required as per the 1995 current price level to achieve that much creation of irrigation potential. Actually, Rs. 19245 crore (at the same price level) had been expended. However, hardly 29 lakh ha potential could be created by end of March 1994 as compared to the targeted ultimate irrigation potential. In site of making provision of outlays at par with the suggestion of Barve Commission, the target of 50% potential only could be realised.

Information regarding capital outlays for irrigation as against the total planned outlays during the Five Year Plan periods during the post-independence period and irrigation potential created in the State is presented in Para. 9,2.1.

Status of the Year 2030

2.2.13 Irrigation potential created by June 1997 has been 32.28 lakh ha. The latest assessments put the total irrigation potential to be created by the year 2030 to 68.20 lakh ha. In order to accomplish this, Rs. 30870 crore investment will be required as per the estimate based on rates prevailing during 1997. This is going to add 77 major, 216 medium and 5064 minor projects in the State by the 2030.

2.3 Commissions and Committees

2.3.1 The importance of irrigation in agricultural countries like India which are dependent on monsoon rains has been appreciated by the contemporary sociatal set-ups since the prehistoric times. After the advent of British power in modern times, they also have to give thought to the irrigation needs and irrigation system. After having set out the developmental schemes in post-independent period, the states and the Centre had to undertake, from time to time, consideration of various facets of irrigation. Some improvements went on taking place pursuant to the committees appointed therefor. Though implementation in case of a few could not take place in entirety, respective suggestions went on influencing the overall policies. An attention to the recommendations of various such commissions and committees appointed from time to time, which are desirable to be pursued in times ahead also, is invited by underlining the same in the following retrospection. The further work can get streamlined thereby.

The British Government had appointed the Famine Commission to suggest measures to overcome the drought prone conditions which happened to be in succession in the latter half of the nineteenth century (of 1878 and 1896 years). The first Famine Commission was appointed in the year 1878. Based on suggestion of this Commission, a famine policy had been evolved after the year 1883. Appointment of the Second Famine Commission could take place after the drought of 1896-97. This commission had offered a suggestion to give priority to irrigation in whatever remedial measures that would be undertaken to ensure protection from drought. The first National Irrigation Commission had fully endorsed this suggestion.

Agriculture practiced with irrigation has inherent advantages: increase in overall productivity, protection of crops and economic benefits. By undertaking study of this effect and instituting a first nationwide comprehensive inquiry in India to decide upon the further irrigation-related policy of the country and modus operandi, the First Irrigation Commission had been constituted on 13th September 1901.

The terms of reference of the commission provided for undertaking studies in following respects:

(1) Verifying the utility/impact of irrigation projects in increasing agricultural production and enhancing land productivity

(2) To undertake a review of state level irrigation schemes from the point of view of increase in production, protection from famine and economic development; and to take appraisal thereof.

(3) Review expansion of irrigation at the State level and to suggest measures therefor.

The commission brought out its report on 11th April 1903 and made it clear that though there was a limit to the Government to make capital investment to increase production and multiply benefits in agricultural sector, no bar be put on expenditure where human life and its safety were of importance; and protective drought prone works be accorded sanction in case capital expenditure on account of projects happened to be not more than 30 times the net revenue or the net expected returns were of the order of 3% of the capital outlays.

All India level committees and enquiry boards which were subsequently appointed in connection with other subjects, had also undertaken consideration of some aspects of the subject of irrigation. For example, the Royal Commission on Agriculture of 1928 put forth the views on irrigation in the context of agricultural production whereas the Taxation Enquiry Committee of post-independence period (1953-54) expressed the opinion after studying the relation between water charges and betterment levy.

2.3.2 Alongwith evolving of long-term guiding principles through the formation of committees and commissions, the work of a few foresighted persons in the British period has laid the foundation of the present irrigation system in Western Maharashtra (contemporary Mumbai Provincial region). Its influence is still being felt all over. Therefore, it is necessary to take a note of those working systems while undertaking consideration of irrigation in Maharashtra. Especially, impact of systems evolved out of works of *Bharat Ratna* Sir Mokshagundum Visvesvaraya, Mr.Beale and Sir. Inglis is still being felt.

a) *Bharat Ratna Sir Visvesvaraya:* The lion's share in the evolution of canal irrigation system in Maharashtra goes even to Sir Visvesvaraya. He had been posted as an Assistant Engineer in Dhule District in the Public Works Department of the then Mumbai Government. He carried Out the study of *Phad* irrigation system which evolved there. By taking up the causative factors which led to success of it, he put forth the concept of block system. For the first time in 1904 on Neera Canals, he started practising block system. As no irrigation was taking place till that in that drought prone area, he surmised that a good utilisation could be possible if in some areas a farmer be given assurance of cash crops every year. He developed the block system through this endeavour.

The then British Government had constituted the Irrigation Commission at India level in 1901. When that commission visited Deccan Canals, Sir 'Visvesvaraya extended valuable help to it and apprised about the block system evolved for irrigation. He brought to the fore the concept which would ensure benefit of irrigation to maximum villages and maximum possible number of farmers. Farm block areas be large ones and 2/3 of its area should get seasonal water every year and 1/3 area can be brought under cash crop like sugarcane by the, beneficiary. Perennial irrigation is assured to that much extent only. Growing cash crops led to economical gains to the beneficiary as that area received assured water during hot weather. This led to accrue 3.5% returns on account of this block system. A note to that effect has been taken in the Mumbai Government's Gazette of 1908. This has rendered an economic stability to irrigation projects.

Notable contribution of Sir Visvesvaraya in engineering came in the form of design of automatic gates and their installation. He managed to fabricate automatic gates as the water storage impounded in the Khadakwasla Reservoir was found to be inadequate and installed the same on Khadakwasla Dam in 1901. They remained functional till 1961.

b) *Mr. Beale:* In order to provide relief to the drought prone area on Deccan Plateau (in old Bombay State wherein lies the present Western Maharashtra area) and to formulate irrigation projects, one comprehensive survey work under the leadership of the then English Officer (Superintending Engineer) Mr. Beale had been undertaken in the then Bombay State. With consciousness and employing resources available at that time he had accomplished that work expeditiously. He had submitted a detailed report in 1905 to the Government incorporating several workable sites for dams envisaging storages across rivers originating in Sahyadri (in sub-basins of Krishna, Bhima, Mula, Godavari, etc.) and indicating prospective irrigation projects (proper sites impounding storages on eastern slope of Sahyadri and facilitating irrigation therefrom). On the basis of this report, the major dams like Bhandardara, Bhatghar, Darana, Khadakwasla, and-canals thereof further took shape. He tapped high rainfall area in Sahyadri which receives regular rains and came out with a layout ensuring use of available water resources by way of a joint system of weirs and canals in drought prone area: The report of Mr. Beale is replete with notings regarding several irrigation projects including Panzra, Girna, Palkhed, Gangapur, Mukane, Dhom, Neera.

The work accomplished by Mr. Beale long before 40 years could prove of immense help when after independence development works were undertaken anew. The founding work accomplished by Beale has led to name the Bhandardara Reservoir commissioned pursuant to the Beale's report during the British period as 'Lake Beale'. The objective of irrigation envisaged in that report could not, however, be continued further. The vision of Beale had found to be reasonable enough to fall in line with the then British tradition which took every care to see that no financial burden would be thrusted on the Government as far financial viability of respective project is concerned. He had worked out the cost economics of projects in such a way as to ensure the revenue accruable therefrom to be more than the interest on the capital investment.

c) *C.C.Inglis:* The very first decade of this century saw the soils in Neera project command being rendered waterlogged and salinity-affected due to excessive use of water. Sir Inglis then undertook study and research in regard to waterlogged soils. A detailed procedure has been evolved by him by conducting a study on the basis of survey taking into account factors facilitating drainage such as groundwater table, depth of soils, *murum* strata, permeability, nature of waterlogged area, cropping system, water to be tendered, how much water would be needed to be drained off the soils by calculations, etc. The procedure also indicated the mode of implementation by carrying out design of drainage trenches for the respective areas.

By the very efforts of Inglis, an independent Pune Irrigation Research Division came into being in 1916 in the Old Bombay Province. In course of time, that very office has now been converted into the Directorate of Irrigation Research & Development. Maharashtra is the only State in the country which has a separate set-up which takes care of accomplishing drainage of soils in commands. Evolution of prescribing X-limit in order to obviate the possibility of waterlogging of soils is the outcome of efforts solely of Sir. Inglis.

He has also derived formulas to assess water availability and to compute design flood by pursuing the science of hydrology. The same are still in vogue in Maharashtra at large. All this study had been conducted by him in drainage basins in the lap of Sahyadri the limits in application of which had also been clearly pinpointed in his notes. Despite this, these formulas still appear to be in use in Maharashtra in the same form.

2.3.3 Inquiry of irrigation issues in regions which were forming a part of pre-independence Bombay Province had been held several times. A study related to irrigation in Bombay Province was conducted by a committee under the chairmanship of Mr. Prant. This report was brought out in 1921. The Bombay Government had made a special appointment of Mr.Bristo in 1928 to undertake study of issues pertaining to canals in Deccan Region. Waterlogging of soils in canal commands had been the main problem prevailing at that time. Thereafter Deccan Canals Financial Improvement Committee had been constituted under the chairmanship of Shri. B.S. Kamat which reported in 1932. Work which could be said to have had a far reaching impact on the irrigation system in Maharashtra was accomplished by a committee appointed under the chairmanship of Shri. Visvesvaraya in 1937 to conduct study about irrigation in Bombay Province. The report of the committee submitted to the Government in 1938 contained the following prominent recommendations.

1. It is necessary to institute a change in present irrigation policy as regards the water distribution in commands likely to be created in future. The water rates should be revised at least after 6 years.
2. Radical changes are to be incorporated in the irrigation policy and the management of Irrigation Department so as to implement equitable water distribution system.
3. A proper set-up be created to improve soils affected by 'waterlogging'.
4. A separate cell be set up for implementation of recommendations offered by this committee.

This very committee had recommended to set up the Block System of Irrigation on irrigation canals which involves rotation of crops and based on the principles of successful *Phad* system being in vogue in Girna-Panzra Basins. This new system came to be established on canals in Maharashtra in pursuance to that. After having gone through some minor changes, the system is still in existence on all old canals of the British Period.

2.3.4 After the Maharashtra State came into being, various commissions / committees were constituted as per the exigency to dictate the irrigation policy and its working modality in the State which brought out their reports. Some main reports amongst them are:

1. Maharashtra State Irrigation Commission - 1962
2. Fact Finding Committee for the Drought Prone Area - 1973 (Shri.Sukthankar)
3. Eight-monthly Water Use Committee - 1979 (Shri. Deuskar, Shri. Dandekar, Shri. Deshmukh)
4. Konkan Master Plan - 1981 (Shri. Swaminathan)
5. Konkan Irrigation Development High Power Committee - 1980 (Shri. Khatal)
6. High Power Committee on Irrigation Management - 1981 (under the chairmanship of Shri. Jain)
7. Regional Backlog in the State Committee - 1984 (Dandekar Committee)
8. Kasbekar Study Group - 1986.

Most of the thoughts expressed in reports submitted by all the foregoing committees and study groups to the Government by undertaking analysis of contemporary subjects entrusted to them are still found to be useful. The Commission is largely benefited by the works put in by the respective committees. The Commission expresses its indebtedness to all of them. Seven committees during the period of 14 years from 1973 to 1986 have thrown light on various aspects of irrigation in Maharashtra.

Maharashtra State Irrigation Commission - 1962

2.3.5 The Government has constituted 'Maharashtra State Irrigation Commission' on 7th December 1960 under the chairmanship of Shri. S.G. Barve to inquire into the issues related to irrigation and water resources development in the State and to submit a report thereon. The following main topics had been incorporated in the commission's terms of reference:

1. To assess the total water resources of Maharashtra; to consider their utilisation for purposes such as irrigation, domestic and industrial uses, etc. and in particular to realistically estimate the potential of irrigation by different project schemes.
2. After assessing the extent of irrigation facilities available through works already constructed or in progress; to accomplish appropriate distribution of available water resources for future and to consider and formulate a specific plan of action with a view to affording protection to scarcity-affected areas.
3. To frame prospective policy for cropping pattern, crop planning, the problems of waterlogged and salinity-affected soils, policy relating to supply of water, etc., and to decide policy regarding measurement and distribution of water and also maintenance & repairs of irrigation projects.
4. To examine the financial returns of ongoing irrigation projects.
5. To consider the necessity of evolving a proper cropping pattern to pave way for economic development and general prosperity of the irrigated areas.

The commission submitted its report to the Government on 9th June 1962 some of the main recommendations of which are:

1. Planning based on 50% dependable availability be adopted in those basins where the same corresponding to 75% dependability falls short so as to achieve maximum use of available water resources.
2. Irrigation facilities such as wells be concentrated in region amenable to irrigation by gravity.
3. Irrigated areas be equitably distributed amongst farmers especially by limiting cash crop area for which individual farmers are to be provided irrigation water.
4. In the policy regarding inter se priority amongst various uses of water, the top priority be given to domestic needs followed by those on industrial count. However, industries which are water-intensive be made to conglomerate in those basins where water is sufficient.
5. The comprehensive schemes envisaging use of water resources in various basins/sub-basins be made all-inclusive so that other projects entailing use not only on account of irrigation requirement but also of other uses will be contemplated.
6. The financial criteria applied to judge the soundness of a project be made to accept the norm of assured annual capital expenditure per million cubic feet and the cropping pattern being evolved under the envisaged project be diagnosed with the same precision.
7. The system of according sanction to concentrated blocks of sugarcane crop prevailing at present on Godavari and Girna canals be encouraged.
8. The gestation period of irrigation development be reduced to 8 years from the commencement of construction or 5 years from the commissioning of irrigation.
9. The domestic water supply needs of rural areas through which canals and minors are to pass be taken into consideration. Construction of *ghats* on canals, permanent roads for the use of villagers be constructed

and they be made open to public. Such betterment projects be included in the formulation.

10. The Government should assume the responsibility of accomplishing actual rehabilitation of people who are rendered refuges because of the project.
11. A comprehensive development scheme for each project be framed which incorporates aspects other than that of engineering to ensure an all-round development of the irrigated area.
12. A special inquiry commission be appointed every 10-15 years to undertake a review of irrigation-related policy.

The Government of Maharashtra had circulated its decisions on the report of this commission in 1964. The procedures followed in respect in Maharashtra during the last 35 years is basically governed by these decisions.

2.3.6 If the names of member of the Barve Commission are gleaned through, one prominent thing comes to notice that the experience all of them which pertains to irrigation had been basically representative of the irrigation system being practised on plateau on east of Sahyadri. As no large scale irrigation projects on the line of modern system had been executed in Vidarbha, Marathwada or Konkan at that time, reflection of experience on that count was not expected in the Barve Commission's report, nor is it even discernible. The whole report of that commission appears to have mainly been influenced by the then existing system on plateau east of Sahyadri in respect of details such as feasibility of irrigation, assessment of water resources, groundwater use, administrative set-up of irrigation, water charges, etc., and timely improvements necessitated therein.

Successful experiments directed at irrigation expansion by constructing anew dams, canals in different parts of Maharashtra have taken place thereafter. A more exhaustive experience gained therefrom - not available at the time of Barve Commission - is now at hand with the Maharashtra. While considering expansion of irrigation, the Barve Commission had held the view that no irrigation projects would be sustained in Konkan. In spite of Ample water availability in basins of west-flowing rivers in Konkan, the table of irrigation potential presented in the commission's report had remarked *'Area that can be brought under irrigation by flow or lift is nil'*. An effort of establishing new irrigated area of hot weather paddy at a continuous stretch has been made for the first time after independence near Karjat facilitated by the discharge released in Raja Nala from the Tata's Power House. Encouraged by that experience, new efforts have been undertaken for implementing irrigation projects in Konkan thereafter. Nor is it that irrigation development could even take place so far on a large area in Konkan. Notwithstanding this, the actual area so far being brought under irrigation is 59.49 thousand hectare now. This figure, too, is quite telling. It has now become easier to advance the planning of water and irrigation in Maharashtra hereafter on the basis of such a new accomplishment.

(3) Water and Irrigation

National Irrigation Commission - 1972

The Government of India constituted this commission on 1 st April- 1969 under the chairmanship of shri Ajit Prasad Jain. Remarkable progress has been achieved in the sphere of irrigation during the post independence period. The irrigation potential has been increased two-fold.' Notwithstanding this, a drought prone condition used to be arisen more often in different parts of the country. The Second Irrigation Commission had been constituted to seek protection therefor and to overcome the vagaries of monsoon. The irregularity in rainfall can be overcome with the construction of irrigation projects. With this in mind, it was expected of the commission to have a perspective of irrigation development for period in future by entailing use of surface and groundwater. The following main issues had been included in the TOR of the commission so as to have an in-depth consideration of various problems pertinent to irrigation:

1. To undertake a review by conducting a study in respect of irrigation progress after 1903, increasing productivity and assurance resulting from irrigation over irregularity of rains.
2. To undertake overview of irrigation facilities available in drought prone & especially in food-deficit areas and formulate proposals for future irrigation projects.
3. To frame broad framework of irrigation development so as to be self- sufficient in food and increase its financial requirement.
4. To assess availability of water in large irrigation projects and prescribe methodology therefor.
5. To suggest administrative and organisational reforms so as to complete projects in time.
6. To evolve norms for project approval.
7. To give a thought to other related aspects of irrigation and offer special recommendation pertinent to that.

The commission reported to the Central Government on 30 Th March 1972. A few of the important recommendations contained in the report are as follows:

1. A river basin be adopted as a natural unit for water resources planning.
2. Top priority be given for domestic water use. A conjunctive use of surface and groundwater be resorted to.
3. The cropping pattern be determined by the departments of Agriculture and Irrigation in consultation.
4. Availability of water in drought prone region be augmented by providing a carry over.
5. A comprehensive plan of command area development be chalked out and a separate command area organisation be created for every project.
6. Modernisation of canal system be carried out every 25 to 30 years.
7. Irrigation rates be stipulated as 5 to 12 per cent of the gross income accruable from crops.
8. A separate director be there to carry out hydrological study. There should be a separate agency at State level to deal with groundwater.
9. An urgent attention be paid to maintenance and repairs of *malgujari* tanks in Maharashtra and adequate outlays be made available for renovation thereof.
10. Percolation tanks, check dams be constructed in that part of the State where groundwater table is deeper.
11. There is no objection to relax B. C. Ratio upto 1 in respect of major, medium irrigation projects in drought prone areas.

(5) Groundwater

i) Groundwater Estimation Committee (1984)

The Central Government appointed one Groundwater Estimation Committee in 1972 in order to assess the groundwater resources. The committee completed its report in 1984.

Groundwater recharge be estimated by the Water Table Fluctuation Method. On the basis of net recharge and net draft, the net groundwater reserve be determined. The number of additionally possible wells then be computed assuming 1 well per 1.5 hectare meter. The estimate of groundwater outside the command areas be separately quantified. These are the key suggestions brought out by this committee.

ii) Technical Committee - 1992

At the directives of the Ministry of Water Resources - Government of India, the Government of Maharashtra constituted one Technical Committee through G. R. dated 20th August 1992 under the chairmanship of the Secretary, Ministry of Water Resources to assess the State's groundwater resources and irrigation potential thereof. The committee reported to the Government with the following recommendations:

1. The recharge through rainfall and the same in the commands through other sources are to he quantified in isolation.
2. The assessment of groundwater be carried out with watershed as a unit, delineating the latter by blocks or *talukas* for the planning.
3. State's ultimate irrigation potential through groundwater is assessed to be 41 lakh ha -in commands being 8 lakh ha and outside it 33 lakh ha.

iii) Groundwater Resources Estimation Methodology - 1997

The Ministry of Water Resources, Government on India appointed in 1997 one Groundwater Resources Estimation Methodology Committee devolving on it the task of reassessment of the ground water resources. The committee has proposed division of watersheds belonging to hilly, saline groundwater, non-command (of canal) area and so forth. Groundwater resources are to be assessed taking into consideration the variation in the geomorphological and geohydrological characteristics: and monsoonal & non-monsoonal groundwater be assessed in separation. These are the prominent suggestions the committee offered.

7) Pricing of Water

i) Report of the Vaidhyanathan Committee - 1992

The Planning commission at the Centre appointed on 23 rd October 1991 one committee under the chairmanship of Dr. A. Vaidhyanathan (ex-member of the Planning Commission) to determine the price of water. The committee reported to the Government of India in September 1992 and came out with the following recommendations pertinent to pricing of water:

1) The feasibility of projects be decided on by adopting the Internal Rate of Return (IRR) norm in lieu of the benefit-cost ratio.
2) The revised price of water be such that the entire expenditure incurred be recoverable through that. Similarly, the farmers be motivated to go in for economic use of water. Water levy is a service charge - not a tax. The irrigation service be improved alongwith the hike in rates.
3) The states to undertake revision of water rates in such a way as to assure full recovery of expenditure incurred and to pave way for prompt recovery of all outstanding.
4) The affordability of farmers be kept in view while undertaking any revision in water rates.
5) Water rates he fixed in accordance with the following categorisation of projects for respective commands:
    * Major and medium projects
    * Major and medium diversion weirs
    * Minor projects
    * Lift irrigation on canals
    * Irrigation through groundwater draft
    * Moreover, the states with large areal extent and where diversity in agroclimate prevails, the determination of water rates be resorted to taking into consideration this divergence.
6) The Irrigation Department is experiencing need to radically change the attitude of practising irrigation management. The Irrigation Department is accordingly to undertake the management of works upto main canal and distributaries exemplifying

high grade quality in the enterprise and parting, at the same time with management of distributaries and water distribution bestowing the rights thereof on the farmers.

7) 10% amount out of the grossly available outlays in respect of major and medium projects be spared for undertaking repairs and management necessitated for delivering water volumetrically in command of respective project.

8) State government are to undertake timely review of expenditure being incurred on establishment for irrigation management, maintenance and repairs, and water rates. One irrigation water pricing board be constituted every 5 years to enable the beneficiaries to vent their views and offer suggestions.

9) It be decided upon whether both the functions-irrigation recovery and assessment - are to be carried out by the Irrigation Department or assessment be done by that Department and recovery be made by the Revenue Department. In case, the Irrigation Department is to be entrusted with both, the officers of that Department be empowered with rights of recovery like their counterparts in the Revenue Department.

10) State government are to put an end to the prevailing practice of water supply (the provision of water on credit). Instead, it is to switch over to the practice of delivery only by exacting advanced water charges. Similarly, assessment be warranted on volumetric basis instead of it being crop specific.

11) A basic fee of Rs. 50/- per hectare be charged for all cultivable area in commands of major, medium and minor projects. This fee will confer a right to secure water to the farmer. (The concept of betterment levy only is implicit in it, as the fee is going to be assessed every year irrespective of water is used or otherwise.)

ii) Tenth National Finance Commission - 1994

The irrigation water charges are used to be deliberated upon on the premise of revenue through the Finance Commission being appointed to undertake a 5-yearly review of the national financial set up. The report of the Tenth Finance Commission of the Government of India (1995-2000) is brought out in December 1994. The Finance Commission offered the following recommendations through it:-

1) Irrigation water rates structure in a state be framed in such a way that the recovery accruable through that be commensurate with the annual returns equal to the expenditure being incurred on maintenance and repairs of the irrigation schemes and 1% of capital expenditure thereof.

2) State Government's yearly expenditure on the establishment and machinery be not exceeded than 20% of the provision at its disposal.

3) Maintenance and repairs norms in respect of major, medium and minor projects be like the following:-
   * Irrigation potential utilised Rs. 300 per ha
   * Irrigation potential unutilised Rs. 100 per ha
   * 30c/c excess rates for hilly area
   * Norm for minor project be 50% of that for major and medium projects. The Chief Engineers of the Irrigation Departments of states are to conduct quarterly review of expenditure of maintenance and repairs.

Barring this, several committees had been appointed at the national and state levels which were intended to undertake review of new concepts like Watershed Development and having developed that offered recommendations in regard to the further course of action. Based on their recommendations different types of works having undertaken on a large scale for areas which are deprived of irrigation through conventional methods.

National Water Policy - 1987

2.3.15 The national manual largely influencing all such policy matters in recent times is the 'National Water Policy'. In order to be readily available as a guidance module to the Centre which receives numerous proposals from various basins belonging to a number of states in the country to tender approval and also to the within - the - states water utilisation programmes, the National Water Policy is evolved as a concise formulation.

Water is a priceless and scarce national resource. Planning, development and conservation of it be managed in such a way that environmental balance will be maintained and growing demand for water from state-to-state will be met in an increasingly satisfactory manner. The National Water Resources Council set up for this by the Government of India with the Prime Minister of India as the chairman and the concerned Union cabinet ministers and the Chief Ministers of all the states as the members has, after detailed deliberations on its forum brought out the National Water Policy in September 1987. The same has been rendered into various languages and disseminated by the states. The salient guiding principles contained in it are:-

1) A nationwide water related information compilation centre' should be set up integrating with it the existing Central and state level agencies.
2) Water resources planning should be performed with drainage basin as a unit While undertaking planning of a sub-basin, the basin should be considered as a coherent whole. A multidisciplinary planning unit should be set up for accomplishing basin planning.
3) A water resource project should be formulated as a multipurpose project. The project planning is required to incorporate components such as environment, catchment area treatment, rehabilitation, command area development and so on.
4) There should he regular inspection/monitoring of structures, canal system & DISNET works and observations be compiled together and evaluated. Modernisation and rehabilitation programme should be undertaken as and when necessary and be based on outcome of the consolidated reports of monitoring after its evaluation.
5) Dam safety organisations should be created at national as well as state levels to evolve safety regulations and guidelines for effecting safety inspections of dams and to undertake updation thereof.
6) Groundwater potential should be assessed on a scientific basis. Estimation of groundwater use and net recharge should form a part of it. Water quality and economic viability for use should also be taken into consideration.
7) Overexploitation of groundwater should be curbed in coastal areas to prevent ingress of sea water into sweet water aquifers.
8) In planning and operation of water resources systems, allocation priorities should (broadly) be as follows: i) Drinking water ii) Irrigation iii) Hydropower generation iv) Navigation v) Industrial and other uses.
9) There should be close integration of wateruse and landuse policies
10) Water allocation (in an irrigation system) should be done with due regard to equity and social justice.
11) Both surface and groundwater should be regularly monitored for quality. A phased programme should be undertaken for improvements in water quality.

12) Efforts should be made to progressively involve local voluntary organisations in water distribution.
13) Flood control and management organisations should be established for respective basins.
14) In planning water resources, drought prone area should be given priority.

Water Policy in Other States

2.3.16 In pursuance of the National Water Policy - 1987, the Orissa State Government promulgated its state water policy and set up the 'Department of Water Resources Board' to initiate its implementation. The states of Punjab, Rajasthan, Tamilnadu have also followed suit by drafting water policies for their respective states.

Second Bihar State Irrigation Commission 1994

2.3.17 The Bihar State Government has, in 1991; set up the Second Bihar State Irrigation, Commission under the chairmanship of the Minister, Water Resources Department, Government of Bihar. Mr. Jagdananda had been holding the Ministership. The commission reported to that government in August 1994 and came out with a report comprising 6 volumes. The following main recommendations appear to be offered by the commission:-

1) The state should be delineated into 26 basins in accordance with the catchments of major river basins to formulate land and water use plans.
2) Suitable enactments should be effected to ensure safety of irrigation structures in command and to carry out irrigation management; and implement the same.
3) Command Area Development approach should be adopted in all the projects in the state.
4) A dam site should be developed as a tourist place
5) A water resources board should be constituted under the chairmanship of the Minister. Water Resources to achieve optimum use of water by co-ordinating the various activities embarked on by the diverse user agencies in the state and the Water Resources Department.

Commission on Utilisation of Irrigation Potential in Andhra Pradesh

2.3.18 The Government of Andhra Pradesh had appointed on 17-02-1981 one-man commission with Mr. Sayyad Hashmi Ali - the then Commissioner for Agriculture and Second Secretary - as the chairman to resolve the discrepancy between created irrigation potential and utilisation thereof in that state vis-a-vis the resulting decline in agriculture production. The commission submitted its report in November 1982. The prominent recommendations offered through the report are:-

1) The irrigation management in the state should be totally separated from the construction wing (right from the Chief Engineer's level to the lowest rung of the ladder). Command area development agency and the irrigation management should be amalgamated. Such a set up be formed by regarding basin as a development unit of irrigation management.
2) A multidisciplinary organisation (encompassing disciplines such as irrigation, groundwater, agriculture, social sciences, economics) should be created to implement the equitable policy in irrigated agriculture and through that the practices like water allocation with due regard to the various agro-climatic zones, seasons, rotations, conjunctive use of water, etc., be enforced.
3) In order to achieve an equitable water distribution policy in command, each beneficiary should be provided with equal

quantum of water per hectare by extending irrigation facility to larger area and benefiting maximum number of farmers.

2.4 Geography and Social Status

2.4.1 The State of Maharashtra came into being on 1st May 1960. The geographical location of Maharashtra is bounded between latitude 16.4^0 to 22.1^0 N and longitude 72.6^0 to 80.9^0 E and has an area of 307.71 thousand sq. km of the Indian Sub-continent which is about 9.4 percent of the total geographical area of India. Maharashtra occupies main portion of the Indian Sub-continent. The State has 720 km long coastline along Arabian Sea. The western hill ranges are almost parallel to this coast line. The State is divided into two physiographic regions of Konkan and rest of the State (Deccan Plateau) as a result of this north-south continental divide. The average altitude of the Sahyadri ranges of Western *Ghat* is about one km (MSL 610 m to 2134 m). The Deccan Plateau spread over on the east side of *ghat* has east-west slope. In general, the altitude of the plateau varies between 300 to 600 m. Maharashtra has Gujarat on north-west, Madhya Pradesh in north and east and Andhra Pradesh. Karnataka and Goa in south with coterminous boundaries.

Physiography

2.4.2 The State is divided into five major regions physiographically:

i) Konkan strip on western side (ii) Sahyadri ranges iii) Plateau on eastern side (iv) Hilly ranges of Satpuda and adjacent area on north and (v) Hilly and forest region of north-south Wainganga Basin.

1) Konkan Strip

The narrow strip of land extending from Damanganga Basin in north to the border of Goa State in south is the Konkan. It has Sahyadri ranges on east and Arabian Sea on west. The Konkan strip is about 53 to 60 km wide and 500 km long along north-south. The widest stretch is about 100 km in Ulhas River Basin in north. Width decreases as one proceeds towards south. The region becomes hilly and altitude increases from the depressed coastline towards east.

2) Sahyadri Ranges

These continuous mountain ranges extend almost parallel to the western coast line. The ranges extend beyond Kerala. It is known as Western *Ghat.* The average height of Sahyadri in Maharashtra is 900 m with extensive plateau regions like Mahabaleshwar situated on ghats. The average height of the Sahyadri ranges is more in the north and diminishes towards south. The highest point of Sahyadri ranges in Maharashtra. is Kalasubai (1646 m) at the interdistrict boundary Ahmednagar. Besides, Salher, (1576 m) Mahabaleshwar (1438 m) and Trimbkeshwar (1374 m) are other important high places.

3 Eastern Plateau Region (Deccan Plateau)

Ajantha hills (600 to 800 m), below that Godavari Basin, Ranges, Balaghat Ranges (824 m to 323 m altitude), Manjra Basin, Puma - Painganga - Wardha River Basins, Bhima Basin - Mahadeo Hills - Krishna Basin on south constitute this region. The height of this plateau goes on diminishing from 600/700 m on western side to 300 m in the Wainganga Basin on east. The centrally located Manjra Basin is at the highest level in this region and is surrounded broadly by mountainous part upto 780 m high. This region is formed from lava of igneous rocks.

All the districts of Khandesh, Marathwada, Western Maharashtra and the western districts of Vidarbha, viz., Buldhana, Akola, Yavatmal and Nagpur in this region.

4 Satpuda Ranges and Tapi - Purna Basin on North

Satpura hill ranges lie on the Northern boundary of the State. 'Gavilgad' in Amaravati District whereas 'Toranmal' (1461 m). in Dhule District are situated in these hill ranges. The height of Chikhaldara in Gavilgad Range is 1016 m south of this range lies the flat deltaic region of Tapi Basin and its tributaries. This region is spread over in the districts of Amravati, Akola, Jalgaon and Dhule.

5 Eastern Region Consisting of Wainganga Basin

Wainganga River flows in north-south direction on the eastern side of the State and flat paddy field region lies along both the banks of the river at an elevation of about 300 m. On the eastern side of this flat region along the Maharashtra - Madhya Pradesh boundary are the hills of different geological formations other than the Deccan Trap. Many eastern tributaries of Wainganga originate from this hill range. The height of this hilly plateau is around 800 m and this whole region is known as hills of Gadchiroli.

River Basins

2.4.3 Maharashtra State is mainly covered by the basins of Krishna, Godavari and Tapi except the west-flowing rivers of Konkan strip. A small portion on north comes under Narmada Basin. Similarly, a small portion on east of Wainganga lies in Mahanadi Basin. Some of the major tributaries of these three rivers join them outside Maharashtra instead of within it. For example, Bhima. All these three basins do not wholly lie in Maharashtra but the territory of Maharashtra is formed of the region of their sub-basins. Though the concept of comprehensive planning of these rivers is mainly connected with the interstate water aspects, it appears that sub-basinwise planning can be done independently within the Maharashtra. There are in all 380 rivers in Maharashtra State and their total length is 19269 km (11974 miles) whereas the total length of nallas joining thereto is 19311 km. The lengths of rivers in Konkan totalled to 1609 km (1000 miles). Most of the land in Maharashtra is undulating and hilly. Comparatively, continuously hilly plateau lands are very few. Because of this, flow canal systems in Maharashtra are very expensive, though there are large number of suitable sites for building water storage reservoirs.

Number of rivers originate from Sahyadri and flow westward to Arabian Sea through the Konkan strip. These rivers originate in Sahyadri at about 500 to 700 m elevation and flow through a distance of about 100 to 150 m in a meandering manner. Damanganga, Surya, Vaitarna, Ulhas, Karla, Kundalika, Kal, Savitri, Vashishthi, Shastri, Gad Karli, Tillari and Terekhol are these prominent rivers. The creeks have been formed all the months of these rivers due to sea water instrusion. Because of these cracks, the old ports came into existence at Vasai, Dharamtar, Roha, Mahad Chiplun, Dabhol, Jaigad, Rajapur and Vijaydurg for navigational transport. These rivers are of shorter length holding fair amount of water during monsoon but run totally dry during summer months. The natural calamities such as land erosion, salt water intrusion, land subsistence etc. are often inflicted upon Konkan.

Tapi and Narmada are the two west-flowing plateau rivers coming from Madhya Pradesh and flowing down to Gujarat State through Maharashtra. Narmada River forms 54 km long common boundary of the State in Dhule District along northern border. The Tapi River originating from Madhya Pradesh flows for about 65 km along northern border of Amravati. District and again enters into Madhya Pradesh. It again renters into Maharashtra in Dhule / Nandurbar Districts and flows down to Gujarat. Puma, Girna, Bori, Aner, Panzra are the tributaries of Tapi. Pedhi, Katepurna, Mun and Nalganga are the tributaries of Puma. Total length of Tapi River in Maharashtra is 208 km. All these rivers and tributaries have render the land of Khandesh fertile.

Wainganga River flows in north-south direction independently of others. Important tributaries of Chulband, Human Dina, Khobragdi join her on the Eastern side after flowing down the Gadchiroli Hills. Kanhan and Wardha join her from the western side. The length of Wainganga in Maharashtra is 476 km. Godavari is the principal east-flowing river with Manjra as the main tributary. Godavari - the longest river in Maharashtra (968 km) - originates at Trimbakeshwar at Nashik District and enters Andhra Pradesh near Dharmabad in Nanded District. It again flows for about 48 m along southern boundary of Gadchiroli District and enters Andhra Pradesh on south, Darna, Pravara, Sindhphana, Purna, and Pranhita join Godavari. After the confluence of Wardha and Wainganga, the river is known as Pranhita. The confluence of Pranhita with main Godavari is near Sirocha. Manjra River originates in Beed District and flows through Beed and Latur Districts before entering into Karnatak and Andhra Pradesh. It reenters into Maharashtra in Nanded District and joins Godavari.

South-east flowing Bhima and mainly north-south flowing Krishna are the major rivers of South Maharashtra. Bhima River rises near Bhimashankar in Pune-District an flows through Pune and Solapur Districts. Ghod, Man, Pawana, Neera and Sina are the main tributaries which join Bhima. The semi-circularly flowing Bhima at the pilgrim centre Pandharpur is known as Chandrabhaga. The length of Bhima in Maharashtra is 451 km. It joins Krishna on the Karnataka-Andhra Pradesh boundary near Raichur.

Krishna rises near Mahabaleshwar. The Krishna is 282 km long in the State. On West it is joined by Koyna, Wenna, Panchaganga while Yerala joins it from east. The confluence of Panchaganga-Krishna is at Narsobachi Wadi - a Datta Pilgrim Centre. Thence onward Krishna enters into the Karnataka.

Forests

2.4.4 Mountainous terrain and climatological differences render an unevenness to the spread of forests over the State. Dense forests are mainly extant in the Sahyadri and Chandrapur and Gadchiroli Districts of East Vidharbha. The rainfall diminishes from Sahyadri to plateau region and so also the forests. The gross area of Maharashtra is 307.713 lakh ha out of which 63.842[6] lakh ha (21%) land is in the possession of the Forest Department as forest land. The forests in Maharashtra are mainly classified into 5 types.

1) Tropical evergreen forests

These forests occurs along the westerly sloping Sahyadri *Ghat* where incident rainfall is 2500 to 3000 mm. Especially South Konkan is replete with these type of forests. Big trees like wild mango, black plum, shrubs like wild banana, *Karwi, Netche* and *bamboo* are thickly populated in these forests. Wood obtained from these forests, being hard, is of least economical importance.

2) Tropical partially evergreen forests.

These forests come across non-contiguously at the foot of Sahyadri on its westerly slope and places on *ghat* area like Khandala where it rains 1500 to 2000 mm annually. Both types of trees-evergreen and deciduous like *Kinjal, Shewari,*

6. Information received through the Forest Conservator, Working plan Circle, Nagpur's letter No. Cell/T/F52/1021/98-99 dated 18-01-1999.

Oin, Hedoo, Kadamb and to some extent *bamboo* occur in this forest. Few species among these are of economical importance.

3) Deciduous forests

These forests occur on east of Western *Ghat* where rainfall is of the order of 1000 to 1500 mm. The Mahadeo, Harishchandra and Satamala ranges of Sahyadri, Satpuda ranges in Dhule District and hilly area of Thane District are also overlain by these forests. These types of forests are extant in Chandrapur and Bhandara Districts too. Trees of species like teak, Oin, Kusumb, Shewari, Raintree, Palas, Khair, Shisoo, Anjan, etc., are also found in these forests. From the economics view point these forests are important.

4) Thorny and stunted vegetation forests

Vegetation is quite sparse in the scanty rainfall area on plateau region owing to the dearth of and infertile land. East part of Nagar, Pune, Satara, Sangali Districts and Solapur Marathwada and Western Vidarbha are overlain with this type of forests.

5) Littoral forests

Over the marshy land along the coast line and saline tract the mangrove forests, which could extract salt from the surface, foster. These constitute species like *Chipi, Marandi, shrubs, Tis* trees, etc., which grow merely in saline water:

Considering actual forest cover (46.14[3] lakh ha) it appears that 23.62[3] lakh ha area is overlain with dense forest while sparse forest is extant over 22.40[3] lakh ha area and very marginal area is Covered with mangroves. Compared with the geographical area of Maharashtra the dense forests occupy hardly 8 percent area and roughly equal area belongs to spare trees/shrubs and pastures. The area under forest is 15 percent of the geographical area of Maharashtra. District-wise, Chandrapur is the highest with 54[3] percent. In 9 districts this proportion is between 10 to 43[3] percent while 18 districts exhibit the same in less than 103 percent. The Osmanabad District is the lowermost in Maharashtra (0.04[3] percent) in this respect. The administrative divisionwise scenario of percentage area under forests in Maharashtra is like this. Konkan-9%, Nashik-l8%, Pune-10%, Aurangabad-5%, Amravati-16% and Nagpur-42%. In order to assess in what way the forest life is related to the economic status of the masses, the Commission has got done an independent study of Economic status of Gadchiroli District. The outcome pertinent to this is presented in Topic 2.6.

Administrative Set up

2.4.5 Administrative point of view the State of Maharashtra is divided into 6 divisions. At the commencement of the year 1999 the number of districts is 33 while that of *taluka* is 328. Administrative divisionwise number of districts and *talukas* (as at the beginning 1999) are:

Sr. No.	Administrative Division	No. of districts	No. of Talukas
1.	Konkan	6	49
2.	Nashik	5	49
3.	Pune	5	56
4.	Aurangabad	7	59
5.	Amravati	5	55
6.	Nagpur	5	60
	Total	33	328

The Government has recently created 2 districts - one in Aurangabad Division, viz. Hingoli and another one Gondia in Nagpur Division.

3. Information received through the Forest Conservator, Working plan Circle, Nagpur's letter No. Cell/T/F-52/1021/98-99 dated 18-01-1999.

On an average, a *taluka* encompasses geographical area of 90 thousand ha and a district 10 lakh ha. Basins of rivers and tributaries in Maharashtra, if viewed, reveal that the area of a district is spread over various sub-basins, but the greater part of a *taluka* generally lies in a single major sub-basin. Therefore, a *taluka* appears to be a unit of water planning akin to natural disposition. But in case of district this does not appear to be so. One *taluka*, on an average, contains 125 villages and the geographical area of each village broadly is 800 ha on an average.

Irrigation Facility

From the point of view of irrigation, varying geographical dispositions render different degree of irrigability to the *talukas*. It is quite possible to provide irrigation to *talukas* through canals or river, e.g. Niphad, Rahuri, Newasa, Majalgaon and Gangakhed which are situated either on the rivers or near the confluence with tributaries thereof. It is expensive and difficult to provide irrigation to *talukas* like Chandwad, Kaij, Kalamb, Osmanabad. Washim, Yeotmal which are situated on high plateau area. The consolidated framework of irrigation development of Maharashtra when prepared turns out to be extremely favourable to some *talukas* physiographically while equally contrary to some others. As the economical viability is also to be respected in irrigation development, it does not appear possible to bring all the unfavourably located *talukas* on equal footing as far as irrigation facility is concerned. It is imperative to go in for other alternatives which are not water-related for their economic prosperity as well as development on priority.

In Maharashtra generally the lands along the rivers are suitable for farming as well as for irrigation purpose but the rivers like-Tapi where the deep ravines have been formed due to rainwater erosion along both the banks the development of farming or of irrigation is rendered difficult and ’uneconomic. It is estimated that about one lakh ha of land has become fallow due to formation of river ravines in Maharahstra. Though for these areas water is available nearby, heavy cost of land levelling and soil conservation make it necessary to evolve different mechanism for these belts. Particularly it may be necessary to develop a new methodology deploying modern methods like drip and sprinkler system and accordingly experiments need to be undertaken in this direction.

According to the economic survey of 1997-98 of Maharashtra there are 15 corporations. 220 municipalities, 29 districts councils, 317 *panchayat* committees, 27620 *gram panchayats* and 7 cantonments. In this manner the developmental works are taken care of through local self-government from village level to district level.2

Land Holding

2.4.7 There are in all 94.70 lakh cultivating land holders in the State as per the Agricultural Census for the year 1990-91 owning among them total cultivable area of 209.25 lakh ha. That is, average cultivable holding works out to be 2.21 ha. The same average had been 4.28, 3.11 and 2.64 ha as per the Agricultural Censuses for the years 1970-71, 1980-81 and 1985-86, respectively. Out of cultivable land holders of the year 1990-91, 94.9 per cent are individuals, 4.9 per cent are joint ones while merely 0.2 per cent are institutes.

The number of cultivable land holders, total and average cultivable area according to the classification of cultivable area as per the Agricultural Census for the year 1990-91 is as follows:

Sr. No.	Classification of cultivable holding (ha)	Number of cultivable land holders (lakh)	Percentage with total cultivable land holders	Cultivable holding (lakh ha)	Percentage with total cultivable area	Average cultivable holding (ha)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	Less than 0.5	16.67	17.6	4.12	2.0	0.25
2	05.-1.0	16.07	17.0	12.06	5.8	0.75
3	1.0-2.0	27.28	28.8	39.83	19.0	1.46
4	2.0-3.0	13.97	14.8	33.69	16.1	2.41
5	3.0-4.0	7.29	7.7	25.11	12.0	3.44
6	4.0-5.0	4.47	4.7	19.86	9.5	4.44
7	5.0-10.0	7.24	7.6	48.70	23.3	6.76
8	10.0-20.0	1.53	1.6	19.75	9.4	12.91
9	20 or more	0.18	0.2	6.13	2.9	34.82
	Total	94.70	100.0	209.25	100.0	2.21

Source: Agro-Statistics of Maharashtra (Districtwise) Part-II (1995-96) Commissionerate of Agriculture, Maharashtra State, Pune.

It appears from the table that the proportion of marginal cultivating holders (holding less than 1 ha) is nearly 35 per cent while that of small cultivating holders (holding 1-2 ha) is 29 per cent. The large cultivating holders (holding 10 ha or over) number about 2 per cent. The combined holdings in respect of marginal holders is about 8 per cent and that of large holders is, however, 12 per cent in spite of the fact that the latter constitute 2 per cent of the over all number of cultivating holders.

Amongst districts, the proportion of marginal cultivating holders is highermost, i.e., 66.3 per cent of the total number of cultivating holders in Kolhapur District. It is followed by Raigarh (63.8 per cent) and Thane (53.3 per cent). Yevatmal is the lowest (merely 4.2 per cent) in this respect.

The proportion of large cultivating holders (holding 10-ha or more) ranges from 0.4 to 4.2 per cent (of the total number of holders of the respective district) from district to district. The highest is. Solapur (4.2 per cent). Kolhapur and Bhandara with 0.4 per cent (individually) are the joint lowest.

In irrigation planning, classification of cultivable holdings based on number of Cultivating holders proves to be of vital importance in detailing canal distribution system and also the density of wells *vis-à-vis* mutual intervening distances thereof or deciding upon alternatives for private and community wells. The number of cultivating holders in different groups leads to undertake the planning for irrigation system basically for half the cultivable holding of that for 1-4 ha. Supplementary changes for smaller and larger holdings will then be undertaken to follow suit. There are 32 lakh holders (almost 35 per cent) whose (individual) holdings are under 1 ha. Their enormity warrants essential supplementary facilities to be provided. Notwithstanding this, it may not be possible to distribute water upto their farms, provide field channels or farm roads all over the distribution system in case of such marginal holders. On the contrary, a different consideration from different angle will have to be in order in context of irrigation management and farm roads for that over 40 per cent holding which belongs to cultivating holders with holdings more than 4 ha. individually. Detailed planning of irrigation system turns out to be complex in view of the presence of all categories of holders in most of the commands of projects attendant with canals. More elaborate discussion pertinent to this is undertaken elsewhere (Topic 5.1).

2.5 Climate, Rainfall, Agro-climate Zones

2.5.1 Maharashtra is a region having mostly a seasonal climate. Four distinct seasons are noticeable in a year, viz. (1) Monsoon: Here the rains start with the south - west winds. Mainly it rains during the four months from June to September, but it often extends up to October. (2) Post-monsoon season from October to mid December is a fair weather season with no rains wherein initially October heat is felt every where. Gradually the weather gets more mild. These are the initial months of the post-monsoon, *rabi* crops and the condition of latter depends upon the weather during these months. (3) Winter is generally a period of two or two-and-a-half months, from mid-December until about end of February. Most of the *rabi* crops are harvested during these months. (4) Summer, however, lasts for at least three months - March to May.

There is considerable variation in weather and rainfall among the five different geographical regions of Maharashtra.

1. The coastal districts of konkan experience heavy rains but mild winter. The weather however is mostly humid throughout the year.
2. The maximum and minimum temperatures here range between 27^0 C and 40^0 C and 14^0 C to 27^0 C respectively. The relative humidity is 81% to 95% during June to August while 30% to 65% during January - February.
3. The western parts of Nashik (Ozar) Pune, Satara (Mahabaleshwar) and kolhapur districts show a steep reduction in rainfall from the mountainous regions towards the East. The maximum temperature ranges between 26^0 C to 39^0 C and the and the minimum temperature between 8^0 C to 23^0 C. The relative humidity is 81 % to 99% in August and only 20% to 30% in March.
4. The eastern part of the above four districts together with Ahmadnagar, Sangali, Solapur. Aurangabad, Jalna, Beed and Osmanabad districts fall under the rain shadow of Sahyadri Mountains and therefore the beginning and end of the rainy season is quite uncertain, in these parts. The rainfall is also meagre. The climate is extreme. The summer temperature is high (maximum temperature 36^0 C to 41^0 C) but winter temperature is low (minimum temperature . 10^0 C to 16^0 C). The relative humidity in August is between 82% to 84% but only 19% to 26% in April. The rainfall increases as we go towards east such s on Parbhani. Nanded and Yavatmal. Many a times the eastern winds during the tail end of monsoon cause precipitation here.
5. Likewise the Tapi Basin, the southern parts of Satpuda ranges and Dhule-Jalgaon districts towards west is low rainfall part like that of rain shadow region. But towards east Buldhana, Akola, and Amravati Districts experience a heavy rainfall summer temperature in all this region is quote high (39^0 C to 43^0 C) and minimum winter temperature is found to be 12^0 C to 15^0 C. Relative humidity between May to August is 82% to 87% whereas in March, April months It is 12% to 31%.
6. The Wainganga Basin on east of Maharashtra and the hilly region still farther east is, on the whole, a zone having good rainfall, but as it is some what low lying area, the climate is even more extreme. The summer temperature is very high (39^0 C to 45^0 C) while it is cooler here in winter as compared to other regions (12^0 C to 14^0 C).
7. The details of the month wise maximum and minimum temperatures as well as relative humidity figures for different districts are given in Tables 2.5.1 and 2.5.2.

Rainfall

2.5.2 Maharashtra gets rain both form the south-west and the north-east monsoon winds. About 98% of the rainfall in Ratnagiri District and about 90% in Solapur District derives from the south-west monsoon. The proportion of the rainfall derived from the north-east monsoon increases towards east. Even then the proportion of rainfall obtained from the south-west monsoon remains around 80% to 85%.

The average rainfall of the State is approximately 1360 mm. Nearly 98% of the total average rainfall occurs between June to September, while nearly 9% occurs between October to December July is the month of maximum rainfall in all but Ahmadnagar, Beed, Aurangabad and Solapur Districts of Maharashtra, September is the month of maximum rainfall in these four districts. The rainfall during the months of January to May is on an average about 4%. The rainfall over Konkan and the *ghat* area is more intense during June to September. The winds from the Bay of Bengal entering the hinterland crossing the coastline bring cyclonic rains over the region on east of Central Maharashtra. The proportion of the north-east monsoon rains is higher in East Maharashtra due to this reason. There is a considerable variation in the amount of reliability of the rains in different parts of the State. The annual rainfall in Konkan is between 2000 to 3500 mm. At Mahabaleshwar it is 6208 mm. while at Panchgani, Just 15 km to its east, it is merely 1923 mm.

The steep decline in the rainfall to east of Sahyadri is strikingly noticeable. In the 30- 50 km wide belt to east of *Maval*, the average rainfall is observed to be less than 650 mm (as low as only 500 mm at some places) That is exactly why this region is known as rain shadow region. Thereafter the rainfall increases steadily towards east and the average rainfall in the easternmost districts is observed to be 1400 mm. At many places in Maharashtra there are rains due to pre-monsoon thunderstorms. These storms usually break after around 2 O'clock in the afternoon during the months of April and May. Severely low pressure zones are sometimes formed wherein humid air is pushed upwards till it reaches the freezing point. When water molecules are transformed into icicles which adhere together to form hail. This is the reason why sometimes there are hail storms.

Regionwise Rainfall

The India Meteorological Department has 44 observatories, 275 raingauge stations and 2 water analysis units (Dhule District), thus totalling 321 centres of activities in Maharashtra. It is seen from the analysis of the districtwise data regarding rainfall and rainy days over the period 1901 to 1970, collected by these stations regionwise, that the average annual rainfall is highest (3161 mm) in Konkan and the second highest occurs (1106 mm) in Vidarbha. The average annual rainfall in Western Maharashtra is 1000 mm while the lowest in Marathwada Region, is 826 mm. Of this average annual rainfall, the rainy season from June to September (*kharif* season) gets 94% in Konkan (barring Greater Mumbai), 84% in Western Maharashtra, 85% in Marathwada and 88% in Vidarbha. The proportion of the post-monsoon rains is 5% in Konkan, 11% in Western Maharashtra, 10% in Marathwada and 7% in Vidarbha.

The pre-monsoon rains during March to May are maximum in Western Maharashtra (5%) while in Marathwada it is 4%, in Vidarbha it is 3% and the minimum is in Konkan (1 %). The winter rains during January - February are more than 2% in Vidarbha but less than 1% other three regions.

Rainy Days

2.5.3 The day on which rainfall is 2.5 mm or more is noted as a rainy day. The average annual number of rainy days in Maharashtra is observed to be 59. The number of rainy days in monsoon (June to September) is 6, in the pre-monsoon period (March to May) it is 3, while in January-February it is just 1 day (Table 2.5.4).

There is wide variation in regard to this aspect when different regions of the State are considered. The number of average annual rainy days is maximum 95 days in Konkan, 55 days in Vidarbha. 51 days in Western Maharashtra and the minimum 46 days in Marathwada.

Out of the total cultivable land in Maharashtra about 53% is under *kharif* and about 30% is under *rabi* crops. This mostly comprises of food grains and oilseeds. The average rainfall during June to September which affects both the *kharif* and the *rabi* crops, is about 88% on an average. That is why the regularity of rainfall during this period is of importance. But it is seen that there is considerable fluctuation in the number of rainy days as well as the amount of rainfall year to year. The fluctuation in rainfall is observed to be 25%, 40%, and between 20% to 30% in Konkan, Central Maharashtra and Vidarbha. Crop management on fields during this period thereby becomes quite difficult. An efficient water management of the fields will be possible for a cultivator if weekly or fortnightly predictions of rainy days are made available. In view of this, special efforts in collaboration with the India Meteorological Department, State Agricultural Department and agricultural universities in the State are called for.

Variations in incident rainfall even in different parts of the same *taluka* according to geographical disposition are also noticed. A *taluka* is also divided into 2-3 parts according to rainfall being received. But barring areas covered by irrigation projects, only one raingauge station in a *taluka* seems to be extant. As informed through letter No. NDC 058/59/2 dated 7.6.99 by India Meteorological Department, Pune the acceptable distance from the station meant for relative humidity and temperature measurements is 50-60 km. The effective radius is thus taken as 25-30 km. The acceptable distance of the raingauge station for rain measurements should not exceed 30 km. The maximum effective radius is thus taken as 15 km. Therefore, objective data about the rainfall in different parts of a taluka is not properly obtained. The number of raingauge stations should, therefore, be increased such that one rain gauge station for every watershed identified by the Groundwater Surveys. & Development Agency should he available. It will then be possible to carry out an in depth study of variability in rainfall.

Agro-climate Zones

2.5.4 The Agriculture Department has divided the State into nine different agro-climatic zones depending upon the climate, foliage, topography, soil and cropping pattern in Maharashtra. These are depicted on a map of the Maharashtra State.

1) *Very High Rainfall and Lateritic Soils Zone*

This zone having lateritic soils situated between 0 to 500 m above the mean sea level and having very heavy rainfall, encompasses the South Konkan coastal region including Ratnagiri and the far-western parts of Satara and Kolhapur Districts. The rainfall period in this zone exceeds 100 to 110 rainy days and the annual rainfall is between 2000 to 3000 mm. The soil is predominantly of lateritic type derived from Basalt. Small belts of saline soils are noticed to have been formed near the river mouths. Paddy is the main crop in the low lying areas while finger millet is cultivated on high lying areas. Horticulture is also practised on a large scale.

2) *Very Heavy Rainfall and Non-lateritic Soils Zone*

This is akin to the aforementioned lateritic soils and very high rainfall zone in respect of altitude from the sea level and incident rainfall encompasses Thane and northern part of Raigad Districts and western-most parts of Nashik, Ahmadnagar and Pune Districts. Red to grey reddish loamy soils devoid of lateritic rocks occur predominantly in this area. Near the river deltas alluvium and saline soils occur. Paddy, finger millet and pulses are predominantly grown in this region. Similarly this region is also conducive to horticulture and for growing mango, coconut, arecanut, sapota, banana. Movements on the Bay of Bengal lead to very intense rains in Konkan. While receding to west these cyclonic storms reach to South Maharashtra, resulting in good rains in winter up to Kolhapur and Sangli.

3) *Ghat Zone:*

Sahyadri ranges and the region with slope 500 to 1500 m on its west extends to the west of Nashik, Nagar, Pune, Sangli and Kolhapur Districts. Average annual rainfall in this part is of the order of 2500 to 4000 mm. The soils on slope of hill ranges are shallow, pale grey to dark grey and laden with silty alluvium. Hilly ranges on west of this region exhibit red to red grey lateritic soils. The principal crop of this area is finger millet.

4) *Zone of Easterly Sloping Ranges of Sahyadri* (Transition Zone - 1):

The part of 500 to 1000 m altitude on eastern slopes of Western *Ghat* belonging to Dhule, Nashik, Ahmadnagar, Pune and Satara Districts falls in Transition Zone - 1. The rainfall of this zone ranges from 1250 to 2500 mm. The reddish and black soil occurring in this area is derived from basaltic rocks. Heavy rains in winter are conducive to paddy growing. Pearl millet, sorghum and groundnut are the principal crops grown in low lying part.

5) *Zone of Easterly Sloping Ranges Of Sahyadri (Transition Zone - 2):*

The undulating terrain of the plains comprises the Transition Zone - 2. The central part on west (middle west part) of Dhule, Nashik, Nagar, Pune, Satara, Sangli Districts and north-east part of Kolhapur District fall in this zone. The altitude of this zone from sea level varies from 300 to 1000 m and rainfall variation is of the order of 700 to 1200 mm. The entire terrain is underlain by Deccan Trap. The soils are greyish to dark-greyish and varying in depth. The major *kharif* crops are pearl millet, sorghum and groundnut while paddy is cultivated in scattered strip on small scale.

6) *Zone of Scanty and Irregular Rains*

This vast scarcity plains zone is situated at an average altitude of 600 m. The zone encompasses eastern parts of Dhule, Nashik, Ahmadnagar, Pune, Satara, Sangli and western parts of Jalgaon, Solapur, Beed and Osmanabad Districts. The zone is bounded between isohytes of 500 and 700 mm. Moreover, the rainfall is unevenly distributed. The terrain of this 7one too is underlain by Deccan Trap. The soils are calcareous greyish black in colour and are of varying depths and textures. The cropping pattern is of *karif*-cum-*rabi* type.

7) *Assured Rainfall Zone*

The terrain is situated at an itude lesser than 600 m. Major parts of Jalgaon, Aurangabad and Osmanabad and eastern parts of Beed Parbhani, Nanded, Akola and Amravati are bounded within this zone. Rainfall range is in between 700 to 900 mm. The rains necessary for *kharif* crops are already assured in this zone. The *kharif* crops mainly include sorghum, cotton and groundnut. Calcareous clay of dark greyish to black colour formed of Deccan Trap occurs in this zone.

8) *Moderate to High Rainfall Zone*

This zone, characterised by moderately assured rains and soft soils, is situated at an altitude the same as that of assured rainfall zone. Wardha, Nagpur, Yevatmal and part of . Amravati Districts fall in this zone. The rainfall ranges from 900 to 1250 mm and is evenly distributed in the south- west monsoon period. The depth and texture of soils formed of Deccan Trap vary in different parts of the zone. Alluvium occurs in Tapi, Wardha and Painganga river basins. *Kharif* crops are extensively grown in the very rich soils of these basins. Alongwith, *rabi* crops are also harvested. The low pressure belt developed in the Bay of Bengal causes intense rains in this zone.

9) *High Rainfall Zone with Soils Derived from Composite Rocks*

This zone of Wainganga Basin, soils of which are formed from the composite parent rocks and which is characterised with high rainfall, extends over Chandrapur, Bhandara, Gadchiroli and eastern part of Nagpur Districts with an assured rainfall between 700 to 1250 mm on an average. The soils of this zone are derived from gneisses, granites and other Dharwad and Vindhyan period mountainous rocks. It is formed into red sandy loams or black clayey soils. The predominant crop is paddy in *kharif* season and wheat & sesame are main *rabi* crops.

Changes in Rainfall

2.5.5 The outcome of study in respect of i) Monthly & annual average rainfall and rainy days pertinent to the period 1901-1950 and 1951-1990, ii) Increase or decrease in rainfall and rainy days during the period 1901-1950 as compared to that during 1951-1990, and also iii) Variability in rainfall and rainy days during the period 1901-1990 pertaining to 9 stations one each from the respective agro-climatic zones of Maharashtra is presented in the Statements 2.5.5 and 2.5.6.

The stations selected for the study undertaken are the following:

Sr. No.	Agro-climatic zone	Station selected
1.	Very high rainfall and lateritic soils zone	Deogad (Ratnagiri)
2.	Very heavy rainfall and non-lateritic soils zone	Karjat (Raigad)
3.	Ghat zone	Igatpuri (Nashik)
4.	Transition zone - 1	Bhor (Pune)
5.	Transition zone - 2	Akole (Ahmadnagar)
6.	Zone of scanty and irregular rains	Barshi (Solapur)
7.	Assured rainfall(and mainly of kharif crops) zone	Aurangabad (Aurangabad)
8.	Moderate to high rainfall zone	Morshi (Amrawati)
9.	High rainfall zone with soils derived from composite rocks	Armori (Chandrapur)

Average annual rainfall during the period 1951-90 is increased than that for the period 1901-50, stationwise extent of increase being Bhor (18%), Deogad (11%) - statistically which is appreciable whereas there is decrease in respect of rest of the stations viz. Igatpuri (less than 1 %), Akola (9%), Morshi (4%) and Armori (20%). The decrease is appreciable in case of Armori station. The number of average annual rainy days during the period 1951-90 appears to have changed as compared to the same for 1901-50 period. The stations Akola (11%), Morshi (13%), Armori (23%) exhibit decrease (the extent indicated in brackets) which is statistically appreciable. Though not sizeable few stations do exhibit increase Monthwise number of rainy days also seem to have changed; especially during September the different stations present considerable increase or decrease in the number of rainy days.

Essentially the study of causal relationship be undertaken on a continued basis. Presently no set up undertaking such continuing study seems to have been in existence. It will he useful if an independent group to overview the long term changes so taking place be formed within the newly emerging Statewide hydrological set up.

Monthly average rainfall during monsoon for the period 1951-90 seems to have changed (either increased or decreased) than that for the preceding period. Maximum increase in average monthly rainfall occurs in August (32-47%) while maximum decrease (22-24%) appears to be in the month of September.

Gleaning through the variability of changes in the annual rainfall from year to year, it is revealed that the variability is the lowest in case of Igatpuri (12%). While it is 21% for Karjat and also Deogad, 26% for Barshi and 28-38% for rest of the stations. Such a wide variability in the Natural poses a major difficulty in instituting a reliable water management. It is therefore, essential to keep flexibility in all water use systems duly appreciating this variability. The same be studied comprehensively. The Commission likewise contends that a set up be instituted to undertake an in depth study of mountain ranges, their alignments, type of clouds; their sizes, wind and its direction. The Commission is firmly of the opinion that the study should be location-specific and carried for smaller belts. This could facilitate appraisal of area and duration specific variability of rainfall. Sub-basinwise average rainfall, rainy days and variability thereof is presented in Statement 2.5.8.

Evaporation

2.5.6 Evaporation is being monitorised at different stations on behalf of the State Irrigation Department. Districtwise information in regard to it and based on data so compiled is presented in Statement 2.5.7.

The data reveals that mean annual evaporation in Konkan Region is comparatively lower. The lowermost evaporation in a year is 1478 mm and that occurs in Ratnagiri District whereas the same is quite high, i.e., upto 2475 mm in the 3 districts, viz., Nashik, Dhule and Jalgaon. The other 3 districts of Buldhana, Akola and Amravati, it appears, also exhibit the scenario in the range of 2360 to 2420 mm. The Marathwada Region falls in the range of 1770, to 2035 mm as far as mean annual evaporation is concerned.

If, mean monthly evaporation and mean monthly rainfall are compared evaporation appears higher even than rainfall in the months of July and August in Nagar District and in September in Jalgaon, Buldana and Akola Districts. That is why, even during monsoon crops are badly in need of irrigation in these months.

If all foregoing statistics is gleaned through, one thing is clear naively the account of evaporation in water planning is of no mean consequence. The quantum of water being lost through evaporation from reservoir or irrigated area should have been amenable to quantification. Nevertheless, as it appears, the assessment and computation of evaporation have so far not been subjected to needed standardisation. Evaporation is a function of reservoir spread, wind, reservoir water temperature and many other factors. Evolving technique for curbing evaporation calls for proper appraisal of the process of evaporation also. Water-related database is therefore going to incorporate the important component of 'measurement of evaporation' here-in-after. Establishing proper corelation among data pertinent to evaporation being accrued by various agencies at various stations presents difficulty. The Meteorological Department, agricultural universities and the Irrigation Department are used to carry out evaporation measurements in diverse climatic configurations. The variation in measurements may be attributable to this factor also. In summary, this topic is going to attract increasing attention in times to come.

Land Productivity

2.6.5 The total geographical area of Maharashtra is 308 lakh ha of which 64 lakh ha is forest land (21%) and 225 lakh ha is cultivable area (73%). However, net sown area is 179 lakh ha (80%). During 1996-97, the total cropped area out of irrigated crops was 33.38 lakh ha as against net land area of 25.49 lakh ha. Of that, area irrigated on wells was 13.92 lakh ha(55%). About 4.9 lakh ha land area was from irrigation commands (1994-95).

Ordinarily, foodgrains are grown in 70% area of the total cropped area (214 lakh ha). Area under the crops of cotton and oil seeds is 13% each. Area under sugarcane is, however, hardly 4% if the total area of the State is considered (6.19 lakh ha, 1996-97).

Area under food crops during the year 1991-92 was 2.4 lakh ha in the State. By end of 1996-97, it has been increased to 10.5 lakh ha. Per ha production of fruit crops was hardly in the range of Rs. 4000-12000. On the other hand, the same in case of fruit crops, as the statistics of 1996-97 revealed, was far more, i.e., sweet lime: Rs. 60000, banana: Rs. 1.8 lakh, mango: Rs. 1.85 lakh and grapes: Rs. 2.9 lakh (all per ha). Besides this, area under vegetables was 2.4 lakh ha (1991-92) and income accrued therefrom was between Rs. 33000 to 130000 per ha.

The foodgrain production mark achieved in the State during 1996-97 is 145.6 lakh ton whereas that of cotton is 5.34 lakh ton, of groundnut Rs. 7.56 lakh ton, of sugarcane 418.05 lakh ton.

The annual food grain requirement of Maharashtra (1996-97) is 170 lakh ton. The total primary production in the agricultural sector amounted to Rs. 29012 crore. It means on an average. Rs. 16230 per ha production is achieved from the land preserved for farming practice.

Production Accruable from Livestock

2.6.6 As per the Livestock Census - 1992, the total livestock in the State is 364 lakh. The number of hens, ducks etc. is 322 lakh. The cows number 59 lakh (16%) out of the total livestock of which 10 lakh are hybrid cows whereas the numbers of other livestock are: she-buffaloes - 32 lakh (9%), oxen - 70 lakh (19%), calves - 46 lakh (13%), sheep - 31 lakh (9%). goats - 99 lakh (27%) and others 27 lakh (7%) - among them are baby-buffaloes, buffaloes: pigs, horses, donkeys, etc.

Hardly around 51.57 lakh ton total milk production resulted in the State from the milching cows and buffaloes which number 43 lakh (48% of their combined total). That averaged 3-4 litres per day per animal. The approximate production of eggs in the State was of the order of 269 crore and that of meat was 1.73 lakh ton.

Fish Production

2.6.7 The State of Maharashtra is benefited by a 720 km long sea coast. The length of main rivers in the State totals to 17100 km approximately. The sea fish production accrued during the year 1996-97 was about 4.81 lakh ton whereas that from fresh water was of the order of 1.25 lakh ton.

This could amass total income of Rs. 360 crore for which 2.11 lakh ha reservoir area proved of help.

Forest Product

2.6.8 In Maharashtra, the production of building wood had been about 1.25 lakh m^3 during 1996-97 the cost of which amounted to Rs. 62 crore. Fuel wood production had been around 4.94 lakh m^3 the approximate cost of which was of the order of Rs. 11 crore. The cost of secondary forest product was Rs. 61 crore. In view of the total 64 lakh ha forest area in the State, it is worth noting that it could accrue hardly an income of Rs. 209 per ha on an average. The farm produce could muster the highermost production of Rs. 157 crore during the year 1990-91. Annual income accrued from all types, of forest produce during the year 1996-97 was Rs. 1796 crore as per the current price level. Comparative scenario of per ha average productivity in case of various land uses is as per the following:

* Agriculture (inclusive of all production)	Rs. 13393
* Fish production	Rs. 17061
* Farm produce	Rs. 2806
* Minerals	Rs. 2398

2.7 Hydrology

2.7.1 Hydrology is that branch which studies the source of all waters on the Earth, its movement and distribution, physical and chemical properties and also its interaction within the atmosphere. The quantification of gross availability of water on the Earth is as follows:-

Spatial description	Percent	Availability (Billion km^3)
Total water	100	1.3575
Oceanic water	97.2	1.3195
Fresh water	2.8	0.0380
		(Lakh km^3)
A) Glaciers and ice sheets in polar regions	2.15	290
B) Sub-surface water	0.64	86.85
1. Within 750 m	44*	38.85
2. In the depth span 750-4000 m	56*	48
C) Water in rivers, lakes and reservoirs	0.33**	1.254
D) Atmospheric water	0.035**	0.133
(*With respect to the total sub-surface water)		
(**With respect to the fresh water)		

The annual average flow in rivers of India is of the order of 1869 TMC (1869 km^3), i.e., about 1.5 percent of the gross water contained in rivers, lakes and reservoirs on the global scenario. The territory of Maharashtra holds in all 163.82 TMC (163.82 km^3) water which is nearly 9% of the country's water resources and, in global comparison, it matters about 0.13 percent.

The entire fresh water on the globe is obtained as a result of transformation of condensed water of oceans into ice or rain. The cyclic sequence of events which is instrumental for exchange of sea water between land and atmosphere is known as hydrological cycle. This cycle gets onset from the ocean. The oceanic water gets transformed into vapour by evaporation. Having been solidified, a part of it falls on the land in the form of rains or snow, whereas the rest straightly reaches back to sea only. A portion of what that falls on land falls on vegetation while bulk of water gets infiltrated into the soil. The evapotranspiration and evaporation lead this water back to the atmosphere in the form of vapour. Remaining water returns back to the sea through lakes, rivers-rivulets and underground channels.

The need of precise quantification of water that is really available is growing in view of the increased demand for flood control, hydel development, irrigation, navigation, etc., during the preceding four decades.

Tenets of Hydrology

2.7. 2Characteristics of hydrological cycles of different terrains are dependent upon climate of the region surface and sub-surface formations, storm movements, duration-distribution of rain and wind speed, wind direction, temperature and humidity as well.

The south-west and north-east winds bring rains to the State. The 98% rains in Konkan and 80 % that in Marathwada are caused due to the south-west monsoon. Elsewhere, the north-east and the eastward winds shower rains in the range 2 to 20 percent Configuration of hill ranges and mountains, from the standpoint of wind directions, largely influences the rain intensity and its distribution as well. The winds blowing from the Arabian Sea get elevated and the Konkan receives abundant rains. The intensity thereof, too, is highly remarkable. Similar type of local effect is also achieved due to Satpuda, Ajantha and Balaghat ranges. That is why, different parts of Maharashtra experience rainfall in varying proportions. Moreover, the variability in the hydrological cycle lends considerable variation in the rains occurring over the territory of Maharashtra. The upper bound of variability is 80 to 100 percent occurring in the months of January and February of winter whereas the variability is 40 to 50 percent and corresponds to the months of June to September. Only in area adjacent to the western coast the variability is 30 percent. The September exhibits 60 percent variability. To sum up, the variability in monthly rainfall is considerably larger. Despite this, one thing is definite- the long term average annual rainfall is stable as revealed through studies carried out from time to time. Therefore, the variables like annual rainfall, river flow based on long duration series (over 60 years) prove useful as features-revealing basic characteristics.

Evaporation

2.7.3 The evaporation too varies as the seasons change. Lesser wind speed and temperature but higher humidity is conducive to low evaporation. As the temperature and wind speed increase the humidity declines. The evaporation, however, increases. The rate of evaporation is high during the months of April and May, while it falls down remarkably as the monsoon approaches consequent to which the humidity rises. Average annual evaporation in Maharashtra varies in the range of 1900 to 3170 mm from place to place. The evaporation maxima is 290 mm and is of May at Sawantwadi in Konkan Region. The minima appears to be as low as 70 mm as of July. Overall, the annual evaporation is 1773 mm. The Yerala Sub-basin under Krishna Basin exhibits annual evaporation of 1923 mm. The monthly maximum is 235 mm as of May whereas monthly minimum falls in January to 115 mm.

The Aurangabad in Godavari Basin experiences annual average evaporation of 1774 mm. The monthly maximum is 250 mm and occurs in May whereas the minimum monthly appears to be 97 mm in December. At Nanded, the average annual evaporation is 2800 mm. The monthly maximum average evaporation is 410 mm as of May whereas the corresponding minimum falls down to 152 mm in December. In Tapi Basin at Jalgaon the average annual evaporation is 2530 mm. The monthly maxima and minima stand at 400 mm (in May) and 110 mm (in December), respectively. In Vidharbha at Yeotmal in Penganga Basin the annual average evaporation is 3050 mm, the monthly average-based maxima and minima being stood at 464 mm (in May) and

183 mm (in December) respectively. The water regime of a basin cannot be understood in its entirety merely from the rainfall pattern. It is essential to acquire proper knowledge as to the manner and proportion in which the obtained water is being returned to the natural cycle as a result other of extraneous influences present in nature. Different places with identical average rainfall exhibit a widely varying evaporation scenario, e.g., the annual rainfall at Nashik and Latur are nearly same, but the annual evaporations are 2156 and 1985 mm, respectively.

As long as water deficit was not used to be felt, no attention had initially been paid to the evaporation - a water consumptive factor. But it being a highly influential factor in the hydrological cycle, it has now become necessary to subject it to detailed probing. But, field measurements in this respect are, however, falling short. Undertaking the same on extensive scale is an urgent necessity. The evaporation and transpiration are determined on the basis of condensation of water into vapour made possible through the available soil moisture and the moisture-absorbing capacity of the atmosphere compounded with their inter-se exchangeability. In case there is ample soil-Moisture present, the water loss taking place due to evaporation and transportation occurs merely due to vegetation and is termed as evapotranspiration. The solar energy extracts water through both these media. It has been attempted to estimate the evapotranspiration in different parts of Maharahstra on the basis of other properties of the climate. However, the data so obtained is required to be compared with the actual measurements. The India Meteorological Department and the agricultural universities have already embarked upon the measurements of evapotranspiration by lysimeter. It is revealed in case of Aurangabad that the actual (lysimeter-measured) evapotranspiration is 1.5 times of that based on summer seasonal climate. What is urgently needed therefore, is well informing all over Maharashtra the actual measurements-based real state of affairs in this regard. While determining the crop-water requirement, it is essential to have a proper knowledge of the values of evapotranspiration.

Need of Hydrological Studies

2.7.4 To sum up, planning based merely on raingauging and stream gauging cannot now be relied upon. The quantitative and qualitative planning of water is not possible unless proper knowledge of various factors such as groundwater movement, evaporation, evapotranspiration, surface and sub-surface percolation, solubility of chemical constituents of water etc. is within the reach. In order this to materialise, the need of trained staff in the discipline of Hydrology will as much be experienced as the frequency of field inspections pertinent to the topic is required to be increased. Presently engineers trained either at the National Institute of Hydrology. Roorkee or from abroad are sparsely available in Maharashtra. Very few of those, Who are there, have been engaged in this task. Forthwith 250 to 300 hydrology-trained experts are immediately needed to undertake the proper water accounting in various sub-basins. This topic is multi-disciplinary. A co-ordinated approach involving experts from geology botany, engineering and computer as well, will enable to grasp the hydrological cycle in its proper perspective and only then a practicability could be infused in its planning.

In different parts of Maharashtra, e.g., that covered with ranges of Sahyadri or Satapuda- all these factors, viz., vegetation, geology, storm movement, intensity thereof present a diversity. Applying a single runoff formula or a transpiration formula everywhere is, therefore, far less scientific. For that, perspective studies of different regions are needed to he accomplished. Climatological experts are also to be got involved in such studies. The reason is: the incident rainfall is also determined by the clouds, direction of winds, size of clouds and types thereof. However, study of these topics is regrettably meagre in the State. In view of the necessity of increasing expertise warranted here-in-after in planning of water, It is recommended that the hydrological studies per sub-basin / sub-area be undertaken forthwith.

Advanced Hydrology

2.7.5 Professor Peter Eagleson, Professor at the Massachusetts Institute of Technology (MIT) in the USA has been awarded the 1997 Stockholm Water Prize for his valuable contribution in the Science of Hydrology.[4] He introduced a dynamic description Of the entire movement of water in a catchment. Following that, he developed a complete theory of soil-plant-atmosphere interactions related to water. He evolved a concept describing the optimal balance between vegetation and its environment. He went on predicting the location and dominance of different vegetation types across the globe. His work in this area resulted in the text hook 'Dynamic Hydrology'. It redefined Hydrology as a rigorous, quantitative science. Hydrological probing of the terrain of Maharashtra along this line is a necessity in the coming future.

2.8 Surface Water Resources

2.8.1 In Maharashtra, there are 380 small or big rivers having total length of about 20000 km. The entire geographical area is basically divided amongst the 4 major river basins - Godavari, Krishna, Tapi and Narmada. Moreover, there are 22 narrow basins of west-flowing rivers of Konkan. The basinwise geographical status is briefly spelt out in the following:

1. **Godavari:** (Geographical extent in Maharashtra: 152811 km^2)

The basin spread over between Satmala-Ajantha and Harischandra-Balaghat ranges is known as Godavari Basin. The central portion of the State is entirely encompassed within this Basin. The Wainganga is the major tributary having catchment of 74049 km^2. The Godavari originates from Trimbakeshwar near Nashik in Western *Ghat* at an attitude of 1067 m. It flows eastward in a gorge upto Nashik City. Apart from Maharashtra, its catchment is spread over in the states of Madhya Pradesh, Andhra Pradesh, Karnatak and Orissa. It joins Bay of Bengal 80 km below Rajmahendri. In this area only, it forms a large delta. Country's 10% geographical area belongs to Godavari Basin. The length of Godavari River is 1465 km.

2. **Krishna:** (Geographical extent in Maharashtra: 69032 km^2)

The Krishna Basin is identified as the territory spread between the Mahadeo ranges and the Sahyadris. It rises near Mahabaleshwar at an altitude of 1337 m in Western *Ghat.* The Bhima, its main tributary encompasses 48632 km^2 catchment. The Krishna Basin extends into the states of Karnataka and Andhra Pradesh apart from Maharashtra. The Krishna also forms a delta before flowing into the Bay of Bengal. It is 1401 km long.

3. **Tapi:** (Geographical extent in Maharashtra: 51304 km^2)

The elevation of Tapi Basin falls in the range of 200-300 m from the mean sea level. The actual river course, however, appears to be descended down by 15-20 from the bed. The Basin is bounded by Satpuda and Gavilgad hills on the north and the Ajantha ranges of Sahyadris on the south. The river gorge is filled with alluvium while the other portion of the Basin is formed of Deccan Trap.

4. ICID News Update, March 1997.

The Tapi rises near Multai in Betul District of Madhya Pradesh at an elevation of 752 m and runs westwards. It crosses the Western *Ghat* through a deep but narrow gorge. Streams from the Satpudas, Ajantha mountains and Satmala join this river before that. Barring Maharashtra, the states of Madhya Pradesh and Gujarat (partly) fall in this Basin. It joins the Arabian Sea near the Gulf of Cambay. It is 724 km long.

4. **Narmada:** (Geographical extent in Maharashtra: 1048 km^2)

The Narmada originates on Amarkantak Plateau in the Maikal ranges in Madhya Pradesh at an elevation of 900 m. The Basin is bordered between the Vindhyan ranges on the north and the Satpuda ranges on the south and spreads across 30-65 km on either sides of the course. It forms a waterfall near Jabalpur in marble rocks. It passes through a gorge 150 km long well before leaving the plateau. It forms an estuary before joining the Gulf of Cambay below Broach. It receives streams from the Vindhyas on the north and the Satpudas on the south. Its length is 1312 km. Along the course in the gorge of Narmada a number of waterfalls are developed. Apart from Maharashtra, its basin encompasses parts of Madhya Pradesh and Gujarat states.

5. **Basins of West-flowing Rivers of Konkan:** (Combined geographical area: 33228 km^2)

Nearly 22 rivers - smaller or bigger - extend their catchment on the western side of the Western *Ghat* of Konkan. All these rivers are shorter in length and swift-flowing. Deep gorges are carved along their courses. They generally flow mutually parallel. Ultimately they drain into the Arabian Sea. Several of these have steep gradients before they join sea. The Vaitarna, Ulhas, Savitri, Vashishthi are the prominent rivers among them.

Catchment admeasuring 290 km^2 of the Mahanadi Basin lies on the far east of the State. This part belongs to the Gadchiroli District.

Rainfall Pattern of Maharashtra

2.8.2 The Western *Ghat* of Sahyadri receive abundant rains. As we go eastwards the rainfall intensity goes on diminishing. As a consequence, the rivers rising in the Western *Ghat* come under the influence of south-west monsoon. They entirely depend on the rains for their flow. They begin to flow with the advent of the first good rains occurring in June. They start overflowing both the banks during the profuse rains followed thereafter. By mid- October their flow starts depleting rapidly. In summer, it almost vanishes. Nevertheless few rivers manifest a nominal flow on account of replenishment from the underground streams. On the plains side of Maharashtra, flows in rivers belonging to the prominent major basins are influenced by rains round the year in a manner described in sequel. The upper reaches of Krishna and Godavari and their tributaries are generally dry before the advent of south-west monsoon. They begin to flow on the onset of rains. July and August are the months of maximum discharge for these rivers. The volume of flow in these very two months varies from 55 to 85 percent of the annual flow in upper reaches of the Krishna. The same flow dissipates to 50 to 60 percent in its lower reaches while the flow in Godavari at this time happens to be 40 to 75 percent of its annual availability. In respect of Krishna, there is a sharp fall in the river flow in September and October. It varies from 15 to 45 percent of the annual and declines sharply in October in case of Godavari. In general, the volume of flow during the 6 months of June to November is 97 percent of the annual in Krishna while it remains 90 to 100 percent in tributaries of Godavari.

Normally the south-west monsoon winds bring rains to Konkan by 7th June. About 94 percent rains occur in monsoon period (June to September). The river basins in the State belong to following broad divisions in accordance with the incident rainfall. (Figures in bracket are of average annual rainfall based on climatological data for the period 1901-1950)

1) Upper Godavari: Rainshadow region (900 mm)
Lower Godavari: Assured rainfall region (1100 mm)
2) Wainganga - Pranhita: Assured rainfall region (1120 mm)
3) Krishna: Assured rainfall region (1160 mm)
4) Bhima: Rainshadow region (680 mm)
5) Tapi: Rainshadow region (700 mm)
6) Konkan: Abundant rainfall region (2940 mm*)
*(Based on data of 1891 - 1994)

By mid-October the rains due to south-west monsoon cease to occur. The rains occurring in post-monsoon period are, therefore, far less and sparse. Few basins are subjected to low pressure due to speed of winds blowing from the Bay of Bengal during this period. Even there duration is short (heavy rains occur merely in 1 or 2 days causing floods). Sub-basins of Wardha, Painganga, Tapi, Sindhaphana, Manjra etc., in the State are subjected to such flashy rains. Ordinarily every 3rd or 4th year brings these flashy rains in such basins. Obviously, yearly flows in such basins exhibit a wide variation. In Manjra Sub-basin, this phenomenon is quite rampant. That is why the average annual yield appears to be 45 percent more than that of 50 percent dependable.

There is wide diversity in the rainfall incident over Maharashtra, spatially as well as temporaly. It influences water resources that is made available in river basins or sub-basins in various parts. In order to assess its influence, the variability of rainfall - the prime cause of water resource - is used to be determined by statistical methods.

The terrain of Maharashtra is divided into 4 main meteorological sub- divisions by the India Meteorological Department (IMD). On the basis of climatic diversity the year is broadly divided into 4 seasons all over the State. On the basis of data compiled by IMD for the 80 years period from 1891 to 1970, the various seasonwise variability indices (per cent) in annual average rainfall in respect of all the 4 sub-divisions are indicated in the following:

Seasons Sub-divisions	Winter (Dec. to Feb.)	Summer (Mar. to May)	Monsoon (June to Sept.)	Post monsoon (Oct. to Nov.)	Annual
Konkan	262	153	18	75	18
Central Maharashtra	166	65	30	56	27
Marathwada	144	88	26	67	25
Vidrabha	103	86	25	68	20

The territory of Maharashtra occupied by the river basins of Godavari, Krishna, Tapi, Narmada and those bigger and smaller ones in Konkan is delineated into 25 sub-basins in all by the Commission. Determination of planning features is attempted in consonance with natural characteristics of the respective territorial divisions. The premise on which this scheme is based is explained in somewhat elaboration further in Topic 3.2. The purpose to mention it here is that the compilation, presentation and analysis of information / data are carried out in accordance with the proposed scheme of sub-basins.

Raingauge and Rivergauging Stations in Maharashtra

2.8.3 An extensive network of raingauge and riverguaing stations is set up to help assess surface water resources of Maharashtra. These stations belong to various agencies. It is imperative to take into consideration the corelation between incident rainfall in a region and surface runoff being generated as a result thereof so as to assess surface water resources of that region.

The response mustered by rainfall from a catchment varies in accordance with climatic and topographical diversity. Discharge measurement of rivers is therefore, of vital importance for an assessment of water resources. Assessment of water availability based merely on rainfall measurements cannot be realistic. Rain gauging is, however, relatively simpler to carry out and is less expensive also. Discharge series are, therefore, not available For longer duration than they are available in case of rainfall. River flow measurements have, however, systematically been carried out since long. Thus, the catchments for which water resource assessment is based on stream gauging are recognised as gauged catchments, the rest being termed as ungauged. The catchment of all the sub -basins in Krishna Basin and the Grina in Tapi Basin are gauged whereas catchments of rest of the sub-basins are either partially gauged or ungauged.

In Maharashtra, there are numerous raingauge stations that are in operation under the ownership of various agencies (Statement 2.8.1). As per World Meteorological Organisation standards, the number of automatic raingauge stations should at least be 20 percent of the total number of raingauge stations. This proportion happens to be 32% in case of Maharashtra. Therefore, no special necessity appears of augmenting the existing number of automatic raingauge stations. In order to have a realistic determination of rainfall average, a network of optimum number of raingauges is required. The number Of such stations required accordingly in the proposed 25 sub-basins is indicated in the Annex 2.8.1. In accordance with that the sub-basins in which the number of raingauge stations are required to be sizeably increased are: Upper Godavari, Lower Godavari, Purna (including Dudhana), Middle Wainganga. Indravati, Middle Tapi (South), Upper Krishna (West). In order to have a high quality estimation of yield, even the discharge gauging is required to be accomplished for sufficient duration and at properly selected sites. The present scenario attests that an enough stations (and numbering rather on higher side) have already been in operation in Maharashtra (Annex. 2.8.2).

Methodology of Establishing Corelation between Rainfall and Yield

2.8.4 In view of the additionally made available raingauge and rivergauging data of the intervening period (subsequent to the First Maharashtra Irrigation Commission - 1962), establishing a new rainfall-runoff relationship will prove of worth. With this premise, sub-basinwise surface water resources are assessed (Statement 2.8.2). It is desired to have discharge series of at least 30 years duration. Otherwise, with the available of rainfall observations, the yearly estimates are arrived at establishing rainfall - discharge relationship based on available longer duration rainfall series. While supplying information to the Commission, the field officers have, in general, adopted this method to compute the natural availability in various river basins of the State. However, that is based on series of limited duration. Annex 2.8.3 contains in an abstracted form the duration details of the rainfall and discharge series on which the field officers have based their estimations of water resources of various sub-basins proposed by the Commission. Rainfall of longer duration series are available on most of the IMD-monitored stations. As an illustration, in the Annex 2.8.4 is presented duration of available data in respect of some stations *vis-à-vis* the sub-basins in which these stations are located. The National Hydrology Project has already been launched in Maharashtra to cater to densification and extension of the existing raingauge and river gauging network in the State and through that medium more precise information of water, that is available in future, will be forthcoming here-in-after.

Estimates of the Preceding Commissions as to the Surface Water Resources of Maharashtra

2.8.5 (1) The Maharashtra Irrigation Commission has estimated in 1962 the available surface water resources of the State. As its inference goes, the availability of 75% dependable water resource in Maharashtra is 111297 Mm^3 (3931 TMC). Per major basin it is as follows:

	Mm^3	TMC
Krishna	21772	769
Bhima	8777	310
Godavari	11410	403
Wainganga	20385	720
Tapi	6484	229
Konkan Basins	42469	1500

This estimate is based on rainfall and discharge data that could be made available in compiled manner at that time. It was far too short for precise assessment. It has already been stated to that effect in the report too. It has also been suggested to improve upon that estimation of the resource in light of extensive information made available during the subsequent period. Estimation of water resource merely as per 75% dependable availability is stated. Moreover, availability in the Narmada Basin is not at all taken into consideration, nor any clear mention of availability in Mahanadi Basin is found in its report, the area covered by the latter being meager.

2) The estimates of water availability, as assumed by the various river water disputes tribunals in respect of Krishna, Godavari and Narmada and by the Ayyangar Committee in case of Tapi (based on that assessed by the Cenral Water Commission before 1958) are as follows:

	Mm^3	TMC
1) Godavari	37825	1336
2) Krishna	27251	962
3) Narmada	308	11
4) Tapi	7029	248
5) Kokan Basins	49269	1740

The combined availability as per 75% dependability in all the basins of Konkan Region is indicated as accepted by the *Konkan Sinchan Vikas Uchchadhikar Samiti* (Konkan Irrigation Development High Power Committee) (June 1981). The same is based on the findings of the committee named Water Resources Planning in Konkan Region (March 1981) constituted under the chairmanship of Dr. M. S. Swaminathan.

3) The National Irrigation Commission (1972) has considered the annual average availability in Maharashtra as per the following:

	Mm^3
1) Godavari (Including Pranhita)	37830
2) Krishna (Including Bhima)	27920
3) Tapi	7250
4)Narmada	620
5) Konkan Basins	42480

Having determined, the Water Resources Divisions of the Irrigation Department have presented before the Commission, the estimates of natural availability of water in all the hydrological drainage units (sub-basins) as proposed by the latter (Statement 2.8.3). An independent volume titled 'Sub-basinwise Planning and Management' is presented as Volume II of the Commission's Report. It contains sub-basinwise assessment of water resources as compiled by field officers in a prescribed manner. The assessment in case of Manjara is, however, based on the study carried out by the Central Design Organisation (CDO) Nashik.[7] An extensive sub-basinwise exposition of surface water resources that is available in nature is offered in Volume II. The Central Government had appointed water disputes tribunals regarding water allocations in 3 interstate river basins, viz.,

7. Note on Water Availability Studies of Manjra Basin by Miss. P.K.S. Naidu, P. Venugopal and D.G. Mogane: Paper presented during the Workshop 'Water Planning in Manjra Basin (11/97, Ambajogai) organised by the Commission.

Godavari, Krishna and Narmada. Their awards have been brought out: Krishna (1973), Narmada (1979) and Godavari (1980) in that order. According to these awards, the water allocated to Maharashtra for use is less in quantum than the respective basins are naturally endowed with.

Water allocation in the interstate river basin of Tapi is governed by the recommendations of the 'Ukai Technical Committee' appointed by the Central Government in October 1957. Mr. M.S. Tirumal Ayyangar, the then Chief Engineer of Hirakud Project chaired the committee. The committee reported in January 1958. A quantum of 7401 Mm^3 has been allocated for the reach above Ukai as per its recommendation. The division of this allocation between Maharashtra and Madhya Pradesh is effected as per the decision arrived at the 21 st meeting of the Inter State Control Board of these States in January 1986. The planning for water in Tapi Basin is presently proposed in accordance with that. The Statement 3.5.1 presents how much sub-basinwise water is allocated to Maharashtra for use as a result of aforementioned awards. Calculations of water availability are shown in detail in the Appendix 3.5.1. These calculations be regarded merely for the sake of planned use of water.

Study of Surface Water Resources Availability in Maharashtra

2.8.6 Water resources study in Maharashtra is being carried out through the Irrigation Projects Investigation Circles functioning under the respective regional offices. These circles keep the surface water account in respect of basins falling within their respective jurisdictions on behalf of the Chief Engineer (Water Resources) and Joint Secretary, Irrigation Department in Mantralaya. The sole responsibility of seeking approval to the projects from the Central Water Commission, New Delhi rests with them.

The National Water Development Agency (NWDA), New Delhi set up under the Ministry of Water Resources, Government of India is entrusted with the task of identifying the possible interbasin transfer links in the country, undertaking investigations and carrying out detailed studies further. Yield studies pertinent to the principal interstate basins all over the country are undertaken within the ambit of National Perspective Plan as evolved by the NWDA. Water balance studies in respect of basins falling within Maharashtra, viz., Godavari, Krishna. Tapi & Narmada and also Damanganga and Par (Nar inclusive) among the west-flowing rivers in Konkan Region are being carried out by it. This study is almost completed. However, the Government in Irrigation Department has directed CDO, Nashik to undertake water availability study in respect of Tapi Basin in order to ascertain the veracity Of surplus availability of water in some basins as is surfaced in such studies completed by NWDA. Having completed such a study, the CDO, Nashik has submitted the same to the Government in November 1997. By this very time CDO, Nashik has come out the water availability study in respect of Manjra Basin. Mention to that effect has already made earlier. Yield studies upto Wardha and Penganga Project sites have earlier been carried out by it. Use can be made of the foregoing studies to determine the water availability over the entire stretch of the respective basins. It is recommended that assessments of water resources availability in basins be improved upon in light of such sort of forthcoming studies likely to be carried out by the CDO, Nashik.

Hydrology Project

2.8.7 Hydrological data is used in diverse fields such as water resources development, water supply, water pollution control, waste water disposal, flood management, irrigation, power generation, sewage disposal and so forth. This entails a need to acquire data on a large scale mainly pertinent to rainfall, temperature, evaporation, wind velocity, humidity, yield, etc. Owing to this, an uninterrupted acquisition of data based on observation, measurement and inference is mandatory in a hydrological study. The concept of Hydrology Project has cone to the fore out of this necessity of processing, analysing, presenting in compact form and disseminating the same to the needy agencies.

The Central Water Commission (CWC) has installed a network of river gauging stations on all the major rivers all over the country which is aimed at facilitating basinwide water resources assessment. Nevertheless, the network density is sparse. It falls short to meet the modern needs. A network of analogues stations even on the State level is needed for that. Similar is the case with raingauge stations and climatological stations set up through out the country by IMD. If a network of raingauge stations and climatological stations is extended from state to state in consonance with the prescribed standards of IMD, the supplementary data accruable therefrom will definitely go a long way in enhancing the utility as well as accuracy of basic data. Earlier, a limited attention was used to be paid to the parameters of groundwater, water quality, sediment load etc. The then existing database was therefore, falling short for exercising pollution control and achieving environmental protection. The growing importance of these factors being dawned upon generally from 1980 onwards as a result of which the programme of groundwater measurement, quality monitoring and sedimentation monitoring has been recognised as an inseparable part of the Hydrology Project.

2) Scope and objectives of the Hydrology project

On being proposed by the Central Water Commission and the Ministry of Water Resources - Government of India, the following 8 states have joined the National Hydrology Project:

1) Maharashtra 2) Andhra Pradesh 3) Gujarat 4) Kerala 5) Karnataka 6) Madhya Pradesh 7) Orissa 8) Tamilnadu.

The following central organisations are party to this project:-

1) Central Water Commission (CWC), New Delhi
2) Central Ground Water Board (CGWB), New Delhi
3) National Institute of Hydrology (NIH), Roorkee
4) India Meteorological Department (IMD), New Delhi.

The said project is being implemented with financial assistance of the World Bank and is aimed at achieving the following objectives:-

1) To improve the organisational efficiency of institutes undertaking surface hydrometry and to enhance their technical ability.
2) To procure modern instruments/equipment for undertaking measurements.
3) To arrange for data verification, processing and analysis.
4) To facilitate exchange of information regarding hydrology, hydrometeorology and water quality among the Central Government and the 8 participating states.
5) To institute quantitative and qualitative improvements in hydrological data.

The national, state and special project levels are going to be benefited with this data for effecting water resources allocation, planning and management in the spirit of National Water Policy (1987). The implementation of this project in Maharashtra is entrusted to the Chief Engineer, Hydrology Project.[8] Subsequent to its creation in 1996, the office has started functioning, w.e.f. 26th June 1996.

3) Hydrology Project - Programme in Maharashtra

To set up 30 new stations to augment the network of river gauging stations established by the Central Water Commission in various river basins of Maharashtra and to upgrade the 27 stations is envisaged in the Hydrology Project. Upgrading of a river gauging station implies an adoption of current meter dispensing with the measurement by float. The scope, extends in setting up 18 new meteorological stations and upgrading 9. Installation of sunshine recorder is conducive to an upgrading of a meteorological station. Programmes such as installing 40 wireless sets for flood control in Maharashtra, conducting sedimentation study with the aid of modern equipment, establishing 21 of Grade-I and 2 of Grade-II laboratories for water quality testing, installing instruments at 70 project sites to measure inflow entering into reservoirs, providing calibration at 50 dam sites to precisely measure outflow over the spillways, establishing centres to arrange for return flow measurements in commands of 8 projects and 1 computer centre to collect and analyse data therefrom & duly interconnecting them and providing arrangement for other facilities like supplementary training, etc., are forming a part and parcel of the Project.

4) Future of the Hydrology Project

One computerised data bank on national and state levels is proposed to be developed as a part of the Hydrology Project. The chief objective of the Hydrology Project is to make the information readily available. Making available scientifically flawless and precise hydrological data as and when needed and using it for judicious planning and development at various levels will be possible in future when tasks assigned to the Hydrology Project are accomplished in time. Hydrology being a continually developing science, to deploy the paraphernalia gathered under the cause of Hydrology Project and develop it as the need arises even beyond the expiry of its proposed duration is the need of the future. It is, therefore, recommended to continue the set up of the project beyond its 6 years' duration (expiring in September 2001). This will be circumscribing the agreement with the World Bank effected in September 1995:

5) *Climatological Stations in the State*

There are in all 132 climatological stations already functioning in Maharashtra. Basinwise locations therefrom are of these stations *vis-à-vis* availability of climatological data as accruable therefrom are as follows:

Sr. No.	Basin	Climatological stations	Data availability	
			Less than 15 years	More than 15 years
1	2	3	4	5
1	Krishna	42	42	-
2	Godavari and Tapi	52	52	ö
3	Basins of west-flowing rivers in Konkan	38	26	12
	Total	132	120	12

The Hydrology Project envisages setting up/upgrading 109 full cimatological stations all over the State. Besides, all or a few of the climatological instruments are already installed at 200 dam sites forming a part of major, medium and selected minor projects. The field officers with whom the operation and maintenance of

Government (Irrigation Department) Resolution No. NHP 1095/223/95 W.R.P. dated 14.6.96.

projects/dams is entrusted are expected to arrange for measurements at the stations and maintain records thereof.

Notwithstanding this, the functions of data compilation and analysis thereof are required to be streamlined in a befitting manner by devolving the responsibility of infusing systematisation in this regard and making available data so acquired to the Computerised. Analysis Centre under the Hydrology Project at Nashik. Every year project-specific and basinwise water account should be published in order to accomplish basinwise delineation of water availability and its use. So also, a report be brought out determining quantum of water that flowed past a basin / sub-basin, that infiltrated into the ground or stored in a gorge and utilised by undertaking basin and sub-basin specific measurements of annual incident rainfall.

Dependability of Water Availability: Evolution of the Concept

2.8.8 The practice of basin planning of water resources development projects on water availability as per 75% dependability is in vogue all over the country and even in Maharashtra. The Commission has probed into the evolution that led to conceive the 75% dependable water availability for planning. A large number of irrigation projects were started being referred to the then Central Water and Power Commission to seek approval from allover the country after around 1951. At the time of implementation of the Second Five Year Plan, Shri Hardikar - the then Chief Engineer of Old Hyderabad State - insisted the Planning Commission to recommend 75% dependability criteria. The Central Water Commission wanton even upholding the suggestion. On 23 rd March 1963, the Union Minister for Irrigation and Power had made the following statement in the *Lokasabha* in connection with water allocation of Krishna and Godavari;

"In the matter of availability of supplies, from overall consideration, a criterion based on 75% dependability has been considered to be the most suitable and for the purpose of our projects that have to go forward, this criterion of dependability may be adopted."

In fact the 75% percent dependability criterion being adopted in projects planning is far from scientific. It is devoid of any logic. Notwithstanding that, the concept of dependability has assumed precedence in the country. Earlier to 1951, the projects planning in old Mumbai Province was used to be based on 80 to 90 percent dependability criteria. Mainly the following 3 issues had been posed before the Krishna-Godavari Commission (1962) constituted by the Central Government.

To review the position in respect of availability of supplies in the Krishna for:

1. 86 percent dependability criterion as assumed in 1951
2. 75 percent dependability criterion
3. Such other dependability criterion as may be considered appropriate.

The Krishna - Godavari Commission refrained from vouchsafing any decision in this respect. None the less, it invited attention towards shortcomings such as inadequacy of available discharge data, want of river gauging stations in some basins, etc.

In pursuance of the recommendation of the Administrative Reforms Commission, the Union Council of Cabinet Ministers had constituted one sub-group in 1973. One of the functions entrusted to this sub - group was to offer a considered decision as to the adoption of dependability criterion while embarking upon water planning of irrigation projects. The sub-group recommended to relax this criterion to 50 percent dependability in the least in case of drought prone area. A review was undertaken of this recommendation by the erstwhile Irrigation & Power Ministry. The stand it assumed was not to make applicable the criterion of 50 percent dependability at least to major projects (in draught prone area) lest it may enable a particular state to use all water at a terminal storage of a major interstate river. The downstream riparian states are likely to beget a meagre allocation of river water as a consequence. Moreover, major river basins are prone to receive ample rainfall due to mountain ranges in upper reaches. The rains and consequently river flows are relatively less assured in the lower down reaches. Considering all the pros and cons, the Agriculture & Irrigation Ministry and the Planning Commission as well came out with a suggestion of adopting 75, 60 and 50 percent dependability criteria in case of major, medium and minor projects, respectively in drought prone area. A latitude of relaxing this criterion to 50 percent for the medium projects of deficit basins in draught prone area under exceptional circumstances is granted. The Fact Finding Committee (1973) constituted by the Government of Maharashtra to undertake an overview / survey of draught prone area had recommended to take into consideration for planning the available water resources in draught prone area as per 50 percent dependability.

Review of Dependability Criterion for Water Availability

2.8.9 A need has arisen to undertake a review of the logic behind the 75 percent dependability criterion that had been in vogue from 1951 or so. The veracity of the dependability is to be carried out in the light of criteria of scientific sanctity, tenability and economic stability. These criteria do not lend any basis to the 75 percent dependability. Statistically, an average measure will be scientific in case of variables of varying scatter. It will not be an ad-hoc figure unlike that of 75 percent dependable quantity. It will have to be not so much variation - sensitive to annual data series. It is going to be a basin specific basic parameter of a permanent character. Project planning accomplished on the basis of availability as per average dependability, in general, turns out to be even beneficial also. In initial period of the post-independent era when the stream flow data that is available is of limited duration and the data is of dubins quality, it was far from possible to undertake comparative study of water availability as per various dependability' that is leastly assured. The state has changed now. Stream flow data of more than 30 years duration pertinent to a good number of basins in the country is at hand. The Systems Engineering technique in conjunction with the computers can conveniently be deployed on a large scale to attain optimum water resources development. The integrated river basin planning and management can he handled in a far better manner thereby. The best possible quantification of water that is assuredly available for use by the judicious regulation of a particular storage reservoir is no other than the annual average flow.

The long term statistics of a particular basin, if gleaned through, reveals that good years (from the rainfall point of view) ordinarily follow good years (annual rainfall exceeding the long term average). Similarly the bad years (annual rainfall short of long term average) trail behind the bad ones in sequence. Secondly good years, in comparison, are far less numerous than bad ones. In short, the frequency of bad years is more.

If the flow quanta are beset with considerable variability, then instead of going in for year-to-year storage, it is best to provide for carry over storage in water reserves of projects. Provision of carry over storage entails advantages in light of circumstances such, as late commencement of monsoon, density of good years falling short of that of bad years, also increasing use of water for diverse purposes and so forth. Manjra Basin is a typical example of this scenario. Water availability in this basin as assessed by the Central

Designs Organisation. Nashik indicates that the annual average yield is 1.45 and 2.5 times the yields available as per 50 and 75 percent dependabilities, respectively.

Just by keeping in view the need of increased use of water the Krishna, Narmada and Ravi Development Authorities have beforehand incorporated in their respective resolutions the themes of panning of water and use thereof that is reliably available in 50 percent of the years.

Nowhere in the world the criterion of 75 percent dependable annual availability is adopted. Neither the nationwide assessment of river waters carried out by the Central Water Commission nor the various standards brought out by the Bureau of Indian Standards uphold that view. The World Bank, too, treats this criterion as far from acceptable. In view of this, there remains no objection to adopt the annual average or lesser dependable availability while sizing the storage capacities in water planning of projects. Accomplishing scientific planning of projects solely applying the economic viability and practical management criteria is warranted here-in-after.

The quantum of requirement for irrigation, municipal or industrial use, which is put forth is in practice of adjustable nature. For example, no matching effect is discernible on productivity by applying in practice 20 percent less water to crops than their real requirement in an irrigation season. Likewise, during a deficit year it can easily be pulled through by resorting to temporary economy even on the fronts of domestic and industrial use. Nevertheless, the calculations which do take into consideration 75 or 90 percent success criteria lead to treat that year to be entirely a failure year in case the availability as regards to water falls even minimally shorter than the expectation in that year and this leads to misunderstanding that no one is, in fact, going to receive water during such a year. Such kind of reasoning is, therefore, far from true in practice. It disregards the making judicious and full use of available water.

As such, a success or failure year is, therefore, assessed to be so depending upon the consideration as to what extent the shortage of water likely to be experienced in that year is made good rather than merely basing it on statistical ramifications. A planning is practically reckoned to be unacceptable only when the number of years, which are not amenable to accommodating the shortage, exceed 1 or 2 in 10 years span. In view of the growing shortage of water it is essential here-in-after to undertake planning of water with an open eye. The management of projects and basins is here-in-after required to be suggested on this line by the proposed sub-basinwise planning and regulation committees.

2.9 Groundwater

Apart from the water lost by evaporation and evapotranspiration, rainwater either runs off at the surface through drainage channels such as streams and rivers or percolates into the ground and is stored as groundwater. Hence the two main sources of water in any region are surface water and groundwater. Of course part of surface water percolates to join groundwater and part of groundwater emerges at the surface and is run off through streams. Therefore; even if surface water and groundwater are considered to be two main sources for human use, they are mutually convertible, and are not therefore, two different sources, but are two exchangeable phases of the same water cycle. Therefore, for planning, it is reasonable and also essential that they are considered and assessed together. As long as their use was small as compared to availability, it was possible to consider them separately and to maintain separate accounts of the two, but with rapid increase in utilisation as compared to availability it has become necessary to consider together the interdependent availability of the two sources. Groundwater storage and availability depend mainly on rainfall, topography and geological formations.

2.9.1 On the basis of average rainfall in different parts, Maharashtra can be divided into three[9] principal zones.

High Rainfall Zone: Mainly the Konkan Region with an area of 0.30 lakh sq. km lying between the Arabian Sea and the Western *Ghat* ranges. This includes Thane, Raigad, Sindhudurg and Ratnagiri Districts and the average rainfall is 2000 to 3000 mm. Some peaks in the Sahyadris get even 4000 to 6000 mm rainfall. Out of that 0.10 lakh sq. km area in Ratnagiri and Sindhudurg Districts has very steep slopes. Though rains in this area are high the steep slopes render the groundwater occurrence meagre. Similarly, due to capping of laterite on the Deccan Trap considerably less (2-2.5%)[10] of rainfall infiltrates into the ground and the remaining goes as runoff. The pore spaces in laterite are interconnected and hence the percolated water also flows away from the basement. Hence in this region, availability of groundwater for irrigation as far as dug wells or bore wells are considered is limited.

Moderate Rainfall Zone: Nearly 1.27 lakh sq. km of the area covering the Nagpur, Wardha. Chandrapur, Bhandara, Gadchiroli, Amravati, Akola, Yevatmal, Kolhapur, Nanded and Parhhani Districts falls in the belt of assured rainfall zone. This zone receives an assured rainfall of 800 to 1500 mm. The groundwater recharge is satisfactory in this region because of assured rainfall and favourable geomorphological and geological conditions (except the metamorphic area in Gadchiroli and Bhandara Districts). There is still considerable scope for construction of open dug wells in this part and for tube wells in river alluvium.

Drought Prone Area: Nearly 30 to 50 km wide belt to the east of the main Sahyadri ranges (Map 2.9.1) falls in the rain shadow region. This encompasses nearly 1.5 lakh sq. km area of Maharashtra. The average annual rainfall in this region is 400-700 mm. A total of 94 *talukas* from Ahmadnagar, Nashik, Dhule, Jalgaon, Pune, Solapur, Satara, Sangli, Aurangabad, Jalna, Beed, Osmanabad, Latur and Buldhana Districts fall within this region. The groundwater occurrence in this area mainly depend upon the geological formation. Due to excess withdrawal of groundwater than the annual recharge, the dead storage has also been affected in this area, resulting in drying up of wells during summer. Also the scarcity condition for drinking water is prevailing every year in this very rural area.

2.9.2 Physiographic Status

The physiography of the State can broadly be divided into three[11] divisions (Map 8, Volume IV).

1) Runoff zone (A Zone): (Highly dissected and hilly plateau) - 28%,
2) Recharge zone (B Zone): (Moderately dissected plateau) 44%,
3) Storage zone (C Zone) : (Undissected and valley fill area) 28%.

The terrain in the run off zone is highly dissected and hilly and slope is more than 20%. As a result, surface runoff is high and only small quantity of water infiltrates into the ground. Flow irrigation being difficult and expensive, is not suitable for this area. Hence only lift irrigation schemes Will have to be considered. Also the terrain in the recharge zone is moderately dissected plateau type with slopes between 5 to 20 percent and the extent of infiltration is moderate.

9. Directorate, Groundwater Surveys & Development Agency, Pune.
10. Article of Shri. M. M. Sarbhukan.
11. Director, Groundwater Surveys & Development Agency, Pune.

In this zone, it is necessary to have coordinated development of lift and flow irrigation. In storage zone, the terrain is flat and of river alluvium where ground slope is generally less than 5 percent. This leads the infiltration to take place on a large scale and the area is amenable and favourable to flow irrigation.

The Groundwater Surveys and Development Agency has divided the entire geographical area of Maharashtra into 1505 (Map 7) watersheds by means of analysis of physographic, geological and geomorphological conditions on the basis of studies of remote sensing and landsat imageries supplemented by local field survey. For groundwater survey and planning, units such as watersheds or mini- watersheds which are smaller even than sub-basins, prove more useful from the scientific and practical points of view.

Geological Conditions

2.9.3 The landmass of Maharashtra is built up of rocks of all geological ages from the oldest to the youngest (Map 7). These include the igneous and metamorphic rocks of archaean pre-cambrian age, consolidated and semi-consolidated sedimentary rocks of Vindhyan, Cuddapah and Gondawana supergroup, multilayered lava flows of Deccan Trap, laterite and unconsolidated river alluvium (Annex 2.9.1). Out of total area of Maharashtra, 81,20% is occupied by the multilayered Deccan Trap rocks formed by cooling and consolidation of lavas. Considering the hard rocks of other groups along with this, 93.72% of the area of Maharashtra is occupied by hard rocks. Hence study of groundwater resources of Maharashtra is mainly the study of groundwater in Deccan Trap rocks.

Distribution of Deccan Trap Rocks and their Characteristics

The Deccan Trap flows, in general, are thick tabular sheet like in form having large aerial extent. The depressions caused by thinning and increasing extent of flows are filled by younger flows. Usually, the thin flows have much less lateral spread. It is impossible to trace any flow to its limit in view of the extensive erosion and dissection, the terrain has undergone since their effusion. As a result, it becomes difficult to locate water bearing rocks with precision. For this, it is necessary to map lava flows from the geohydrological point of view with the help of detailed field studies.

There are broadly two schools of thought amongst the geologists regarding the classification of Deccan Trap. One school classifies the Deccan Traps into two types: with vesicles spots and black devoid of vesicles. In geology they are called amygdaloidal basalt and compact basalt respectively and in rural areas they are known as '*manjrya'* and *kala pashan*', respectively. In amygdaloidal basalts, cavities formed by the escape of gasses from the lava are filled with secondary minerals and the rocks are blackish green or grey according to the colour of cavity filling minerals. Compact basalts are devoid of gas cavities, somewhat glossy and black or bluish black in colour. Water percolates in rocks in openings of two types. One is the minute pores in porous rocks like sandstones (primary porosity) and the other is the cracks in rocks caused by different processes (secondary porosity). Both types of basalts are formed by the cooling and consolidation of lava and hence do not have pore spaces. As there is little scope for percolation of water in pore spaces the only water that can percolate in them is through cracks in them. Contraction joints are the main cracks in the basalts of Maharashtra, but these are limited to compact basalts, and there are very few joints in amygdaloidal basalts, Hence as amygdaloidal basalts are non porous' and also are disjointed they are completely impervious (when, fresh and undecomposed) and water can neither be infiltrated nor stored in them.

On the other hand joints, cracks are generally abundant in compact basalts and water percolates in them. Also as compact basalt flows are thick and extensive, they become excellent aquifers. Though amygdaloidal basalts cannot store water when fresh, conditions become more favourable for storage as decomposition proceeds during atmospheric weathering. Because in the intermediate stages of decomposition they become porous, develop sheet jointing and are converted into flaky *murum.* In this condition they become good aquifers and wells in them get abundant water. Also, some portions at the top and bottom of compact basalt flows become amygdaloidal and do not contain joints. This means that only middle portions of a compact basalt flow are jointed and water will percolate only if such jointed middle portions of a flow are exposed at the surface.

Usually, there is no problem of groundwater in areas in which well - jointed compact basalt occurs. Only in areas where the pattern of jointing is not favourable for storage of water, moderate scarcity may be felt in some part. But serious scarcity is experienced in areas of amygdaloidal basalt. In these areas the only possibility of storage of water is in the weathered layer that has developed sheet jointing as a result of chemical weathering. Hence the success of wells depends on the thickness of this weathered zone. Where fresh undecomposed amygdaloidal basalt is exposed at the surface or where the weathered layer is thin there is little possibility of getting groundwater, and in such regions it will be advisable to dig wells only after detailed scientific studies.

It is seen from the foregoing discussion that in the Deccan Trap area geological conditions are not favourable on the whole for formation of large storage of groundwater. Groundwater storage is possible only if compact basalt with open joints or amygdaloida basalt weathered to a considerable depth occur at the surface. The extent of areas in which there is no possibility of getting groundwater is large. Hence it is necessary to keep these adverse geological conditions constantly in mind while considering groundwater conditions in Maharashtra.

In the Geological Map of Maharashtra only one colour, viz., green is used to depict the entire area occupied by Deccan Trap. That gives the idea that rocks of only one type are occurring in this region. But this does not seem to be correct from the groundwater point of view, because the water bearing capacity of the two main types, compact and amygdaloidal basalts, is entirely different. Hence it is desirable to show separately the regions of these two types of basalts. Geological maps of small areas like mini watersheds drawn to a large scale and showing more geological details would prove useful for the purpose of groundwater studies. These maps show details such as different flows of basalts and their lateral extent, areas of well-jointed and poorly jointed compact basalt; areas in which amygdaloidal basalt exposed at the surface and the varying thickness of the weathered zone in such areas, etc.

Some geologists hold different views regarding the classification of Deccan Trap described in the preceding para. In their opinion it is not correct to divide the rocks into two broad categories like this. This is due to the fact that groundwater realities' exhibit a considerable diversity. Nevertheless, such classification will do for areas smaller in extent. According to the surveys carried out by the Geological Survey of India,[12] of the Central Government, lava flows are mainly of two

12. Geological Survey of India, Central Region, Nagpur.

types: Pahoehoe and Aa. The areas which are predominantly covered by pahoehoe flows present distinctly different geomorphological manifestation as compared to those of predominantly aa flows. The pahoehoe flows weather more easily and give rise to conical hills with smooth hill slopes. The dense massive sections of aa flows, on the contrary, stand up as prominent cliff sections and the alternating massive and fragmentary tops give rise to steep cliffs and flat shelves, presenting step like appearance. Aa flows are predominant in southern, south-eastern and eastern parts of Maharashtra. The pahoehoe flows are dominant in Thane, northern parts of Raigad, western and central parts of Dhule, western parts of Nashik, Ahmadnagar and Pune Districts. In western part of greater Mumbai, as flows predominate. In short, a roughly NE-SW tending area is predominantly of pahoehoe type. In this segment where the flow units are thin, the rock is generally vesicular/ amygdaloidal.

Geohydrological Conditions and Properties

2.9.4 All rocks mentioned in the preceding section can not store the same quantum of water. More or less, the capacity of these rocks to store and transmit water depends on their physical characteristics such as porosity, transmissibility and storage capacity, as also on the weathered zone therein and thickness thereof. However, the thickness of the weathered zone and the proportion of cracks in rocks are not the same everywhere. In Deccan Trap rocks the thickness of weathered zone has been found to vary from few metres to 15 m and joints cracks have been found up to a depth of 150 m. Availability of groundwater in any region depends on how many such water bearing rocks occur, which means it depends on geological conditions. However, as its extent is not same at all places, transmission of groundwater is erratic and uncertain.

As a very large area of Maharashtra is occupied by the Deccan Traps, consideration of groundwater in Maharashtra is mainly the consideration of groundwater in these rocks only. The storage capacity and transmissivity of these rocks are quite limited. Hence the capacity of a well to strike water depends on its location and geological characteristics of the rocks. In the areas occupied by Deccan Trap and other hard rocks, such capacity is generally 1 to 4% of the volume of the aquifer, and in the areas occupied by alluvium and sedimentary rocks it is 5 to 10% according to the estimates made by the Groundwater Surveys and Development Agency (GSDA) and Central Ground Water Board (CGWB). As 93.72% of the area of Maharashtra is covered by hard rocks, the 72 hour duration pumping test necessary as per the rules of hydrology can not possibly be conducted. Usually, the well goes dry after 3 to 6 hours of pumping which is then required to be stopped. As a result, precise details of groundwater parameters can not be obtained.

For this, some other reliable method has to be established by invoking discussion on a scientific forum. However, these pumping tests also provide information about vital groundwater parameters like rate of recuperation and rate of transmissivity. Groundwater storage in a watershed can be estimated on the very basis of these. Hence after carrying out a maximum possible number of pump tests in various aquifers in different watersheds demarcated by GSDA, realistic groundwater parameters obtained from these should be used for groundwater assessment.

Studies carried out by the GSDA and CGWB indicate that the weathered Deccan Trap in Western Maharashtra (low rainfall zone) has higher permeability and specific yield compared to weathered basalt in Vidarbha (assured rainfall zone). However, the same in respect of dissected Deccan Trap rocks in Marathwada, they are of transition characteristics. It is because of this variation in specific yield, the discharge from wells in Western Maharashtra is higher than those in Vidarbha.

GSDA and CGWB have assessed the water bearing capacity of regional aquifers in 1505 watersheds by means of nearly 7000 aquifer pump tests, and according to the properties of rocks have estimated the storage capacity, specific yield and transmissivity for general use which are as shown in what follows:

Aquifers parameters Rock type of water bearing formations

Sr. No.		Range		Average scenario	
		Specific yield (%)	Transmissivity (m^2/day)	Specific yield (%)	Transmissivity (m^2/day)
(1)	(2)	(3)	(4)	(5)	(6)
1	Massive basalt	0.01-0.2	8-100	0.015	20
2	Fractured basalt	0.6-2.9	31-450	2.7	7100
3	Weathered basalt	0.05-2.1	8-240	0.5	60
4	Weathered and fractured basalt	0.40-1.2	88-255	1.0	88
5	Vesicular basalt	0.8-2.8	36-503	2.7	7100
6	Weathered Vesicular basalt	0.20-2.8	47-534	2.0	70
7	Laterite & jointed basalt	0.08-8.0	28-655	1.0	-
8	Weathered granitic gneiss	0.5-2.5	24-191	1.5	-
9	Alluvial area	2.9-25.0	100-1000	-	-

Source: Hydrogeology of Maharashtra, Central Groundwater Board, 1994.

Occurrence of Groundwater in Maharashtra

2.9.5 Groundwater occurrence and availability in Maharashtra is in three types of aquifers: shallow water table aquifer, deep semi-confined aquifer and deeper confined aquifer. Out of these in shallow aquifers the natural process of annual recharge from rainwater takes place depending on their hydrogeological characteristics. In the Deccan Trap areas of Maharashtra basically porosity, joints and cracks favourable for storage of water are scarce. However, by the process of weathering cracks, joints and *murum* are formed up to a depth of 2 to 12 m in moderately dissected and undissected plateau of different geological formations resulting in limited groundwater potential therein.

Some estimates about groundwater yield have been made after 15 years of study of characteristics related to groundwater recharge at 8 hydrometeorological stations established in different agro-climatic zones of Maharashtra. According to these, the annual recharge of groundwater ranges from 5 to 28% in different aquifers. This recharge is upto 5% in high rainfall regions like Konkan, 28% in the Tapi alluvium whereas 15 to 23% in the normal and drought-prone parts of the Deccan Trap areas. The new groundwater storage is usually created mainly in shallow aquifers by the rainfall that is generally incident between 15th June and 31 st October. The process of recharge is more prominent at the beginning of monsoon. Also it is more dependent on the intensity of precipitation. Out of the total 307.71 lakh ha of area, this storage takes place in 225.42 lakh hectares, i.e., in 70% area of culturable land, GSDA has established 3920 observation wells for studying the process of recharge in shallow aquifers. The water levels in these wells are recorded every October and May.

According to the information collected so far in respect of 1505 watersheds, water level rises every year by 2-4 m in observation wells. These measurements make it possible to estimate groundwater storage capacity. Broadly, the availability estimated Way is the availability at the beginning of the monsoon. It is different in different months and is the least in the month of May. Because of the limitations of the shallow aquifers, if there is a delay in withdrawal, the storage created comes to, the surface. Recharge due to rains after November and the recharge in the command area of irrigation projects are in addition to this recharge and they are estimated according to the formula prescribed by the Groundwater Estimation Committee.

Multi-aquifer Systems and Water at Greater Depth

The borewells drilled by Groundwater Surveys and Development Agency in Maharashtra yield water from the deeper semi confined and confined aquifers alongwith the shallow aquifers. From the conclusions drawn from the field studies of exploratory borewells and tube wells drilled by Central Ground Water Board[13] and the study of 18716[14] exploratory wells drilled by GSDA, it is seen that at some places deeper aquifers exist and they contain water. However, their extent is very limited. For example, in Latur-Osmanabad area, 40-50% of the successful borewells drilled for drinking water have struck water at greater depths and their capacity has increased. However, actual figures of estimation of groundwater and pertinent technical details are not available in respect of deeper semi-confined and confined aquifers. Hence there is considerable doubt about their existence. Geologists seem to be essentially unanimous about multi-aquifer systems in alluvium. But there is considerable difference of opinion among the geologists about the multi-aquifer systems and deep seated water in Deccan Trap.

Some geologists have a number of objections against the multi-aquifer systems. In their opinion deep seated water and multi-aquifer systems are not possible in Deccan Trap. Because an essential condition for the formation of a multi-aquifer system is that aquifers must be inclined. This means that a multi-aquifer system can not exist unless there are inclined aquifers and in Maharashtra, the Deccan Trap rocks, barring a few exceptions, are not inclined. Everywhere more or less essentially horizontal flows occur and therefore there is no possibility of the occurrence of multi-aquifer systems in Maharashtra.

If water is to percolate to deeper levels, there must be a continuous sequence of previous rocks. But in the geological conditions prevailing in Maharashtra this does not seem possible in other hard rocks except the Tapi-Purna alluvium. Maharashtra is composed of horizontal flows of Deccan Trap basalts piled upon one another and all these flows are not previous. Groundwater storage can be formed only if a previous rock occurs at the surface. But, more or less, these basalt flows are alternately previous and impervious and hence there will be an impervious flow underneath a previous flow at the surface and water will not be able to percolate deeper. Hence water will not be able to percolate more than 50 or 60 ft below the surface. Moreover, it is the actual experience that at number of engineering projects for which deep excavations were carried out, no water was encountered at depths. Also, nobody has ever shown on the basis of geological conditions how water can occur at greater depths. Hence these geologists argue that deep seated water can not occur in Maharashtra.

13. Hydrogeology of Maharashtra, Central Ground Water Board, Nagpur (1994).
14. Groundwater Surveys and Development Agency, Pune.

Geologists, according to whom water can occur at greater depths even in Deccan Traps, opine that joints occur in these rocks up to a depth of 150 m. Also there are cracks in rocks and there is a network of joints and fractures in deep seated rocks. Water percolating into cracks exposed at the surface seeps upto a depth of 150 m through them and accumulates therein. It is this water that deep drill holes tap.

So taking into account the two divergent opinions about multi-aquifer systems and deep seated water, it is seen that a number of questions in this regard are still unanswered. These are: How water reached upto these depths? What is the nature of the aquifer? Which rocks occur between the surface and the aquifer? What is their geological structure? How is this structure favourable for transmitting water to these depths? Are these aquifers get recharged by the rain water from the surface through a natural process? Detailed scientific studies are required to be carried' out for getting satisfactory answers to these, questions. Taking into consideration the special importance of deeper aquifers for drinking water, it is necessary to carry out detailed studies and research as to their characteristics such as depth, extent, yield, etc.

In the extensive alluvial belt in the Tapi-Purna Basin multi-aquifer systems exist up to a maximum depth of 200 m in Tapi and 250 m in Puma. This deeper water is contained in semi-confined and confined aquifers. This area gets recharged by rainwater every year. Recharge also takes place through the Bajada zone existing at the foot of Satpuda hills. This zone also recharges most of the deeper aquifers in the central parts of Tapi Basin.

Importance of Lineaments in Geohydrological Studies

2.9.6 Scientists defined lineament as 'a mapable, simple or composite feature of surface, whose parts are aligned in a rectilinear or curvilinear manner and which differ distinctly from the patterns of adjacent features, presumably reflects a sub-surface phenomenon'. From the definition it is clear that the term lineament is purely descriptive and does not necessarily have any genetic significance. Therefore, lineament is not necessarily to reveal any geologically significant surface evidence. For example, linear river course, in itself, is a simple mapable surface feature and, therefor, can be called a lineament.

Lineaments not due to any geological structure are many times shown this way only. For example the Godavari Lineament which is considered to be one of the main lineaments in Maharashtra is merely a lineament drawn along the course of the Godavari. Similarly, in the lineament map of the earthquake area prepared by the Department of Space, Government of India after the Killari Earthquake, 53 lineaments are shown. Ground verification has revealed that all these lineaments are drawn along the courses of Terna and *nallas* joining thereto. When the beds of Terna river and these *nallas* were examined in detail by geologists, it was seen that there did not occur in the beds any geological features such as faults or fractures which are capable of producing lineaments, and the lineaments depict only the courses of streams.

It is claimed that in the Deccan Trap areas of Maharashtra water has been struck along the lineaments seen in satellite imagery. It is not stated that which geological structure have produced these lineaments. But based on the strength of these examples, it is claimed that lineaments can be used for the investigation of groundwater. Considering together the geological conditions in the Deccan Trap covering 81% of Maharashtra and the information that can be obtained from lineaments it seems that lineaments can be used only to a limited extent in the groundwater investigation.

It is often taken for granted that a lineament corresponds to a fault. But it is far from correct to assume' that only faults produce lineaments. As it can not be known what has produced a lineament unless the lineament is verified on ground, it is dangerous to attribute a different meaning to a lineament not ground verified other than that is simply a line in aerial photograph in the context of groundwater. No geological information is obtained from a lineament without the ground verification. Dykes, faults and fractures are geological structures that influence the occurrence of groundwater, and if their existence is proved by the ground verification of a lineament such lineaments produced by these features can prove useful indicators of groundwater occurrence. Hence for understanding the significance of lineaments in the context of groundwater, their ground verification is obligatory.

In 3/4th of the area occupied by the Deccan Trap in Maharashtra there exist no faults barring a few exceptions. Faults are mentioned at some places but there is no unanimity among geologists about the existence of these faults. Fractures at which no movement has taken place are, simply called fractures and not faults. Such fractures occur in some parts of the Deccan Trap. Water percolating along fractures brings about weathering of basalts on both sides in the Deccan Trap area. If in any area there is a belt of numerous fractures, which are parallel and not far away from each other, such fracture zones will be seen as lineaments. As there is likelihood of getting water in fractures because of the sheet jointing produced in them lineaments produced by such fracture zones can prove to be indicators of groundwater.

As dykes are seen on the ground as belts extending over long distances, they are seen as lineaments: Conditions are favourable in dykes for the storage of groundwater because of numerous joints which are closely spaced. However, as there is a lot of variation in the frequency of joints and as they often close at shallow depths, occurrence of groundwater in dykes is uncertain. There are examples of dykes which are completely impervious. On the contrary there are also cases in which there is water only in the dyke and not in the enclosing rocks. Among the dykes studied up till now, majority have been found to be impervious.

After having conducted study, the Central Ground Water Board has selected lineament sites in the Deccan Trap and granite rock areas of Maharashtra (Nagpur, Bhandara and Chandrapur Districts) carried out alongwith the geohydrological studies. In the exploratory drilling carried out at these sites, the success of borewells has been found to be 95%. Alongwith their capacity also found to be plentiful. Also it has been stated in their report that the discharges from borewells located near the lineaments are higher than the ones from the borewells located away from it. On the contrary, exactly opposite results were obtained through the study of lineaments on the Beed-Latur Road which was sponsored by the Commission. Ground verification of these lineaments revealed that they had all been drawn on *nalla* courses. No drinking water wells having good yield were seen to be existing nearby. Detailed geological examination of the *nalla* beds showed that no geological features such as faults, fractures, dykes, etc. existed in the *nalla* beds and these lineaments show only their courses. It has been proved by actual observation that there is no connection whatsoever between the lineaments and the groundwater in the surrounding area.

In short, it appears that use of lineaments will be only limited in the groundwater investigation. Up till now, no detailed research studies have been carried out in regard to their technical aspects. Considering the future management of .groundwater it is going to prove imperative to subject them to detailed studies. On the basis of research & studies carried out so far pertaining to lineament, it will be practical to draw conclusions by undertaking an indepth study of geophysical survey, borewell logging, etc. which is necessary for ascertaining that.

Groundwater Estimation

2.9.7 Large area of Maharashtra is occupied by hard rocks and because of variations in their basic characteristics and physiography and variability in the rainfall alongwith that there are limitations on the occurrence of groundwater. Though there is unanimity about this, there is still a considerable difference of opinion among the scientists about the precise degree of these limitations. In order to make available exact figures about the availability of groundwater and in order to ensure maximum accuracy in groundwater estimates, the Central. Government has, from time to time, appointed committees comprising groundwater experts and has laid down guidelines for this purpose. Estimates of groundwater in Maharashtra are being revised from time to time on the basis of these only. Now a days total demand for water from the groundwater domain is increasing. The main reason for this is the self reliance being experienced by users of groundwater. But as this is leading to relentless withdrawal, and as the status as to the total availability of groundwater is of dubious nature, it is urgently necessary to give more serious thought to groundwater planning and to channelise it in a new direction.

Estimate of groundwater made by the Barve Commission was based on very inadequate geological data. Now there has been a considerable accumulation of data gained through geological surveys. Withdrawal capacity has also increased because of the power availability. Estimation of groundwater in Maharashtra in this new situation was first carried out in 1973 under the Agricultural Credit Project. The estimates were subsequently revised in 1977 and in 1980 in accordance with the recommendations of the Over Exploitation Committee and then in 1985 and 1990 as per the recommendations of the Groundwater Estimation Committee in pursuance to the directives from the Central Government to that effect.

Through the Government Resolution No.EST/1092/1544/CR 3089/Water-6 of 20 th August 1992, the Maharashtra Government constituted one Technical Committee to provide information to the Central Government on issues such as groundwater resources, irrigation potential based thereon, present stage of groundwater development, possible number of wells, planning and formulating a programme for the ultimate development of groundwater by 2005 and so on. The report of this committee has been published under the title of "The Estimation of Groundwater Resources and Irrigation Potential from Groundwater in the State of Maharashtra". In this report annual groundwater resources in shallow aquifers have been estimated and their district-wise break up has also been given for implementing development projects. At present, GSDA is carrying out the revised estimates according to the recommendations of the Groundwater Estimation - Methodology 1977, and the revised estimates are expected shortly.

Groundwater Estimation Methodology

2.9.8 Groundwater estimation is being carried out in Maharashtra by the GSDA on the basis of the watershed concept. For this, 3920 observation wells (open dug wells) have been identified. They mainly provide information about pre-monsoon (May) and post-monsoon water levels in shallow aquifers. Groundwater estimation being basically related with shallow aquifers deep aquifers are not presently being considered. Similarly the aquifers feeding borewells and tube wells being situated very deep are also not taken into consideration in the present groundwater estimates: Natural recharge of groundwater by rainfall during the monsoon is estimated by the ‘Water Table Fluctuation’ method only. For this, water levels in observation wells and specific yield of aquifers are used. In case sufficient information is not available about these parameters ‘Rainfall Infiltration Factor’ method is used.

In watersheds in which groundwater level fluctuations have not been observed regularly over a long period or data about water level fluctuations are not available in adequate measure, estimates of the percentage of precipitation percolating into rocks are made according to ‘Adhoc Norms of Rainfall Infiltration’ prescribed by the Groundwater Estimation Committee - 1984. In such areas (Deccan Trap and other hard rocks) calculations of availability of groundwater are based on the assumption that generally 10-15% of rainwater percolates into the ground. ‘Groundwater Estimation Methodology - 1997’ has recommended percolation of 12 to 14% (average 13%) of precipitation as recharge. The geological conditions at many places are not that much favourable for percolation owing to the presence of Deccan Trap and black cotton soil. Hence it is necessary to frequently correct, by actual field measurements, the estimates of water percolating into the ground.

As geological conditions are different in different watersheds, this uniform figure of 12-14% (average 13%) which has no objective scientific basis, has only a limited importance as a rough estimate. If the question of infiltration of water is examined on the basis of theoretical considerations and actual experience, the estimates based on adhoc criteria are seen to be unrealistic. It is not justifiable to presume that everywhere the percolation will be uniformly the same (12-14%) in different extensive regions having wide diversity in physiographic, climatic and geological conditions. For example for the Man Component in the Remaining Bhima Sub-basin (Downstream of Ujjani), which is drought prone and geologically unfavourable for percolation because of ‘*man*’ and black cotton soils, the figure of 18.5% of percolation seems to be unrealistic.

There is a great need of supporting watershedwise planning with actual experiments. As the statistical data and study of parameters - presently being made available from the hydrometeorological stations run by the GSDA - are going to be limited in application because of their location-specific character, it is quite necessary to increase the extent of such experiments. It is necessary to estimate natural groundwater recharge and the groundwater potential resulting therefrom. Only on the basis of observations of pre-monsoon and post- monsoon groundwater levels and specific yield of aquifers. For obtaining this information, it is also necessary to reap the use of detailed, refined and up to date data obtained from the GSDA and the Hydrology Project being implemented through the Irrigation Department. Similarly, after taking an overview of observation wells existing in Maharashtra, it is necessary to increase their number in areas which are not covered. It is urgently necessary to reassess the availability of groundwater by making use of all this information together.

Efforts to make the methodology of groundwater estimation progressively more and more accurate are being made over the last 20 years. But because of the complexity of geology it seems that it will take some more time to perfect it. The groundwater occurrence and permeability in hard rock and alluvium are different. But in the present method they have not been considered separately. Moreover, in the estimates of groundwater, it has been assumed that the extent of aquifers are more or less the same everywhere. Similarly their water bearing characteristics have also been presumed to be identical. However, this is not the case in Maharashtra. The weathered zone is not uniform and similar everywhere. Hence it will be desirable to make realistic estimates of groundwater availability only after expeditiously collecting all information.

According to the policies laid down by the Central Groundwater Estimation Committee, the groundwater organisation in the State is carrying out the study generally for computing the groundwater recharge, withdrawal and balance by studying only the shallow aquifers of groundwater. According to that, this organisation is expected to undertake review and revise the groundwater resources every 3 years. But this has been done only once and even then only withdrawal and not recharge was revised. As planning of groundwater resource is required to be carried out basinwise, while carrying out groundwater estimation it will he necessary to estimate groundwater resources watershedwise in accordance with the recommendations of Groundwater Resources Estimation Methodology - 1997 and to undertake compilation thereof basin / sub-basinwise instead of districtwise. It is also necessary to estimate separately the groundwater resources in areas having recharge facilities, those not having recharge facilities, and in command and non command areas. This will make groundwater planning more precise. Also rocks of different types having different water hearing capacities can occur in a watershed. Hence for the purposes of estimating groundwater availability, instead of considering the whole watershed, separate groundwater development plans must be prepared for each mini-watershed in a watershed by undertaking an independent study of every mini-watershed from the point of view of groundwater recharge. Also it is necessary to determine the classification of groundwater development on the basis of th trend / fluctuation in groundwater levels instead of depending only on measurements of withdrawal. It will be more practical to take decisions about constructing new wells also on the basis of geological conditions in a watershed and the fluctuations of the water levels in existing wells alongwith the available groundwater resources available. Water balance calculations for mini-watersheds (especially developed) are based on assumptions regarding specific yield, area recharge factor, seepage factor for percolation tanks etc. They will however, need to be calibrated by actual field measurements here-in-after. However, hardly a few observations in regard to infiltration characteristics of various soil layers and underground strata are extant today. Hence it is necessary to undertake groundwater estimation more carefully. Similarly, economical use of groundwater is required to be made till the time more detailed information is made available after evolving a proper scientific method based on actual observations on mini-watershed level.

Taking into consideration variation of rainfall in Maharashtra, which is the most influential factor in groundwater estimation, it will be imperative henceforth to estimate freshly every year the groundwater resources. For this, it is necessary to make the method prescribed by the Central Committee much easier to operate and to publish in November every year the groundwater storage created in each watershed and mini-watershed so as to apprise the people about as regards the status of irrigation and drinking water. It would also be necessary to plan and control the use of groundwater under the prevailing conditions. For carrying out this work trained technical scientists will have to be made available in adequate numbers in the GSDA. Publication and distribution of annual reports and related programmes for creating an awareness amongst the people and for educating them will have to be undertaken regularly in November and December under the guidance of the committees proposed in Para 3.4.5 for sub-basinwise planning and regulation. This will enable avoiding scarcity, hectic activity and excessive expenditure that is characteristic of summer.

In the present methodology, it has been assumed that 40% recharge will take place in paddy fields. Rice cultivation carried out in Western Maharashtra is in clayey soil which is practically impervious and as a result water remains standing in fields and marshy condition prevails. There is least possibility of 40% water reaching rocks through this impervious soil. It is therefore, necessary to correct such assumptions.

If groundwater resource in Maharashtra is estimated on the basis of the method prescribed by the Central Committee, it will be in excess of the real availability and there is a possibility of planning going wrong. It is, therefore, urgently necessary for the GSDA to examine the deficiencies in the basic method & parameters and pertinent changes be effected forthwith.

Available Groundwater Resources

2.9.9 Following is the summary of groundwater availability according to the Fifth Groundwater Assessment carried out in 1990 by the GSDA to assess groundwater resources in Maharashtra.

1.	Net annual groundwater recharge	31545 Mm^3
2.	Net withdrawal	7249 Mm^3
3.	Population of existing wells	12.04 lakh
4.	Area under Well irrigation	14.19 lakh ha*
5.	Balance available groundwater	24296 Mm^3
6.	Number of new possible irrigation wells with an average yield of 1.5 ha m	16.20 lakh

Source: Fifth Groundwater Assessment, Groundwater Surveys & Development Agency, Pune. * Economic Survey of Maharashtra, 1997.

Information regarding groundwater availability, withdrawal and balance in 1505 watersheds becomes available from the watershed-based groundwater assessment data. The Commission has worked out its sub-basinwise break-up and sub-basinwise status of availability, withdrawal, balance and present state of development is determined. (Annex 2.9.2). According to this data, the regionwise position is as follows:

Region	Total recharge (Mm^3)	Withdrawal (Mm^3)	Utilisation (%)	Over-developed mini-watershed[15]
(1)	(2)	(3)	(4)	(5)
Konkan	1211	69	6	Nil
Western Maharashtra	11693	3984	34	44
Marathwada	7881	1826	23	-
Vidarbha	10760	1370	12	10

According to the estimate of 1990, annual recharge of groundwater occurring in shallow aquifers of Maharashtra through rainwater and other sources is 31.5 billion m^3. Out of this. 25.4[16] billion m^3 can be used for irrigation. In the total recharge of groundwater the share of recharge through canals in the command areas of different projects in dry period amounts to about 8%[17] whereas 65-70%[18] of the total recharge of groundwater can be used every year. According to the well census of 1990, 7.2 billion m^3 groundwater was used to be utilised for irrigation through wells existing in Maharashtra all over. Today the number of irrigation wells has also increased considerably, and the quantum of withdrawal has also increased in the same proportion. Out of the 1505 watersheds, 34 are overexploited (excessive groundwater withdrawal with utilisation 85-100%), 57 are grey (utilisation 65-85%), and 1414 are white (utilisation 0-65%). When GSDA carried out a mini-watershedwise revised assessment of the 34 overexploited watersheds, it was found that in only 54 mini watersheds (Annex 2.9.3) out of the total of 167 mini-watersheds utilisation was more than 85%. Hence Government has recently declared 54 mini-watersheds as over exploited

15. Groundwater Surveys & Development Agency, Pune.
16. The Estimation of Groundwater Resources and Irrigation Potential from Groundwater in the State of Maharashtra. Rural Development Department, Government of Maharashtra.
17. Note from Shri. Tankhiwale, NABARD, Mumbai.
18. Groundwater Estimation Methodology - 1997, Ministry of Water Resources, GOI.

under section 6 of the Groundwater Act 1993. Hence legal restrictions have been imposed on withdrawal of groundwater in these areas. Details of sub-basinwise withdrawal and its planning have been given in Para 12.1.1.

As already stated, groundwater resources depend upon various natural factors and hence there is lot of variation in it. Usually, the process of creation of groundwater is more rapid in the beginning of the monsoon and depends more on the intensity of precipitation. Because of the limitations of shallow aquifers, if there is a delay in withdrawal of groundwater it comes to the surface very quickly. The groundwater resource estimated today is the availability at the beginning of the monsoon and it is different in different months. Actually it goes on diminishing because of withdrawal and emergence of groundwater at the surface. It is minimum in the month of May. A clear idea is obtained of this seasonal variation in groundwater by observing the rise and fall of levels in observation wells in different seasons. However, seasonwise data about the availability of groundwater is not available today. Similarly, studies regarding the lead lime that elapses between the conservation of rainwater into groundwater and its outbreak at the surface have not even been carried out. As this data is essential for the enforcement of groundwater law, it is urgently necessary to establish methods for these studies. It will be proper to do the watershedwise planning of groundwater only after taking into consideration the quantum of groundwater available every year and its seasonal variations.

Chapter 2
Maharashtra & its Water Resources
List of Annexes. Graphs & Maps

Annex: 2.6.1
Comparison of Maharastra's Economic Status
(1960-61 and 1996-97)

Population: Crores
Culturable area: Lakh ha
Production: Thousand tonne

Sr. No.	Particulars	1960-61	1996-97
(1)	(2)	(3)	(4)
1.	Population of Maharashtra		
	Total	3.96	8.79
	Urban	1.12	3.6
	Rural	2.84	5.19
2.	Towns (Nos)	266	366
3.	Inhabited Villages	25851	41251
4.	Area Cultivated	188.23	216.62
5.	Food Grain-Production	7744	14589
6.	Per capita availability of food grain-gram	196	166
7.	Per capita State Income (Rs.)		
	As per 1960-61 Consumer prices	437	1062
	As per 1996-97 Consumer prices	7117	17295
8.	Rate of Bank Interest (%)	4.75	18.87
9.	Literacy (%)		
	Urban	51.07	79.20
	Rural	21.46	55.32

Source: 1) Economic Survey of Maharashtra 1997-98.
2) All India Consumer Price Index.
Reference Paragraph: 2.6.1

Annex: 2.6.2
Gadchiroli - An Input-Output Study of a Backward District

The Commission has carried out the Study, of Economic Status of a backward district like Gadchiroli entrusting it to Dr. Vinayak Deshpande, Mr. Sreehari Chawa and Dr. Mrs. Anjali Kulkarni (Nagpur University). The exercise is aimed at gathering information about the sectorwise district income in somewhat details in order to enable to assess its economic status. Their broad findings pertinent to the Gadchiroli District are spelt out in the following:

1. The net cultivable area of the district is 14 per cent of the total geographical area whereas 74 percent area is With the Forest Department. As compared to this, the net income from agricultural sector is 47 percent of the net district income and the net income from forest is 20 percent. The income from agriculture and allied sectors is 69 percent.

2. The income from primary sector is 93 percent of the total district income while 7 percent is from secondary sector.

3. The population of workers is 54%. Amongst them 26 percent are cultivators and 13 percent agricultural labourers. In the State, these proportions are 43 percent (workers), 13 percent (cultivators) and 10 percent (agricultural labourers), respectively.

4. The net per capita income of the district is Rs. 2445 that is half that of the State (Rs. 4732).

5. The cultivators and agricultural labourers comprise 85 percent of the total workers and per person per hectare incomes from agriculture and allied sectors are Rs. 4387 and Rs. 7416 respectively.

6. The area with the Forest Department is 74 percent of the total geographical area of the district which is around four and a half times (17 percent) of the corresponding percentage of the State. The area with the Forest Department in the district is 21 percent of that with the Forest Department in the State. The per hectare income from area with the Forest Department is merely Rs. 363.

7. The per hectare income accruable from fish production is Rs. 9334.

8. The district boasts of excellent grade iron ore mines (yield 180 million tons). The net income accruable from the mines is hardly 0.23 percent of that of the State's total.

9. As far as industry is concerned, the district is extremely backward so much so that the district is known as 'no industry' district there being no registered factory worth the name. The pace of development too being slow the income derived from secondary sector is also far meagre.

10. The value added per worker in unregistered factories is Rs. 5529 which is about 1.25 times that accruable per person in agricultural and allied sectors (Rs. 4387) whereas it is over double of the net per capita income of the district (Rs. 2445). It is construed that industrial development is an essential factor for accelerating economic progress.

11. The per capita deposits in the bank amount to Rs. 1430 while per capita advances are Rs. 631. The Credit Deposit Ratio is 44 which is lower than the expected ratio (60 percent).

12. The average per capita annual consumer expenditure during the 4 years from 1991 to 1994 is Rs. 1668. The same was Rs. 1780 in the year 1993-1994. The low per capita consumer expenditure in the State's rural area points to lower purchasing power high exports and low standard of living.

13. The net consumer expenditure of the district for the year 1993-94 is Rs. 149 crore. Considering per capita consumer expenditure of rural Maharashtra of Rs. 3969 and 8.39 Lakh population of the district, the expected consumer expenditure works out to Rs. 333 crores. It means the consumer expenditure of the District is short by 184 crores. The same turns out to be around 123%.

14. The total area irrigated in the district during 1993-94 is 47224 hectare which is 22 percent of the net cultivated area. The irrigated area in the district is expected to increase to 2.48 lakh hectare through major, medium and minor irrigation projects to be taken up. It means an additional area of 2.01 lakh hectare will be brought under irrigation. However, the provisions of the Forest Conservation Act are posing a considerable threat to the progress of these projects. This sector is going to fetch gross net income of Rs. 172 crore as per the Rs. 8561 per hectare income prevailing in 1993-94 in the agricultural and allied sectors. The income of Rs. 7 crore is accruable from the Forest Sector as per Rs. 325 per hectare income rate prevailing in 1993-1994. The additionally accruable income is Rs. 165 crore which forms 90 percent of the deficit in the consumer expenditure of Rs. 184 crore.

15. An income of Rs. 2500 crore is expected from the 180 million tons extraction capacity of the excellent grade iron ore in the district. Assuming that the capacity will last for 100 years ahead, an annual income of Rs. 25 crore is accruable.

16. In 1950-51 the income accruable from the primary and secondary sectors formed respectively 79 and 21 percent part of that of country. The year 1993-1994 saw this changed to 53 and 47 percent while the same remained at 93 and 7 percent during the same year in case of Gadchiroli District. It means the 44 years old prevailing proportion in the country still prevails in respect of this district.

Annex: 2.8.1
Sub-basinwise Raingauging Stations

Watershed Area: sqkm

Sub-basin No.	Name of Sub-basin	Number of Watershed	Watershed Area	Total Rain Gauge Stations	Optimum Number of Stations
(1)	(2)	(3)	(4)	(5)	(6)
1	Upper Godavari (Upto Paithan Dam)	73	15780	20	30
	a) Godavari (Except Mula and Pravara)				
	b) Mula and Pravara	29	6569	10	13
2	Lower Godavari (D/s of Paithan Dam)	80	17616	22	34
3	Purna (Including Dudhana)	102	17252	13	33
4	Manjra	79	14821	10	29
5	Godavari-Sudha-Swarna	2	693	2	1
6	Painganga	111	21462	47	41
7	Wardha	117	22312	58	43
8	Middle Wainganga	116	21445	52	55-82
9	Lower Waingangaa	56	8830	25	23-34
	a) Wainganga-Pranhita				
	b) Inchampalli	2	314		1
	c) lndravati	31	5717	5	15-22
	Godavari Basin	**798**	**152811**	**264**	**318-363**
10	Purna (Tapi)	98	17575	36	34
11	Girna	57	10195	8	20
12	Panzra	18	2729	3	5
13	Middle Tapi				
	a) Tapi (Satpuda)	51	10206 10599	23	26-39
	b) Tapi (South)	59		6	21
	Tapi Basin	**283**	**51304**	**76**	**106-119**
14	**Narmada**	**8**	**1048**	**5**	**3-4**
15	Upper Krishna (West)				
	a) North-West	62	13371	24	34-51
	b) South-West	12	1745	3	4-7
16	Upper Krishna (East)	16	3977	13	8
	a) Yerala				
	b) Agani	6	1307	8	3
17	Upper Bhima (Upto Ujjani)	68	14712	89	28
18	Remaining Bhima	27	7008	48	13
	a) Neera				
	b) Downstream of Ujjani including Man	43	10431	41	20
19	Sina-Bori-Beneturaı	59	12742	44	25
	a) Sina				
	b) Bori-Benetura	22	3739	4	7
	Krishna Basin	**315**	**69032**	**274**	**142-162**
20	Damanganga-Par	11	2508	27	19
21	North Konkan	41	12063	211	93
22	Middle Konkan	16	5929	62	46
23	Vashisthi	7	2233	27	17
24	South Konkan				
	a) Ratnagiri	11	4735	27	36
	b) Sindhudurg	8	4285	32	33
25	25 Terekhol-Tillari	5	1475	13	11
	Basins of West Flowing Rivers in Konkan	**99**	**33228**	**399**	**225**
	Maharashtra	**1503**	**307423**	**1018**	**824-903**

Notes: 1) The State's component of the National Hydrology Project monitors 1153 Raingauging stations all over the state of which 448 are self recording type.
2) The minimum Network Density norms adopted (For Raingauge stations) are:

a) hilly area	1 per 260-390 sqkm
b) flat & arid area	1 per 520 sqkm
c) heavy rainfall area	1 per 130 sqkm

Reference Paragraph: 2.8.3.

Annex: 2.9.1. Geological Scenario of Maharashtra

Area : Lakh Sq. Km

Sr.No.	Name of. Geological Group of Rocks	Types of Rocks	Area	Percentageto Total Area	Districts belonged	Sub-basins belonged
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	River Alluvium (Unconsolidated)	Clay, Silt, Sand, Gravel, etc.	0.145	4.71	All river valley deposits, Buldhana, Akola, Amravati, Jalgaon and part of Dhule District.	Purna (Tapi), Girna, Panzara, Middle Tapi, Wardha
2	Laterite	Laterite, Lithomarge			Ratnagiri, Sindhudurg, Kolhapur, Latur, and Sangli (some part)	North, Middle and South Konkan, Vashishti
3	Deccan Traps	Basalt, Hard Massive Vesicular amygdoloidal varieties with inter trappeans.	2.5	81.2	Gadchiroli, Bhandara, and Nagpur, Chandrapur and all other districts except some part from Yavatmal	(All Sub basins & Basins excluding Middle Wainganga, Lower Wainganga,) Krishna, Godavari, Narmada, Tapi and basin of west flowing-rivers in Konkan
4	Gondwana Super group	Conglomerates, Grits shales, Sandstones, Coal beds, etc. (semiconsolidated sedimentary rocks)	0.047	1.55	Chandrapur, Gadchiroli, Nagpur and part of Yavatmal district	Part of Wardha, Middle and Lower Wainganga basins
5	Pre-Cambrian:- Vindhyans, Cuddapah, Kaladgis	Shales, Sandstones, Limestones, Conglomerates (Consolidated sedimentary Rocks)	0.063	2.06	Yavatmal, Wardha, Chandrapur, Gadchiroli, Ratnagiri, Sindhudurg part	Painganga, Wardha, Lower Wainganga, part of South Konkan basins
6	Pre-Cambrian & Achaean	Granites, Rhyolites, Andesites, Quartzites, Schists, Phyllites, Marbles, Gneisses (Igneous & Metamorphic Rocks)	0.322	10.48	Ratnagiri, Sindhudurg, Bhandara, Nagpur, Gadchiroli, Chandrapur and part of Nanded	Middle and Lower Vainganga, Painganga, Lower Godavari (D/s of Paithan Dam) Upper Krishna (West), Terekhol-Tillari, and part of South Konkan (Sindhudurg)
	Total		**3.077**	**100**		

Source: Geological Surveys of India, Central Region, Nagpur, Maharashtra Remote Sensing & Application Centre, Nagpur and Ground Water Surveys & Development Agency, Pune.
Reference Paragraph: 2.9.3

Annex: 2.9.2. Basinwise Details of Groundwater Resources and Wells

Area - Sqkm
Groundwater - Mm^3

Sub-basin No.	Name of Sub-basin	No. of Water-sheds	Area of Basin	Net Annual Recharge	Ground Water Available for Use (65% of Net Recharge)	Net Draft	Total No. of Wells	Withdrawal(Develop- ment) in percent-age	Withdrawal (Develop-ment) w.r.to availability for Use (%)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Upper Godavari (Upto Paithan Dam) a) Godavari (Except Mula and Pravara)	72	15780	1641	1066	749	157882	46	70
	b) Mula and Pravara	29	6569	613	398	251	64969	41	63
2	Lower Godavari (D/s of Paithan Dam)	81	17616	2497	1623	441	79612	18	27
3	Purna (Including Dud-hana)	102	17252	1905	1238	521	96922	27	42
4	Manjra	79	14821	1719	1117	430	71024	25	38
5	Godavari-Sudha-Swarna	2	693	66	43	10	1443	14	22
6	Painganga	111	21462	2449	1592	298	56534	12	19
7	.Wardha	117	22312	2298	1493	539	108803	23	36
8	Middle Wainganga	116	21445	3037	1974	236	49634	8	12
9	Lower Wainganga								
	a) Wainganga-Pranhita	56	8830	1299	844	19	5077	1	2
	b) Inchampalli	2	314	94	61	3	332	3	5
	c) Indrawati	33	6007	441	286	3	1040	1	1
	Godavari Basin	**800**	**153101**	**18058**	**11738**	**3498**	**693272**	**19**	**30**
10	Purna (Tapi)	98	17575	1768	1149	332	54195	19	29
11	Girna	57	10195	1135	738	383	83816	34	52
12	Panzra	18	2729	309	201	90	20919	29	45
13	Middle Tapi								
	a) Tapi (Satpuda)	51	10206	759	493	220	33272	29	45
	b) Tapi (South)	59	10599	955	621	228	49925	24	37
	Tapi Basin	**283**	**51304**	**4925**	**3202**	**1253**	**242127**	**25**	**39**
14	**Narmada**	**8**	**1048**	**54**	**35**	**3**	**716**	**5**	**7**
15	Upper Krishna (West) a) North-West	62	13371	1555	1010	343	58848	22	34
	b) South-West	12	1745	214	139	67	14669	31	48
16	Upper Krishna (East) a) Yerala	16	3977	423	275	191	34565	45	69
	b) Agrani	6	1307	133	86	64	13558	48	74
17	Upper Bhima (Upto Ujjani)	68	14712	1409	916	459	97873	33	50

(Contd.)

Annex: 2.9.2. (Concld.)

Sub-basin No.	Name of Sub-basin	No. of Water-sheds	Area of Basin	Net Annual Recharge	Ground Water Available for Use (65% of Net Recharge)	Net Draft	Total No. of Wells	Withdrawal(Develop- ment) in percent-age	Withdrawal (Develop-ment) w.r.to availability for Use (%)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
18	Remaining Bhima a) Neera	27	7008	754	490	316	56658	42	65
	b) Downstream of Ujjani including	43	10431	1157	752	410	81623	35	55
19	Sina-Bori-Benetura a) Sina	59	12742	1133	736	435	95156	38	59
	b) Bori-Benetura	22	3739	376	244	138	25286	37	56
	Krishna Basin	**315**	**69032**	**7153**	**4650**	**2423**	**478236**	**34**	**52**
20	Damanganga-Par	11	2508	115	75	2	554	1	2
21	North Konkan	41	12063	533	346	28	13977	5	8
22	Middle Konkan	16	5929	204	133	8	4466	4	6
23	Vashisthi	7	2233	87	57	3	1060	3	5
24	South Konkan a) Ratnagiri	11	4735	150	98	12	3878	8	12
	b) Sindhudurg	8	4285	190	124	16	6287	8	13
25	Terekhol-Tillari	5	1475	74	48	5	1840	7	11
	Basins of West Flowing Rivers in Konkan	**99**	**33228**	**1354**	**880**	**73**	**32062**	**5**	**8**
	Maharashtra	**1505**	**307713**	**31544**	**20504**	**7249**	**1446413**	**23**	**35**

Sources: 1) Fifth Ground Water Evaluation - 1990 (As per Ground Water Surveys & Development Agency. Pune)

2) Marathi letter No. GOM/GW/M1C/1098/Sur-2/F-27/6376/98 Dt. 27-8-98.

Interence: 1) The groundwater development attained in 5 sub-basins is about 40 to 50% of the total availability and is 65-75% as compared to groundwater available for use.

2) There is large scope for groundwater development in sub-basins of Vidarbha.

Reference Paragraph: 2.9.9.

Annex: 2.9.3. List of Dark and Grey Watersheds in the State

Sr.No.	Sub-basin	Taluka	Dark (Mini Watershed)*	Total	Grey (Watershed area)*	Taluka	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	Upper Godavari (Upto	Shrirampur	GV-38 B-1/3	2	GV-25 B	Sangamner	2
	Paithan Dam)		2/3,		GV-29 B	Kopargaon	
	a) Godavari Excluding	Niphad	GV-7-6/9,	4	GV-2	Dindori	10
	Mula and Pravara		7/9		8	Nashik	
			GV-15-1/2		16,17	Niphad	
			2/2,		19,25	Sinnar	
		Sinnar	GV-21-2/8	3	26 A	Chandvad	
			3/8		33 A	Yevala	
			5/8,		137	Nevasa	
					42	Vaijapur	
2	Upper Godavari	Sangamner	GV-107-4/6,	5	GV-102	Akola	2
	(Upto Paithan Dam)		5/6,6/6		126	Sangamner	
	b) Mula and Pravara		GV				
			109-3/4,4/4				
		Rahuri	GV- 117-3/5,	5			
			4/5,5/5				
			GV-123-2/5,				
			5/5				
3	Lower Godavari (D/s				GV 56	Shevgaon	1
	of Paithan Dam)						
4	Purna (Including Dud-		-		GP- 2,3	Kannad	2
	hana)					Sillod	
						Khultabad	
					GP - 13,15	Bhokardhan	2
						Jafrabad	
5	Manjra		-		MR- 9,36A	Kalamb	2
						Omarga	
6	Wardha	Warud	W R-2-		MRJ -1	Ashti	1
			1/6,2/6			Karanja	
			3/6, 4/6				
		Narkhed	WRJ-1-3/5	1			
		Karanja	WRK	4			
			2-1/4,2/4				
			3/4,4/4				
7	Middle Wainganga	Kalameshwar	WGKKC		WGKK-2	Sawner	1
			-1-2/4			Narkhed	
						Katol	
8	Purna (Tapi)				PTV 2	Khamgaon	1
						Nandura	
					PTW- 1	Bhusaval	1
9	Girna	Chalisgaon	TE-35-1/4,2/4		TE - 28 A	Pachora	2
		Bhadgaon	TE-51-2/3		59 B	Chalisgaon	
			TE 60 De-3/3		TE 91	Satana	3
			TE 37 De-2/3		108,130	Chandvad	
		Chandvad	TE-96-2/10	3		Malegaon	
		Nandgaon				Kalvan	
		Malegaon	TE				
			109-1/5,4/5				

(Contd.)

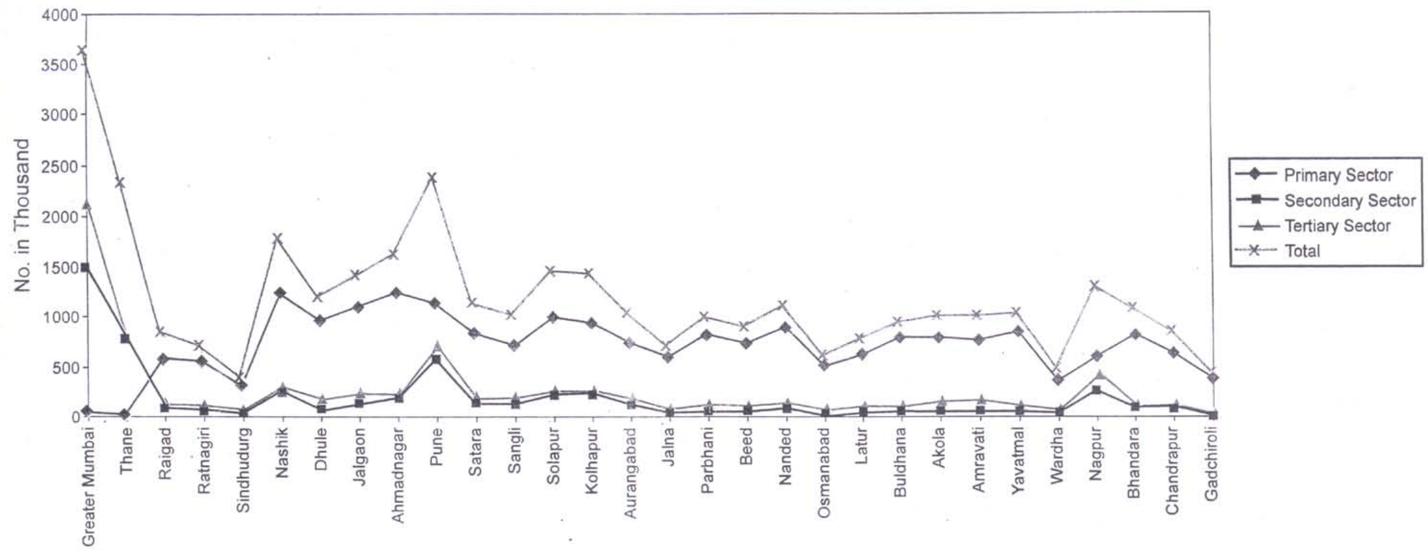
Annex: 2.9.3. (Concld.)

Sr.No.	Sub-basin	Taluka	Dark (Mini Watershed)*	Total	Grey (Watershed area)*	Taluka	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
10	Middle Tapi (Satpuda)	Edalabad	TE-1-2/5	1	TE-84	Shahada	1
		Raver	TE-2-1/4	1	TE-17	Yaval	1
11	Middle - Tapi (South)				TE-13	Jamner	3
					TE-48, TE-8	Amalner Bhusaval	
						Parola	
12	Upper Krishna (North-West)		-		KR-48	Walva Miraj	1
13	Upper Krishna (South - West)	Chandgad	KR-84-1/2 2-2.	2	KR-77	Gadahinglaj Ajra	1
14	Upper Krishna (East) a) Yerala				KR-24,40	Khanapur Tasgaon Miraj	2
15	Upper Krishna (East) b) Agrani	Jath	KR- 38-6/6	1	KR-37	Kawathe Mahankal Miraj	1
16	Upper Bhima	Junnar	BM - 7-4/8	2	BM - 30	Shrigonda	3
	Upto Ujjani		6/8		BM - 20	Khed, Shirur	
		Ambegaon	BM - 12-7/8 8/8	2	BM - 4	Junnar	
17	Remaining Bhima a) Neera	Purandar	BM-58-3/9 5/9,	4	BM - 60 70	Purandar Baramati	2
			BM 59-3/6			Indapur	
			4/6,		87,89	Malsiras	2
		Baramati	BM 75-1/7	3			
			2/7,6/7n				
18	Sina-Bori-Benetura a) Sina	Mohol	SA-29-3/4	1	SA-1.2	Ahmadnagar Parner	2
					SA - 30,36	Madha, Mohol	4
					38,41	N.&S.Solapur	
19	Sina-Bori-Benetura b) Bori-Benetura		-		BM 131,132	Akkalkot South Solapur	2
20	North Konkan		-		WF 12,19	Talasari Dahanu Palghar	2
	Total			54			57

Sources: 1) The report on the Estimation of Groundwater resources and Irrigation Potential from Groundwater in the state of Maharashtra. G.S.D.A., Pune, Department of Rural Development.
2) Director, G.S.D.A. Pune’s D.O. letter No. GSDA/ R&D /JACA /72/99 Dated 5-4-99.
Reference Paragraph: 2.9.9

Graph - 2.6.4

Workers Population as per Economic Classification (1993-94)



Source : Statement 2.6.4

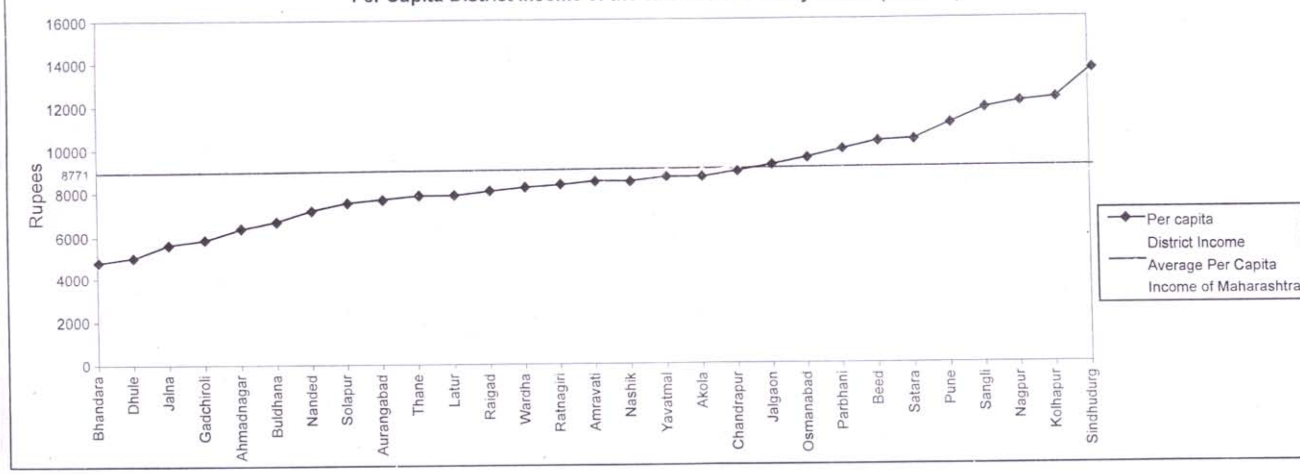
Inferences :

1) Barring the four districts viz. Mumbai, Thane, Pune & Nagpur, where population working in tertiary sector comprises over 10% (even upto 20%) of the overall population, the same proportion is more or less even i.e. 6-7 percent in case of rest of the districts' percentage.
2) The proportion of population working in primary & tertiary sectors in respect of Gadchiroli & Jalna districts is the lowest i.e. 1/8 to 1/10. Elsewhere, it generally ranges between 1/4 to 1/6.

Reference Paragraph : 2.6.18

Graph - 2.6.5

Per Capita District Income of the Workers in Primary Sector (1993-94)



Source : Statement 2.6.5

Inference :

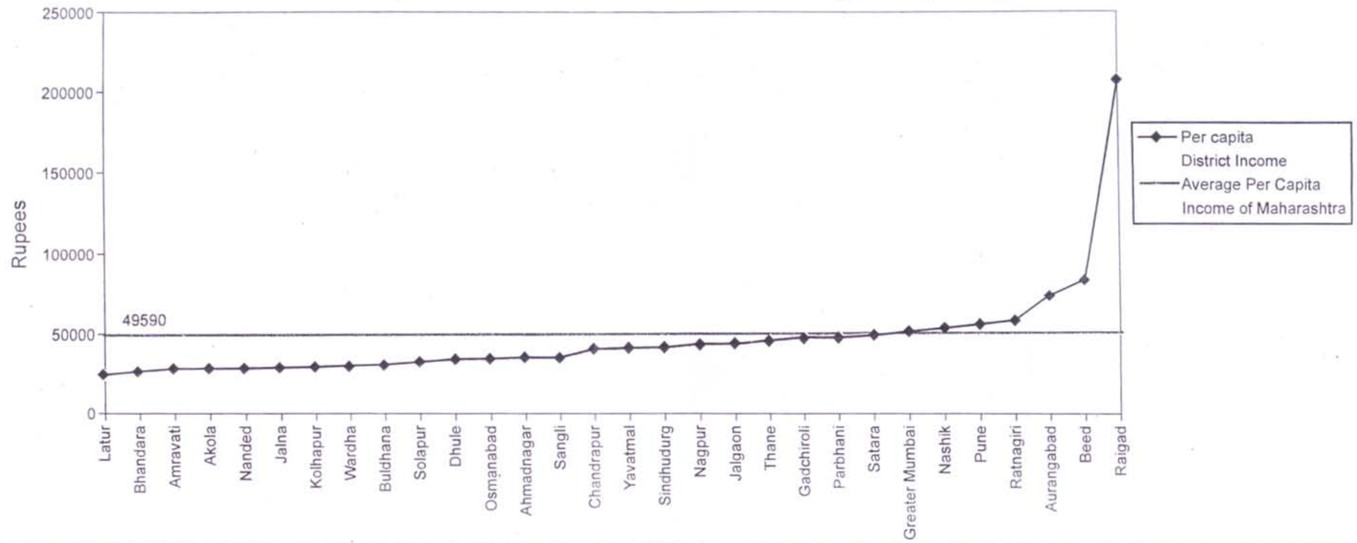
The districts having very low Per Capita District Income (upto Rs. 7000) from primary sector than the State level average per Capita Income from primary sector are i) Bhandara ii) Dhule iii) Jalna iv) Gadchiroli and v) Buldhana.

Agricultural and agro-based system is required to be reorganised in order to enhance the income from primary sector and the productivity in case of these districts and a somewhat different approach of irrigation and water use planning will have to be resorted to in that context.

Reference Paragraph : 2.6.18

Graph - 2.6.6

Per Capita District Income of the Workers in Secondary Sector (1993-94)



Source : Statement 2.6.5

Inference :

Average Per Capita State Income derived from Secondary Sector is Rs. 49590. It is five times that from Primary Sector.

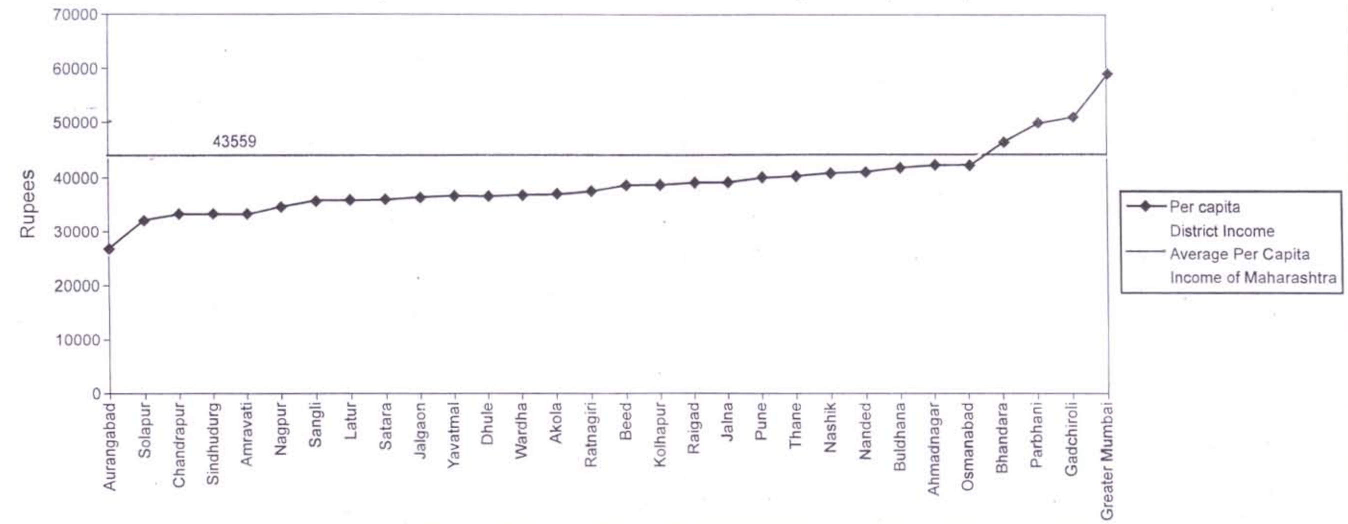
The disparity is quite large. The earners from both the sectors will be closely interlinked if in the minimum the industries in Secondary Sector are largely spread over the State in different districts. This will encourage the process & evening out economic disparity.

Decentralisation and expansion of agro-based industries will pave way for this.

Reference Paragraph : 2.6.18

Graph - 2.6.7

Per Capita District Income of the Workers in Tertiary Sector (1993-94)

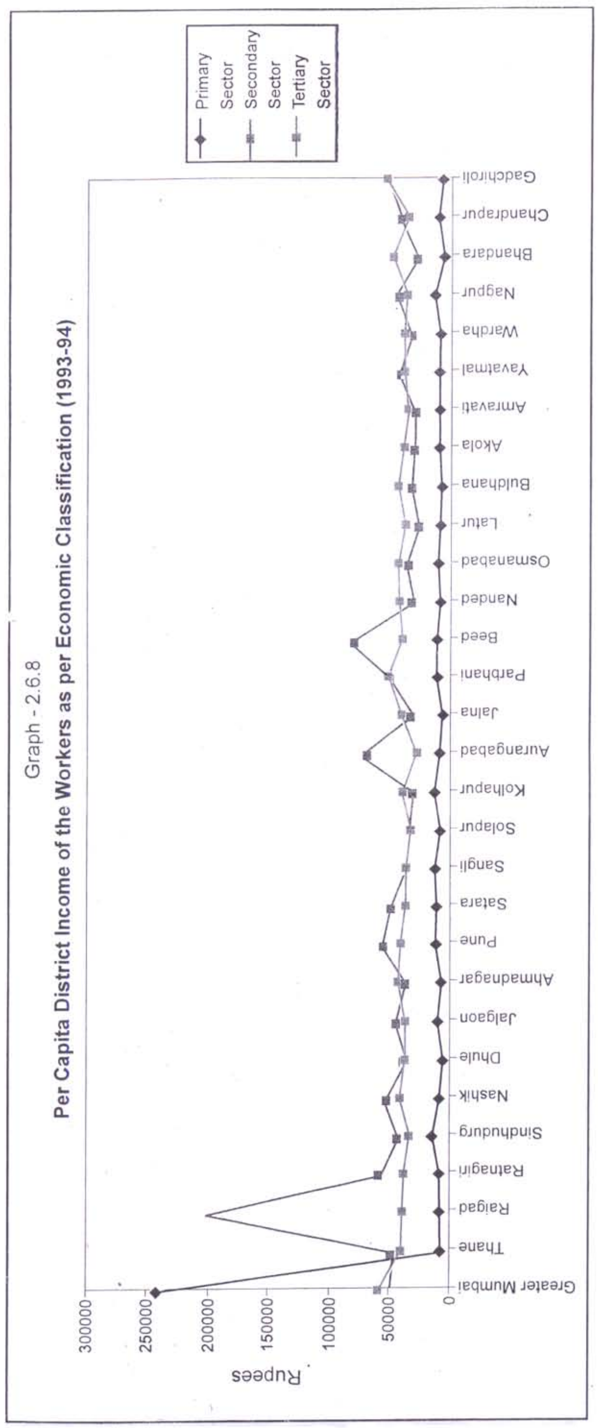


Source : Statement 2.6.5

Inference :

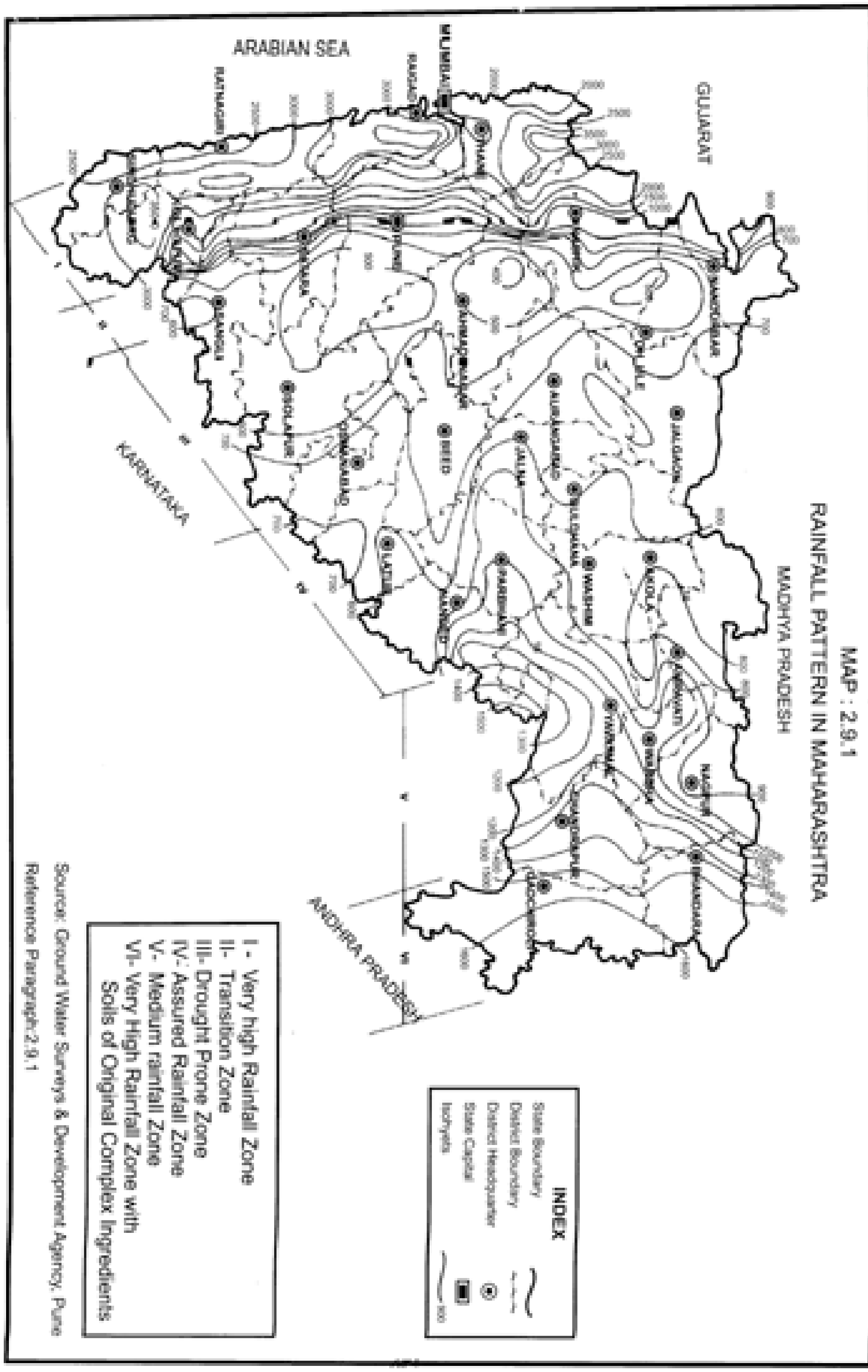
The districts with Per Capita District Income in tertiary sector of 60-80 percent of that for State Average are :
Aurangabad, Solapur, Chandrapur, Sindhudurg, Amravati and Nagpur. The districts Bhandara, Parbhani, Gadchiroli & Greater Mumbai surpass in Per Capita Income in Tertiary Sector than the average for the State in that respect.

Reference Paragraph : 2.6.18



Source : Statement 2.6.5

Reference Paragraph : 2.6.18


MAP : 2.9.1
RAINFALL PATTERN IN MAHARASHTRA
MADHYA PRADESH
GUJARAT
ARABIAN SEA
KARNATAKA
ANDHRA PRADESH
MUMBAI
INDEX
State Boundary
District Boundary
District Headquarter
State Capital
Isohyets
I - Very high Rainfall Zone
II- Transition Zone
III- Drought Prone Zone
IV- Assured Rainfall Zone
V- Medium rainfall Zone
VI- Very High Rainfall Zone with Soils of Original Complex Ingredients
Source: Ground Water Surveys & Development Agency, Pune
Reference Paragraph 2.9.1

Chapter 3
Basinwise Water Planning & Management
3.1 National Water Policy & Related Strategies

3.1.1 Presently, the work of implementation of interstate water dispute tribunal awards is being monitored directly at Mantralaya level. But it is considered necessary to have a separate machinery for the same. This machinery should be charged with the responsibility of monitoring changes taking place in the interstate basins and elsewhere in the country and accomplishing an appropriate planning of water in Maharashtra. It is necessary to keep an eye on long term planning in the wake of changing circumstances and not look into this question only when some dispute arises. No proper estimates seem to have so far been arrived at for water storages with due regard to regional variations in rainfall and required to he created with a view to fully utilising all water that is allocated to the State. Project capacities appear to have been determined on a site-specific basis. Experience gained so far suggests that in any given year it would be possible to use only about 60 to 70% of the designed storages because of annual variations in the availability of water. It is, therefore, absolutely necessary to create more storages to enable full utilisation of total quantum of water allocated. It is also necessary to plan the storage sites in an integrated manner.

3.1.2 Water storages planned by the Irrigation Department should invariably provide adequately for drinking water requirements, other domestic water uses and industrial needs of the area. Since no such provision has been made in the past keeping a long term perspective in view, water is required to be diverted to such non-irrigation uses by imposing frequent cuts in the irrigation use. The burden of projecting the total water use and planning for the same should inevitably devolve upon the department which implements the larger programme of creation of water storages. Since presently several Government departments are handling this, there is no proper coordination in the water use that is being entailed.

3.1.3 In what manner the within-the-State field disputes arising in regard to water use are going to be resolved in management of water in the State will have to be clearly spelt out in the policy of the State.

3.1.4 The water policy should also lay down clearcut guidelines for dispersing benefits of irrigation projects by going in for lifts from storages, canals & K.T. weirs being built across rivers by not limiting the projected irrigation to area bounded by canals and rivers. It will be necessary to lay down guidelines on the measures to be adopted to maintain perennial flows in rivers.

3.1.5 Storing water whenever heavy rainfall occurs and keeping at hand a system entailing its use, is the only reliable way for bringing about ‘prosperity’ from water resources that are available. Presently the storage capacity and the benefited area of storage works are decided on 75% dependability basis. In other words this means that water is allowed to spill over during 75% years without allowing it to be stored. Considering the scarcity of water, it would not he proper to do so. It would be advisable to store larger quantities for utilisation within economic constraints dictated by benefit-cost analysis. It would be necessary to gradually increase utilisation to such limits in phases, if not all at once.

3.1.6 The process of urbanisation and industrialisation should be banned in the command areas of projects as otherwise the irrigated area gets reduced. It would be desirable to establish industries and urban centres outside the command area. No clear guidelines in this regard seem to prevail at present. Not only that, the dearth of good culturable area is also going to be faced hereafter. Diversion of an area with a potential of irrigation benefits to nonagricultural use results in reduction in the productive capacity of the State. It is, therefore, considered necessary to keep an eye on this aspect and the State water policy should contain clear guidelines in this regard.

3.2. Sub-basinwise Approach to Development

3.2.1 To maintain quality of life and a steady state of economic growth, it would not be proper to consider problems of floods, drought, urban and rural drinking water needs, irrigation and industrial developments, power supply & pollution control compartmentally. All these problems have to be addressed in an integrated manner for the entire river basin or sub-basin. Basins and sub-basins are separated by natural boundaries defined by watersheds and they do dictate the interdependence of surface water, groundwater and the supporting environment and as also the geographical integrity.

Water availability and its utilisation can only be assessed within the limits of a basin or sub-basin and, therefore, a basin or sub-basin should only be the unit for planning of water resources development. Present planning is carried out on the basis of administrative division which is far from scientific.

It is internationally recognised that water resources have to be planned and managed on a river basin / sub-basin basis and a recommendation to that effect has also been made by various international conferences and institutions as also the World Bank.

Even in India, many commissions have recommended planning and management of water resources development to be carried out by adopting a basin or sub-basin as a unit. The Krishna-Godavari Commission (Gulhati Commission) made a recommendation to that effect.[1] The National Irrigation Commission (Jain Commission) had devoted one full chapter to this subject.[2] The National Agricultural Commission (Shivraman Commission) has also endorsed the aforementioned recommendation of the National Irrigation Commission.[3]

The National Water Policy has been brought out in 1987. The clear directives as regards to basinwise or sub-basinwise planning and management of development which are contained in it are as follows:

> "Resource planning in the case of water has to be carried out for a hydrological unit such as a drainage basin as a whole or for a sub-basin. All individual developmental projects and proposals should be formulated by the states and considered within the framework of such an overall plan for basin or sub-basin so that the best possible combination of options can be made.
>
> Appropriate organisations should be established for the planned development and management of a river basin as a whole. Special multidisciplinary units should be set up in each state to prepare comprehensive plans taking into account not only the needs of irrigation but also harmonising various other water uses so that the available sources are determined and put to optimum use."

The National Water Board was established (1992) for implementation of the National Water Policy. The sub-committee of this board has issued policy guidelines in the very year 1992 for setting up machinery for planning and management of basinwise water resources development. It also suggested the state governments to set up immediately an agency for such water resources, development with a memorandum giving details as to the functions and powers of such basin wise organisations.

During the 1996 to 1998 period, 5 basinwise Irrigation Development Corporations have been set up in Maharashtra for implementing projects in Krishna, Godavari & Tapi and basins of west-flowing rivers. Groundwater appears to have been excluded from the ambit of these corporations. Moreover the scope of work allotted to the Konkan Irrigation Development Corporation and the Vidarbha Irrigation Development Corporation does not cover all area or projects and also irrigation management in Konkan & Vidarbha, respectively. The Krishna and Godavari Basins are comparatively very large in expanse. There is a wide variation with regard to availability of water, climate, types of soil, cropping pattern and irrigation needs in various sub-basins of these two basins. Such corporations will face difficulty in accomplishing comprehensive planning and management of water resources development for entire basins of Krishna and Godavari in view of their size and diversity therein. It is, therefore, recommended that planning and management of water resources in Maharashtra should be accomplished on the basis of basins of their major tributaries rather than on the basis of basin of major rivers.

Scheme of Sub-basins as Proposed by the Commission

3.2.2 The geographical area of Maharashtra is divided mainly into five major river basins of Godavari. Krishna, Tapi, Narmada and basin groups in Konkan. There are 22 narrow - basins of west-flowing rivers in Konkan.

Krishna, Godavari, Tapi & Narmada being interstate rivers, water planning in these basins has interstate implications. However, majority of the basins of west-flowing rivers in Konkan are solely concerned with the State only.

The Commission proposes 25 distinct sub-basins for planning of water resources development - 19 sub-basins of 4 main basins and 6 sub-basins of 22 basins of west-flowing rivers in .Konkan. These sub-basins are shown in Map 3.2.1. While allocating water, the tribunals constituted for the Godavari and Krishna among those interstate river basins have recognised the existing sue-basins. Recognising these sub-basins and the identification numbers with which they are conventionally known in interstate transactions, the Commission has proposed a scheme of sub-basins for Maharashtra. At the same time this Commission has also taken into consideration characteristic features, (e.g., flood-proneness, drought proneness, agro-climate) which the Second National Irrigation Commission had advised to bear in mind while delineating any such scheme of sub-basins. Correspondence between sub-basins as proposed and those recognised by the tribunals is shown in Annex 3.2.1. Annex 3.2.2 shows the break-up of geographical area of each district in various sub-basins whereas the Annex 3.2.3 shows in a consolidated manner the break-up of area of each sub-basin in various districts.

Volume II of the Commission's Report provides all possible information that is available and descriptive notes exemplifying its characteristic features in respect of each of the aforementioned 25 sub-basins. Especially it provides an account of surface and groundwater availability. Volume V of the Report gives 2 maps for each sub-basin. Such type of sub-basinwise maps and notes are being brought out for the first time. Such sub-basinwise maps and notes, it is contended, would serve as a basic compilation for those engaged in planning and, management of water resources. Captions of notes provided in Volume II and maps provided in Volume V are tabulated in an index form in the Annexes 3.2.4 and 3.2.5 respectively. Statement 3.2.1 provides sub-basinwise information as to the natural water availability (both surface and sub-surface) and per capita & per hectare water availability based thereon.

The categorisation of sub-basins proposed is solely on the basis of availability of water in nature. The basic characteristics of sub-basins are dictated by the hydrological regime which in turn, is a function of climate, rainfall distribution and the draining area The constraints imposed by river water dispute tribunals as regards water use, increase in water availability resulting from import from or diminution in it as a result of transfer to other basins, alterations in water apportionment between upstream and down-stream areas owing to a storage across rivers (which happens to be on the dividing line in between), water made additionally available because of regeneration and reuse - all these factors are not taken into account in this computation of natural availability. Especially, water availability as regards to-regeneration of groundwater, reuse and its transformation into river flows is a complex issue for accounting. Ordinarily the post-monsoon flow into a river is a manifestation of groundwater that percolates into the river course. The very groundwater from nearby area of the basin gets transformed into the river flow under favourable percolating environment. If the same groundwater is extracted through wells before allowing it to reach to a river, the groundwater that is going to be transformed in river flows, is either diminished or vanished altogether. In other words, the river will be rendered dry if all groundwater is exploited through wells. The groundwater occurring within the rocks in Maharashtra is, in general, a perched water. That is why water percolated into the ground manifests itself into a river course and not laid straightly to a sea.

Basis Underlying the Proposed Scheme of Sub-basins and Physiography thereof

3.2.3 Maharashtra State can be geographically divided into 5 river basins the basinwise details of which are as follows:

Basin	Geographical area (km^2)	Percentage with the total geographical area	Culturable area ('000' ha)	Percentage with total culturable area
(1)	(2)	(3)	(4)	(5)
Godavari	152811	46.71	11256	49.94
Krishna	69032	22.45	5627	24.96
Tapi	51304	16.69	3731	16.55
Narmada	1048	0.34	64	0.28
Basin groups in Konkan	33228	10.81	1864	8.27
Total:	307423	100.00	22542	100.00

Note: The area of Mahanadi Basin, being comparatively negligible in extent, is not taken into consideration for the purpose of planning.

The sub-basins belonging to Krishna and Godavari Basins had been identified in the master plans prepared for presentation to the Krishna and Godavari Tribunals as K-1 to K-6 and G-1 to G-11 respectively. Though the sub-basins are referred to in the Commission's Report maintaining that identity wherever necessary (as they have been so conventionalised in, the interstate practice), the Commission has proposed the delineation of five river basins basically into following 25 sub-basins or basin groups in the context of planning and regulation of water:

1	Godavari Basin	1 to 9 (G-1 to G-5 and G-7 to G-1 I)
2	Tapi Basin	10 to 13
3	Narmada Basin	14
4	Krishna Basin	15 to 19 (K-1 to K-3 and K-5 & K-6)
5	West-flowing rivers in Konkan	20 to 25

Brief sub-basinwise features of the 25 sub-basins are spelt out in the following:

1) Upper Godavari (upto Paithan Dam)

(a) Godavari (Except Mula and Pravara)

This sub-basin comprises the river basin of Godavari upto Paithan Dam. River Godavari originates at Trimbakeshwar at RL 1067 m. The Paithan Dam (RL 460m) is situated at 275 km distance on downstream. This sub-basin encompasses 15770 sq. km area which falls in Nashik, Ahmadnagar and Aurangabad Districts. The natural availability of water in this sub-basin is 5137 $Mm.^3$

(b) Mula and Pravara

This sub-basin comprises two tributaries, viz. Pravara (230 km) and Mula (215 km). Both these rivers originate in the Ahmadnagar District in the Ratangad hill ranges of Sahyadri in a medium rainfall zone at RL 1070 m (Ghatghar) and RL 1100 m (Harischandragad) respectively. Confluence of river Mula and Pravara takes place at Sangam Newasa at RL 480 m. Thereafter the river Pravara joins Godavari at RL 465 m at Pravarasangam. This sub-basin is spread over 6569 sq. km area which includes parts of Nashik, Ahmadnagar & Pune Districts. The natural average availability of water in this sub-basin is 2130 $Mm.^3$

Upper Godavari is a developed sub-basin and it will be necessary in coming times to undertake immediately the work of streamlining the uses on account of water for irrigation, industrialisation and municipal supply. Urban habitation and industrial expansion of Nashik and Aurangabad is dependent on the water of this sub-basin only.

2) Lower Godavari (D/s Paithan Dam)

This sub-basin is spread over from of river Godavari near Paithan Dam (RL 432 m) to the State boundary (RL 322 m) in exclusion of the tributaries of Dudhana, Puma, Lendi and Manar. It includes the basin of Sindhphana - a major tributary. Sindhphana Originates at Vedwadi (District Beed) at RL 695 m and after traversing a distance of 118 km joins Godavari near Manjrath (RL 390 m) in Majalgaon *Taluka.* Besides, this very basin group comprises tributaries Wan, Borna, Saraswati, Gavhari, Masoli, Asna, Bindusara, Kundalika, etc. This sub-basin is spread over the districts of Aurangabad, Ahmadnagar, Jalna, Parbhani, Beed. Nanded and Latur. Length of river Godavari from Paithan Dam to the State boundary is 457 km. Area of this sub-basin admeasures 17616 sq. km.

The tail end of this sub-basin around Nanded and river bank downstream thereof is flood-prone. The tribunal award imposes certain limitations on the use of water of river. Godavari below its confluence with Purna - its major tributary. Water use in this sub-basin will have to be planned keeping the same in view. The natural average availability of water in this sub-basin is 4778 $Mm.^3$

3) Purna (including Dudhana)

The river Puma is a main tributary of river Godavari. This river originates at RL 731 m in Ajantha hill ranges at Gautala in Kannad *Taluka* of Aurangabad District and after traversing a distance of 402 km joins the river Godavari at Puma in Parbhani District at RL 355 m. This sub-basin comprises area from Aurangabad, Jalna, Parbhani, Buldana and Akola Districts. Dudhana River is a main tributary of Puma River and it originates at Kolthan at RL 763 m and after traversing a distance of 238 km joins the river Puma at RL 368 m. Be-sides Khelna. Sukhana, Girja and Dhamna are other tributaries of Puma. The total spread of this sub-basin is 17252 sq. km. The natural average availability of water in this sub-basin is $3316Mm^3$.

The first major project completed in Marathwada in the post-independence era, viz., Puma Project (including Yeldari, Siddheshwar Reservoirs) belongs to this basin.

4) Manjra

This sub-basin comprises major portion of river Manjra (upstream of Nizamsagar Dam in Andhra Pradesh) and principal tributaries thereof, viz., Lendi & Manar. Manjra River originates at village Gaurwadi at RL 824 m in Patoda *Taluka* of Beed District and after flowing through Karnataka and Andhra Pradesh reenters Maharashtra State in Biloli *Taluka* of Nanded District and joins Godavari at RL 324 m. Length of river Manjra in Maharashtra is 258 km which mainly lies in drought prone area The river Lendi with a length of 80 km rises at Udgir (RL 650 m) and joins the river Manjra at Matanga at RL 362 m. Similarly 162 km long rivet Manar in Ahmadpur *Taluka* at RL 610 m. Terna, Tawarja, Rena are the other tributaries of river Manjra rises. This sub-basin admeasures an area of 14821 sq. km and has spread over Ahmadnagar, Nanded, Osmanabad, Latur & Beed Districts. The natural average availability of water in this sub-basin is 4685 Mm^3.

However, the Central Designs Organisation, Nashik has carried out study of availability in this sub-basin on the basis of long-term rainfall data. The average availability so determined is 3770 Mm^3.

If we consider long-term rainfall data, average availability appears to be low. It is necessary to take the long-term rainfall data into account while accomplishing planning of a deficit basin like that of Manjra. The Commission has, therefore, upheld the outcome of study conducted by the CDO, Nashik.

5) Godavari-Sudha-Swarna

This sub-basin comprises small sub-basins of Sudha and Swarna in Godavari Basin. Both these rivers originate in Nanded District and join Godavari River in Andhra Pradesh outside the State border. The length of river Sudha in Maharashtra is merely 36 km and it rises at Amdari (Bhokar *Taluka* at RL 342 m) and joins river Godavari at Kondali (Adilabad District) RL 320 m. The length of river Swarna in Maharashtra is only 21 km and it rises in Kinwat *Taluka* and joins the river Godavari in Adilabad District.

Though the watershed area recognised as GV forms in fact a part of this sub-basin, it is included in Painganga sub-basin to maintain contiguity. The watershed area admeasures 174 sq. km. The sub-basins of Swarna and Sudha encompass 693 sq. km area of Maharashtra which wholly belongs to the Nanded District. The natural average availability of water in this sub-basin is 374 Mm^3.

6) Painganga

This sub-basin comprises tributaries like Painganga , Kayadhu, Pus, Adan, Arunavati, etc. The river Painganga rises near the village Madha in the Ajantha hill ranges in low rainfall zone and joins the river Wardha. With a length of 360 km, this sub-basin has an elongated shape. This sub-basin admeasures 21462 sq. km and stretches across Parbhani, Buldana. Akola, Chandrapur, Nanded & Yavatmal Districts. The area on the right bank of Painganga River belongs to Andhra Pradesh which thus has a stake in the development of Painganga. Embracing many administrative units Painganga thus is a sub-basin of importance.

Areas of watersheds-GV from the Godavari-Sudha-Swarna and PR5, PR6 and PRJ from the Lower Wainganga (Pranhita) sub-basins are included in, this sub-basin to preserve contiguity. The last 3 watersheds admeasure 68, 50 and 115 sq. km respectively. / The natural average availability of water in this sub-basin is 5500 Mm^3.

7) Wardha

The river Wardha rises near Gavilgad (District Betul, Madhya Pradesh) in the southern part of Satpuda hill ranges at elevation RL 700 m. After traversing through Madhya Pradesh and Maharashtra, the river joins Wainganga River near village Chaprala at RL 150 in. This sub-basin comprises tributaries of Kar, Jam, Vena, Erai and Bembla. Length of this river in Maharashtra is 486 km. The sub-basin has an area of 22312 sq. km while area in Madhya Pradesh is 1932 sq. km. This sub-basin comprises area from Amravati, Yavatmal, Wardha, Nagpur, Chandrapur Districts from Vidarbha. Viewed from various counts, this sub-basin occupies a pivotal position in Vidarbha. The natural average availability of water in this sub-basin is 5633 Mm^3

8) Middle Wainganga

Wainganga-Pranhita is the largest sub-basin in Godavari Basin. Moreover, it is distinct from other sub-basins of Maharashtra in respect of its topography and geology. For the sake of planning, this sub-basin has been divided into two parts, viz. Middle Wainganga and Lower Wainganga. Wainganga River rises at Gopalganj near Shivni in Chhindwada District of Madhya Pradesh at RL 640 m and joins Godavari River after traversing a distance of 386 km. The Middle Wainganga sub-basin stretches across sub-basins of rivers Bagh and Bawanthadi along the border between Maharashtra and Madhya Pradesh.

The sub-basin encompasses tributaries Bagh, eastern Bagh, Bawanthadi, Kanhan, Sur, Pench, Nag, Kaular, Chandraprabha, Aam, Maru, Chulbandh, Ghadhvi, Khobragadi and Buti. This sub-basin occupies 21445 sq. km of Maharashtra and stretches across Nagpur, Bhandara, Chandrapur, Gadchiroli Districts.

The extent of catchment u/s of Maharashtra and which falls in Madhya Pradesh is 24837 sq. km. The extreme climate is characteristic of this sub-basin. The natural average availability of water in this sub-basin is 10026 Mm^3.

This is one of the few sub-basins where planning is linked with the water being released from upstream. The aforementioned availability is over and above 10589 Mm3 water which is averagely obtained from upstream. Thousands of historical tanks belonging to the Gond period still continue to provide water for irrigation to a far larger area. These are also locally also called as *malgujari* tanks in recognition to the *malgujari* system established during the British regime.

9) Lower Wainganga

This sub-basin comprises 3 component basins in Godavari Basin viz. (a) Wainganga-Pranhita (b) Inchampalli and (c) Indravati. After confluence of Wardha and Wainganga near Chaprala, the combined river course is further differently known as Pranhita. It further joins the Godavari River. Its total length in Maharashtra is 108 km. While the territory on left bank of the river is occupied by Maharashtra, the same on right bank is occupied by Andhra Pradesh. River Indravati rises at Kalhandi (Korapur) in Orissa State at RL 720 m and joins the river Godavari on its left at RL 82 m. The total length of Indravati river is 536 km while the length in Maharashtra is 131 km. After having entered into Andhra Pradesh from Maharashtra, the river Godavari reenters into Maharashtra near Inchampalli where its length is 50 km. This sub-basin comprises areas from Chandrapur and Gadchiroli Districts. The total area of these 3 aforementioned component basins is 14861 sq. km. The direct watershed areas designated as PR5, PR6 & PRJ of river Pranhita are included in Wainganga sub-basin to maintain geographic contiguity. Their total catchment area admeasures 233 sq. km. The natural average availabilities of water in component basins of this sub-basin are 6311, 252 and 3753 Mm^3, respectively.

This sub-basin is endowed with an abundant availability of water resources. The mountainous gradients of Indravati have also bestowed an excellent hydropower potential on this sub-basin. Inchampalli Project - one of those incorporated in the agreement between Maharashtra and Andhra Pradesh - is sited at the mouth of this sub-basin. This sub-basin is of key importance to the Maharashtra as far as both - irrigation and hydropower potentials - are concerned.

A portion on the eastern side of Gadchiroli District forms a part of Mahanadi River basin and has a drainage area of 290 sq. km. This area, however, is disregarded for over all planning.

10) Purna (Tapi)

This sub-basin comprises part of Satpuda hill ranges which are also known as Gavilgad hills. The river Puma rises in Bhaisedehi *Taluka* (Betul, Madhya Pradesh) in this part at RL 900 m which, after traversing a distance of 274 km joins Tapi at Muktainagar (Edlabad). The main tributaries of this sub-basin are Chandrabhaga, Shahanur, Pedi, Uma, Katepurna, Wan, Mun, Morna, Dnyanganga, Vaibhav and Nalganga. The total area of the sub-basin is 17575 sq. km which is spread over in Jalgaon, Akola, Amravati and Buldana Districts.

This basin has a large groundwater potential. However, this water cannot be used for drinking or for irrigation because of high salinity. Farm soils in this basin are also fertile but their potential can not be fully utilised because of lack of salt-free water. This problem and possible remedial measures therefor form the subject matter of Sub-basin 10 of Volume II. The natural average availability of water in this sub-basin is 2536 Mm^3.

11) Girna

The rivers Aaram, Punand, Panzra, Mausam, Manyad, Vitur, Anjani, Hivra, Bahula, etc., form this sub-basin. The river Girna rises in the Kem hill in Western *ghat* in Nashik District near village Hatgada at RL 900 m and joins river Tapi near village Nanded in Amalner *Taluka* of Jalgaon District. It has a total length of 265 km. The area encompassed by this sub-basin is 10195 sq. km and it is spread over Nashik, Jalgaon and Aurangabad Districts. The natural average availability of water in this sub-basin is 1551 Mm^3.

One of the most water deficit, this sub-basin is an almost fully developed. Priority will have to be given to measures entailing economic water use and possibilities of schemes i envisaging interbasin water transfers will have to be explored.

12) Panzra

The main river Panzra of this sub-basin is served by Jamkhed, Karjalnala, Kharanala, Kan River and Umranala tributaries. This sub-basin covers an area of 2729 sq. km spread over Dhule. Nashik, Jalgaon Districts. The length of the river Panzra is 136 km and it rises near Wasigaon at RL 132’ m and joins the main river Tapi at RL 1058 m. near Mudavad. The natural average availability of water in this sub-basin is 529 Mm^3.

By and large, this sub-basin too faces an acute scarcity of water. The well-known *Phad* Irrigation System had been well-developed in this basin and in mountainous tributaries such as Mosam, Aaram, etc., of Girna as well. It is still being practised presently at several places. A special consideration as to precisely what changes and improvements will have to be incorporated in the *Phad* system which taps only natural flow of water by building b*andharas* across these rivers after having constructed new storage dams of modern times thereacross is called for in the context of *bandharas* across rivers in this and those like 1 Mosam, Aaram, etc., in Girna sub-basin.

13) Central Tapi

The river Tapi is a west-flowing interstate river which rises in Multai hill ranges in Betul District at RI, 752 m. This is to be considered in 3 distinct zones. Only the southern portion of Upper Tapi (3243 sq.km) falls in Melghat of Amravati District. This portion is identified as Puma (Tapi) for the planning. This portion is included in Sub-basin. 10. After traversing a distance of 228 km in Madhya Pradesh, the river Tapi thereafter enters in Khandesh and traversing almost an equal distance thenceonward merges with Ukai Reservoir in Gujarat. Its 54 km length forms the common boundary between Maharashtra and Madhya Pradesh. An interstate agreement between Maharashtra and Madhya Pradesh is finalised for joint use of Tapi River water. Water utilisation of the Central Tapi sub-basin is dependent upon implementation of provisions of the interstate agreement. Two storage works required to be created for this purpose come under Upper Tapi stretch and the main storage work (Kharia Gutighat) is located in Melghat. The Central Tapi sub-basin can be divided into two distinct parts from consideration of topography.

(A) Tapi (Satpuda): The region of rivers Waki Gomai Arunavati, Aner in Dhule District and the tributaries - Gul, Mor, Tuki, Bokadnala in Jalgaon District lying north of Tapi is encompassed by the component basin. All these rivers rise in Satpuda ranges on north, of the State in good rainfall hilly zone at RL 400 to 915 m and join the main Tapi River at different places at RL 94 to 220 m. The sub-basins of Sapna, Garga, Khandru, Khapra Rivers in the Melghat area of Amravati fall in Upper Tapi part. However, for the sake of convenience a exposition they, too, are included in the Central Tapi (Satpuda) component basins. These rivers rise at RL 900 to 1135 m and join the main Tapi at different places at RL 257 to 907 m. This component basin has an area of 10206 sq. km which is spread over Jalgaon, Amravati, Buldana and Dhule Districts. As a matter of fact the rivers Panzra and Girna also emerge from south to join the Central Tapi. But lengths of these rivers are comparatively more than those others joining from south. As use of water that is available in both these rivers is, by and large, fully achieved and long-developed *Phad* Irrigation System has been in existence therein, those sub-basins are not proposed to be considered as a part of Middle Tapi and instead be proposed to be dealt with separately. The natural average availability of water y this component basin is 2868 Mm^3.

(B) Tapi (South): This component basin of Central Tapi comprises drainage area of Burai, Arunavati, Bori, Waghur, etc., which lie on south of Tapi. These rivers rise in Sahyadri and Ajantha hills at RL 600 to 750 m and join Tapi at different places at RL ranging from 121 to 135 m. The area of this component basin is 10599 sq. km and is spread over Nashik, Jalgaon, Buldana, Aurangabad Jalna, & Dhule Districts. The natural average availability of water in this component basin is 1634 Mm^3.

Though features of Tapi (Satpuda) component basin are somewhat different than those of Tapi (South) from planning point of view, they both are linked up with overall use of water of Tapi. A single sub-area is, therefore, proposed instead of two different sub-basins therefor.

14) Narmada

This basin group comprises 3 tributaries of Narmada, viz., Devganga, Khar and Udai. All these rivers rise in the fourth range of Satpuda at RL 600 to 875 m and join the river Narmada which flows along the north border of Maharashtra at different places at RL 50 to 300 m. The lengths of these rivers from their origins to confluence points are 36,22 & 90 km respectively. The total area of this basin group is 1048 sq. km and is formed mostly of dissected mountainous region. Akrani region from the newly-created Nandurbar District falls in this. The natural average availability of water in this sub-basin is 580 Mm^3.

The interstate Narmada Water Dispute Tribunal award has allocated 308 Mm^3 water from

Narmada Basin to Maharashtra. Planning of this area will have to be accomplished to ensure use thereof.

15) Upper Krishna (West)

It is proposed to include in this sub-basin the component basins of Upper Krishna (West-North)and Upper Krishna (West-South) amongst those of Krishna Basin. Rivers in both these components rise in the western hill ranges of Sahyadri and after flowing towards south-east join the river Krishna. This sub-basin extends on south upto the Maharashtra border. The RLs of origins and confluence points of these rivers and lengths thereof are tabulated in the following:

River	RL (m)		Length (km)
	Origin	Confluence	
A) West-North			
1 Krishna	1371	-	301
2 Koyna	1341	561	119
3 Varna	900	529	104
4 Panchaganga	532	520	83
5 Dudhaganga	901	534	69
6 Vedaganga	600	536	66
B) West-South			
Ghatprabha	838	680	59

Component (a) encompasses portion bounded by Sahyadri hill ranges and Krishna River in Satara, Sangli and Kolhapur Districts. Only area from Kolhapur District falls in component (b). Areas of these components are 13371 and 1745 sq. km, respectively. The natural average availability of water in this sub-basin is 21324 Mm^3.

Because of good drainage characteristics, this area is ideally suited to intensive irrigation. It is on the Panchaganga River in this area that a model system of lift irrigation on it series of weirs and regulation thereof on the lines of *Phad* System have been evolved.

16) Upper Krishna (East)

This basin group lying on the eastern part of Krishna River includes sub-basins of the rivers (a) Yerala & (b) Agrani as two component basins. Both these rivers originate in drought prone area and their entire courses run through drought prone area only. This basin group, therefore, experiences an extreme degree of uncertainty as far as water availability is concerned.

a) Yerala: The river Yerala rises in hill ranges on east of Krishna River in low rainfall area at Manjrewadi (Khatav) at RL 914 m and joins river Krishna at Brahmanal at RL 550 m. The length of the river is 125 km. The total area of this sub-basin is 3977 sq. km which comprises drought prone areas on eastern part of Sangli and Satara Districts.

(b) Agrani: The river Agrani rises even further east of Yerala sub-basin in low rainfall place of Venapur (Khanapur *Taluka*) at. RL 885 m and joins the river Krishna at Hulgabali in Karnataka at RL 549 m. The length of the river lying in Maharashtra is 97 km and the area encompassed by this sub-basin in Maharashtra is 1307 sq. km. This comprises drought prone area of eastern part of Sangli District.

The natural average availability of water in this sub-basin is. 217 Mm^3.

Compared to the extent of the area, the availability of water in this sub-basin is extremely meagre.

17) Upper Bhima (upto Ujjani)

This sub-basin comprises portion of main Bhima River upto Ujjani Dam and basin areas of Mula, Mutha and Ghod Rivers. The river Bhima rises in the Western Sahyadri *Ghat* at Bhimashankar in Ambegaon *Taluka* at RL 700 m whereas Mula River rises in Mulshi *Taluka* and

Mutha River rises in Velhe *Taluka.* River Ghod and its tributaries - Kukadi and Are - also rise in Sahyadri *Ghat*. The places of origins of all these tributaries of Bhima River lie in good rainfall region. Length of the Bhima upto Ujjani Dam is 275 km. It joins Krishna in Karnataka at Krishna (Raichur District). This sub-basin has an area of 14712 sq. km and is spread over Ahmadnagar, Pune and Solapur Districts.

Like Upper Godavari (upto Paithan Dam) sub-basin, this sub-basin is also advanced as far as industrialisation and urbanisation are concerned. It has a terminal storage at Ujjani. The pollution brought in through the entire drainage area will going to be an important issue f planning and regulation in the context of this reservoir. The natural average availability of water in this sub-basin is 7594 Mm^3.

18) Remaining Bhima

This sub-basin includes the component basins of (a) Neera and (b) Bhima downstream of Ujjani including Man. The Neera River, too, rises in Sahyadri. The development of irrigation on an extensive scale during the British regime has begun on this very river. Neera River originates near Shirgaon at RL 1170 m which after traversing a distance of 209 km joins river Bhima at Narsingpur at RL 463 m. The Neera component basin occupies an area of 7008 sq. km from Pune, Satara, Sangli and Solapur Districts.

The Man sub-basin downstream of Ujjani Dam forming a part of Bhima Basin also wholly lies in drought prone area like that of Yerala and Agrani. The river Man rises at Kulkajai at RL 900 m. It has a length of 154 km and it joins river Bhima at Sarkoli at RL 439 m. Rising in drought prone area, the rivers Bor and Doddanala too drain into River Bhima as does the Man. It is therefore, proppposed to undertake consideration of Man, Bor and Doddanala jointly with the area of river Bhima d/s of Ujjani. Their combined area is 10431 sq. km and is spread over Solapur, Pune and Satara Districts. The natural average availability of water in this sub-basin is 3281 Mm^3.

19) Sina-Bori-Benetura

a) Sina: The river Sina is like Manjra ,Yerala, Agrani, Man Rivers which originate in drought prone area and also flow through drought prone area Sina, Bori and Benetura lie to the east of river Bhima. Sina rises to the west of village Jewoor in Ahmadnagar District at RL 748 m and joins the river Bhima near village Kudala in Solapur District at RL 413 m after traversing a distance of 300 km. This river is joined by Mehekari, Talwar, Unchana, Kautika, Khairi, Haldi, Dudhana, Gorda, Bhogavati, Wadala, Ekrukh, Horgi and so on. These tributaries also rise in and flow through drought prone area only Sina basin is a very narrow sub-basin. Like Yerala and Agrani, it too is oriented in north-south direction. Since rain-carrying winds in Maharashtra mainly follow west-east or east-west orientation, the intensity of feebility of monsoon winds affects simultaneously the whole of the north-south region of this basin either in a good measure or adversely. As a result the intensity of drought or, in exceptional circumstances, of floods also is very severe.

b) Bori- Benetura: The river Bori rises in Tuljapur *Taluka* at RL 640 m and after traversing a distance of 122 km joins the river Bhima near Algadi (Karnataka) at RL 424 m. The basin of this river also includes that of its tributary, viz., Harni. The contiguity makes it probable to consider the tributary Benetura lying on east of Bori along therewith. Benetura rises near Malegaon at RL 661 m and joins Kagna near Malkhed (Karnatak) at RL 393 m. Kagna is a tributary of Bhima.

The natural average availability of water in this sub-basin is 1616 Mm^3.

20) Damanganga-Par

The Damanganga is the principal river in this basin which rises in Magunpada in Peth *Taluka* of Nashik District at RL 2694 m and joins the Arabian Sea near the town Daman. The length of Damanganga River is 90 km. Wal - a tributary of river Damanganga - rises at RL 373 m and joins it at RL 81 m. The basin of river Par which rises in Sahyadri ranges in Surgana *Taluka* of Nashik District at RL 1177 m is also included in this basin group. After traversing a distance of 49 km in Maharashtra it enters the State of Gujarat and after traversing a further distance of 83 km joins the Arabian Sea. Its main tributary Nar flows parallel to it in Maharashtra and joins it in Gujarat. The catchment area of, this sub-basin in Maharashtra is 2508 sq. km and encompasses mainly the tribal area of Nashik and Thane Districts.

The average precipitation that occurs in this sub-basin, is 2194 mm. This is a high rainfall basin. The natural average availability of water in this sub-basin is 4426 Mm^3.

21) North Konkan

This basin group includes basins of Vaitarna, Ulhas and Patalganga Rivers. The length of river Vaitarna from its origin to confluence is 171 km. It rises at RL 1300 m near Trimbakeshwar and joins the Sea at the Amala Creek. The river Ulhas rises at RL 827 m at Thakurwadi. After traversing a distance of 145 km it merges into the Bassien Creek. The river Patalganga rises near Dasturi at RL 822 m and after flowing for a distance of 54 km merges into the Dharamtar Creek. These three rivers together drain an area of 12063 sq. km which is spread over Nashik, Raigad, Pune, Thane, Mumbai & sub-urban area This sub-basin lies in high rainfall zone. The natural average availability of water in this sub-basin is 21369 Mm^3.

In the context of regional development of Mumbai Metropolitan area, tie joint consideration of water planning of this region is continually being pursued for the last few years. This whole area is exclusively identified as Mumbai Hydrometric Area and is conventionalised by that name. As the dense urbanisation and industrialisation being characteristics of this region, one independent committee appointed by the Government in Water Supply & Sanitation Department under the chairmanship of Dr. Madhavrao Chitale is pursuing its water planning in detail. Its report, too, is expected soon. One of the members of the Commission Dr. S.B. Kadrekar (formerly Vice-Chancellor, Konkan Agricultural University) has also been got associated with this committee as a special invitee for, coordination.

22) Middle Konkan

This basin group includes main rivers like Amba, Kundalika, Mhasala, Savitri & Bharja. River Amba originates at Jajemachi at RL 822 m which after flowing for a distance of 72 km joins Dharamtar Creek. River Kundalika rises at Hirdewadi at RL 820 m and joins the Sea at Revdanda. Bharja River rises at Devdongar at RL 536 m and after flowing for a distance of 45 km joins the Sea near Kelshi. This basin group encompasses an area of 5929 sq. km and is spread over Pune, Raigad and Ratnagiri Districts. This basin group too falls in a high rainfall zone. The natural average availability of water in this sub-basin is 15156 Mm^3.

This is a region of abundant water. Since this region is adjacent to the Mumbai Metropolitan Region, diverse activities entailing intensive water use which cannot easily accommodate the development planning of that region can readily be undertaken in this basin group. The consideration of this basin group will have to be undertaken along this line.

23) Vashishthi

This basin comprises areas from Chiplun, Khed, Dapoli, Guhagar *Talukas* of Ratnagiri District. The river Vashishthi flowing down the western slopes of Sahyadri originates at Tivre Village at RL 720 m and after flowing for a distance of 48 km joins the Sea near Guhaghar (Dabhol). This very basin also includes the sub-basin of the river Jagbudi which flows through Khed *Taluka.* The total area of this basin is 2233 sq. km. It belongs to heavy rainfall zone, the average rainfall being 3687 mm. The natural average availability of water in this sub-basin is 5496 Mm^3.

Besides, of 1911 Mm^3 water diverted westwards after hydropower generation from Koyna is available in this basin round the year. Thus this is a basin of abundant availability of water and this feature is required to be exploited fully in the planning of that basin.

24) South Konkan

This region of South Konkan is comparatively more narrow with high rainfall and is predominantly of lateritic rock. The southern portion of Sindhudurg District further down presents a geology quite different from that of Deccan Trap formation and exhibits different physical properties. It would, therefore, be more proper to consider the South Konkan in two different component basins for the set-up of planning of water.

a) Ratnagiri: This component includes Shastri, Kajvi and Muchkundi River basins. All the 4 rivers of these river basins originate in Sahyadri ranges at different places at RL ranging from 900 to 746 m and after traversing a distance of 70 to 64 km join the Arabian Sea. The area of this component basin is 4735 sq. km and lies wholly in Ratnagiri District. This component may, therefore, the called as Ratnagiri component basin.

b) Sindhudurg: This component includes areas drained by Kodavali, Waghotan, Devgad, Gad, Karli, Achara and those rivers which join the Sea near Vengurle. All these rivers originate in Sahyadri hill ranges and flow westward and join the Sea. The area of this component basin is 4285 sq. km. and is spread over Ratnagiri and Sindhudurg Districts.

The natural average availabilities of water in the component basins of this sub-basin are 11299 and 7317 Mm^3 respectively.

25) Terekhol-Tillari

This basin group comprises 2 separate basins of Tillari and Terekhol. They rise in Sahyadri hill ranges at RL 762 m (at Tudye) and RL 806 m (at Gutewadi) respectively and after flowing for distances of 53 km and 98 km respectively join the Arabian Sea. This basin group encompasses 1475 km^2 area of Maharashtra which lies in Sindhudurg and Kolhapur Districts.

This part also falls in heavy rainfall zone. The natural average of availability of water in this sub-basin is 4187 Mm^3.

Both these basins are interstate in nature and are linked with each other by virtue of the Tillari Joint Interstate Project and also through the planning of water and irrigation in the neighbouring Goa State. Therefore, it is going to be appropriate to consider both the basins as a joint group.

The estimates of water availability in various sub-basins presented in the foregoing are to be regarded as very broad ones. Precise comparison among those estimates is far from advisable. The reason is information which is available in various sub-basins and on the basis of which water availability is assessed, belong to different years. Moreover, some are based on river gauging while other are arrived at after establishing R and R relationship whereas at others a correlation between the both is used. Moreover, these studies are carried out in different contexts. Nevertheless, that information is enough to throw light on the state of affairs in general in respect of availability of water in relation to cultivable area and habitation. More accurate account of water will have to be aimed at here-in-after on the basis of hydrology of all these basins/ sub-basins for which separate organizations need to be made operational as early as possible.

It will be desirable from the planning and management point of view to have size of an individual basin ordinarily at par with that of a district, i.e., between 10000 to 15000 km^2. The Governmental set-up has acquired an enough skill of accomplishing planning of that much areal extent during the planning period extending over last four decades. However, for those border sub-basins of smaller rivers, which can not be easily included in the other adjoining areas from the geographical and interstate water accounting point of view, conferring a status of an independent sub-basin is suggested. By and large, there is a danger of overlooking the needs of sub-basins situated along the border of the State and thereby reinforcing the feeling in the public there of being neglected. It will, therefore, be desirable to pay attention to them by conferring an independent status on them as far as planning of water is concerned. Swarna and Sudha sub-basins (693 km^2 in Bhokar *Taluka* of Nanded District within Godavari), Narmada Basin (1048 km^2) situated on north of Maharashtra, Damanganga-Par Sub-basin (2508 km^2) in Surgana-Peth *Talukas* in Nashik District and the joint basin of Tillari-Terekhol west-flowing rivers (1475 km^2) along the Goa border - which are relatively of very small size but important from their interstate implications - are proposed to be recognised as independent in the overall sub-basinwise planning scheme of Maharashtra. On the contrary, there are a few sub-basins further fragmentation from the planning regulation point of view of which is not possible in the local context as the component basins of which they are composed are mutually dependent as far as planning is concerned. Therefore, a sub-basin having more than 20000 km^2 area is proposed to be of larger size instead of proposing it to be further divided. Painganga (21462 km^2), Wardha (22312 km^2) and Middle Wainganga (21445 km^2) are these larger sub-basins.

Barring the provisions mentioned in water allocation of interstate basins, needs pertinent to water account of sub-basins in case of which joint interstate projects are agreed upon as joint ventures are different. The management of Middle Tapi (Satpuda,), Middle. Wainganga, Lower Wainganga (Inchampalli & Indravati) and Terekhol and Tillari basins/ sub-basins is going to present a characteristic scenario on this count.

The priority and detailing as regards to uses of water in different basins are going to be different due to geological setting, fertility of farm lands, different .needs of industrialisation & urbanisation. The blending of these needs in different proportion prevents to suggest planning of all these basins on a similar footing. The executive system of different sub-basins will have to be evolved depending upon the stage of development of respective sub-basins.

Though the single usage as sub-basin is applied to all the 25 geographical units in the contents of the Report for the sake of presentation, several of them, in fact, are basin groups as far as hydrology is concerned. For example, Middle Tapi, Upper Krishna (West), Upper Krishna (East), Sina-Bori-Benetura. The geographical contiguity and similar climatic characteristics have led to suggest their combined consideration as a basin group in Volume II. None the less to facilitate identification, each has been referred to with a simple broader usage as a sub-basin only instead of calling as a basin group. Though there are 22 independent basins in Konkan from geographical point of view, the planning of water of Ulhas and all rivers associated with the Mumbai Metropolitan Authority area spread north-south of the former in North Konkan is suggested in a single geographical unit by name of North Konkan only. The same consideration has led to suggest the basin group on its south as a single geographical unit named Middle Konkan and that of further south in Ratnagiri and Sindhudurg Districts as South Konkan. The planning and regulation of river Vashishthi is linked up with water diverted from Koyna. Therefore, instead of including it in Middle Konkan or South Konkan, that basin has been kept with an independent identity as a geographical unit. The basins in Konkan are whole basins and independent planning of each one of them is possible. But because of similar disposition, instead of suggesting every basin as a different geographical unit in the overall planning of Maharashtra, basin groups of similar characteristics are suggested as a single geographical unit for planning of water. Throughout the contents of the report, the same word sub-basin is generally used to connote all types of sub-basin groups or basin groups for the sake of convenience in deliberation and presentation.

While suggesting a sub-basinwise set-up, the drainage areas of tributaries joining the main river in basins below dams alongwith irrigation areas alongside rivers being benefited from Paithan and Ujjani Dams, are considered as a whole. The reason is, the area on a large scale of these tributaries near the confluence is already falling within the commands of main canals of Godavari and Bhima from planning of water use point of view. Therefore, it is felt, it will be-proper to consider them alongwith the area bordering banks of main rivers instead of sub-dividing these small sub-basins.

The methods of planning of different sub-basins are going to be different in accordance with the type of geographical disposition and climatic conditions prevailing in the hydrological regime of rivers forming the respective sub-basins and not merely in proportion to the total availability of water therein. Especially the rivers Manjra, Sina, Bori, Benetura, Man, Agrani and Yerala originate in and entirely flow through drought-prone area only. As availability of water in them is very uncertain, it is necessary to have a different consideration as regards to the relation of developmental set-ups of these sub-basins with water. On the contrary, a very different consideration is in order in case of rivers like Wainganga with abundant water and which rise from assured rainfall area and entirely flow through assured rainfall area only. The extreme disparity does not make it possible to apply the same propositions of planning of water to all the sub-basins.

While undertaking consideration of sub-basinwise planning of water as outlined in the foregoing, a special attention will have to be paid to sensitive regional areas in some of the sub-basins. The disposition of administrative regions of Maharashtra is not attuned to the natural geographical units. Therefore some part of administrative regions falls in area of sub-basins belonging basically to other regions. However, a special care will have to be exercised which will obviate the negligence with which areas falling in sub-basins outside such regions is subjected to due to such geographical setting. In order not to neglect such units, it will be desirable to give an exclusive and increasing representation to the component basins in sub-basinwise planning committee (exposition on this will appear in Topic 3.4). It will be useful to transfer such areas - which belong to a sub-basin but fall outside the region - to the same sub-basin to which they belong when long-term administrative restructuring will be in the offing.

The basin of Painganga River is the largest interregional basin on this count. It is sandwiched between Vidarbha on north and Marathwada region on south. Also, the areas of Deulgaonraja and Sindkhedraja *Talukas* in Buldana District lie in Puma Basin. The Middle Tapi Basin covers Soyagaon *Taluka* of Marathwada. The Kannad, Vaijapur, Gangapur, Aurangabad and Paithan *Talukas* of Marathwada belong to Upper Godavari, The Sina Basin which is a component of Krishna Basin encompasses Ashti, Bhoom, Paranda, Tuljapur *talukas* of Marathwada. The sub-basin of Bori-Benetura cover Tuljapur and Omarga *Talukas*. The needs of component basins in other administrative regions will have to be properly taken into account while undertaking appropriate planning of water in respective sub-basins. It is expected that the same will be realised through the sub-basinwise set-up suggested for planning and regulation thereof.

Appreciating a large variation in water availability in basins, it is difficult though not impossible to create resource-use density in the same proportion for irrigation and other water uses in all the basins. It will appear proper to promote water-intensive crops, (e.g., sugarcane and banana), water-intensive industries, (e.g., chemical factories, thermal power generation stations), densely populated towns, etc., in sub-basins endowed with ample water availability. It will not be proper to promote such activities in water-deficit sub-basins. On the other hand pastures less water-intensive machine, manufacturing industries, transport. centres, commercial centres, educational centres, etc., will have to be thought of there on priority. Instead of adopting the social objective of equality in available water in the developmental pattern, it will be more practicable to accept the basic proposition of going in for appropriate activities ensuring increased social productivity and value addition in proportion to the available water.

Categorisation of Sub-basins on the basis of Natural Water Availability

3.2.4 (a) Water proves a key element where development of any region with the available natural resources is contemplated. The availability of water in planning proves conclusive especially in regions like Maharashtra where availability of other resources, (e.g., minerals, coal, oil, etc.), is not ample. Generally, there is a custom of adopting two indicators of this resource availability.

1 Per capita water availability
2 Per hectare (of cultivable area) water availability.

Seeing the economic status of and the rural life dependent on agriculture in Maharashtra, the Commission has advocated adoption of 'per hectare water availability' indicator mainly as a basis for planning. If categorisation of different sub-basins based thereon is undertaken, the planning based on water resources development will be quite clear. Of course, the features of planning and regulation will inevitably be different for different categories.

(b) The following main objectives will have to be kept in view while formulating use of water resources for development:

1 Productivity of water be enhanced;
2 Every land holding family in the State be economically self-reliant;
3 Agriculture-dependent community be made available employment at least 8 months in a year
4 Migration of farm labourers and farmers with small holdings taking place every year be prevented.

Assuming average rainfall, medium soils, normal climate, generally every land holder, it seems, necessarily be made available at least 3000 m^3 irrigation water per hectare for enabling him to harvest crops like jowar, safflower, gram, sunflower, Indian muster, Indian bean, cotton, pigeon pea in *rabi* after *kharif*. This requirement is other than that of rainwater agronomic basis of which is presented rather extensively further in Topic 4.2. Critique as regards this from the social justice point of view forms the subject matter of Topic 0 8.1 further. Ordinarily, if average water availability is short of 3000 m^3, it will not be possible for all to grow two crops (one of *kharif* and thereafter of *rabi*). Double cropping facility will be at the disposal of even less than half cultivable area in case less than 1500 m^3 per ha water is available for irrigation. The future planning as regards irrigation in Maharashtra as proposed, in this Report does not foresees any difficulty to support upto 50% cultivable area with irrigation by various means, it appears. Even that much area in those sub-basins which can not be made productive with the irrigation support are going to pose difficulty for management and will really be regarded as deficit sub-basins from planning and regulation point of view.

(c) On the other hand wherever water availability is exceeding 3000 m^3 but less than 8000 m^3 per ha, hot weather crops can be grown alongwith *kharif / rabi* in some parts there. Ordinarily, two excellent crops can certainly be grown. If more than 8000 m^3 water is available per ha, three seasonal crops (round-the-year production) can possibly be grown by adopting modern irrigation techniques. Where per ha water availability surpasses 12000 m^3, either water-intensive non-irrigation uses can be made to concentrate there or export of water (subject to economic viability) elsewhere can be thought of. As such, five preliminary planning categories of sub-basins from planning point of view can be possible.

Per hectare water availability (m^3)

Less than 1500	highly deficit area
1500 to 3000	deficit area
3000 to 8000	normal area
8000 to 12000	surplus area
Exceeding 12000	abundant area

As it goes, this categorization is a very broad one. Water actually being made available for irrigation is going to vary in accordance with the needs on account of non-irrigation uses. Nevertheless, it is intended to control this need skillfully in deficit and highly deficit areas.

Categorywise regulation features of sub-basins are as follows:

1. **Highly deficit area**
   Need of economically viable interbasin water transfers. Sanction to drip irrigation and less water-intensive crops only. Perennials barring Horticulture be totally forbidden. Less water-intensive economic activities be promoted.
2. **Deficit area**
   Reappraisal of cropping pattern and promotion to less water-intensive crops and drip irrigation.
3. **Normal area**
   Emphasis on reuse of water is necessary. Groundwater supported perennial crops may be allowed exceptionally.
4. **Surplus area** Blanket permission to perennial blocks of crops.
5. **Abundant area**
   Liberal planning of water use. High water-intensive industrial projects / nuclear reactors / thermal power generation be promoted.

(d) It is observed through the pilot study conducted at an international level that well being of people is compromised if per capita water availability drops down than 1000 m^3. Per capita availability of 1700 m^3 is considered as satisfactory. If the same is reduced to 1000 m^3, hardships are set in. These include uses of water for various purposes (agriculture, industry, urban use, etc.), of human life. The requirement on count of livestock necessary to support the masses is also being fulfilled therefrom.

(e) If status of sub-basins in Maharashtra is assessed on the criterion of all out needs as such it appears that the state of water availability less than 1000 m^3 per capita already exists in some sub-basins / component basins, (e.g., Girna, Panzra, Middle Tapi - South, Yerala, Agrani, Sina, etc.). The same state is likely to be created in a few more sub-basins / component basins. Balancing of various uses of water in such basins will have to be based on criteria of maximum accrual of returns from water instead of keeping it limited to the objective of mere irrigation expansion. Therefore, the criterion based on population will also going to be important as such for further planning in sub-basins / component basins only next to the categorisation based on irrigation requirements. However, the primary categorization of sub-basins does not seem to be based on that criterion as in majority of sub-basins per capita availability of water is exceeding 1000 m^3 today. Nevertheless, a note to the effect that per capita water availability in majority of the sub-basins is going to be less than 1000 m^3 by 2030 will have to be taken today only while accomplishing planning of future period. (For example: Upper Godavari, Lower Godavari, Painganga, Purna - including Dudhana, North Konkan, etc.).

(f) Moreover, the finding of study conducted by UNO in 1997 is like this: Where entailed water use starts exceeding 40% of the average annual availability of water, the variability in annual availability creates scarcity in the region. On Maharashtra scenario, sub-basins which are already reached to this stage are Upper Godavari, Girna, Yerala, Agrani and Sina. Therefore, the prospective comprehensive planning of these sub-basins will call for extra caution hereafter.

Area, population and regulation features of various categories suggested in case of sub-basins based on natural availability of water are indicated in Statement 3.2.2.

Ultimately, the State Government will have to possess its own powers to accomplish sub-basinwise planning to approve it and to undertake management thereof or implement the same. Also, the planning body and the implementation or management set-up will also be vested with some powers. In particular, powers as to forbidding people not to misuse water resources or guarding against pollution and imposing penalty or punishment for those who violate will have to be, conferred. Exposition as to amendments to acts incorporating provisions to that effect will be found in of Chapter 8.

3.3 Sub-basinwise Planning - Policies & Principles

3.3.1 Sub-basinwise planning is to be accomplished to achieve optimum development of water resources and to realise sustainably beneficial management. Both these subjects are quite involved exhaustive and multidisciplinary. Moreover, there is a diversity among the sub-basins in respect of factors such as geographical disposition, climate, rainfall, types of soil, ways of land holding, population, per capita water availability, history of irrigation, current status of irrigation development, unutilised irrigation potential, cropping patterns & agricultural productivity, means of transport, industry & commerce. The planning of respective sub-basins should reflect this diversity. Therefore, planning of water of all sub-basins is, not going to be of the same pattern or similar. In fact, that very distinctness calls for carrying out the planning process by going down to the sub-basin unit. Only by resorting to this planning/of water is going to be near to reality. Notwithstanding this, the paradigms of development and management of water resources, their objectives and standards or norms of measuring them will basically be similar in respect of all sub-basins. Irrespective of the distinguishing elements, all such factors of development and management will have to be taken into consideration while accomplishing planning.

The water resources embrace in its domain the excellent quality water - surface as well as sub-surface - physical system of storing and conveying the same such as (dams & canals respectively) and by all means hospitable & favourable pure environment necessary for human life in the context of water. The development implies conservation of water resources, its augmentation, improvement in water quality, protection of pure environment, pollution control and optimum & beneficial use of water to be entailed for different purposes.

3.3.2 The manner in which planning for development and management of water resources in the sub-basin is being carried out is going to govern the pace of economic development and its direction. In sub-basins such as Upper Godavari, Sina, Manjra, etc., where water shortage is already being experienced, the entire process should necessarily be undertaken forthwith. Demand for water is going to be on an increase day by day due to population growth and profuse growth of urban population & industrial expansion in itself. Quality of water is going to decline. The future well being of sub-basins will depend on the manner in which these challenges will be faced in respective sub-basins. Sub-basinwise planning will have to be accomplished taking into consideration all those challenges. Some years will elapse before a detailed comprehensive planning and its implementation are accomplished. If immediate action is called for in case of some issues, forthwith pursuance thereof will have to be undertaken and planning comprehensive in character will be realised progressively.

Good sub-basinwise planning will be constituted of four ingredients:

1. A lasting and effective institutional framework.
2. Establishing socially cooperative relations bridging different elements in the entire sub-basin and supportive institutional forum.
3. Scientific foundation (to adopt good policies and to find appropriate solutions) and a set-up to compile necessary pertinent information.
4. Effective participation of society through different institutions, organisations and commitment to sub-basinwise planning.

The chief objectives of water resources development will generally remain applicable mostly equally to all the sub-basins. For example:

1. Optimum use of water resources in a sub-basin be achieved and maximum possible number of people in the basin should go on accruing benefits thereof.
2. Agricultural production and productivity should continually increase owing to proper and economic use of water.
3. Industries, and that too agro-industries, should foster increasing thereby employment.
4. Environment be prevented from becoming polluted and socio-economic development of people in a sub-basin should continually take place.
5. Conjunctive use of surface and groundwater be practised and the modality of management should be attuned to that.

Besides this, decentralisation of population and crowding in sub-basins like North Konkan will remain the main objective whereas the additional main objective of scientific forest development will remain applicable to sub-basins like Narmada and Lower Wainganga (Indravati, Inchampalli).

3.3.3 Though planning of water resources development is a part of comprehensive areal development of that sub-basin, the development of only those sectors which have a direct bearing on the planning of water resources development be mainly considered. For example: drinking water, quality thereof, public health, agriculture, irrigation, watershed area, hydropower generation, marketing and export arrangement for agro-produce, fisheries, lake-related tourism and so on Quality of water will continually be observed and monitored, with an especial consciousness.

Other functional sectors of development, which have no Close connection with water but are important, will be looked after by executive agencies related thereto. Broad spectrum of information pertinent to them will have to be kept at hand. However, an in-depth study of long-term planning of those subjects is not necessary to form a part of water resources planning. Instead, water resources and those developmental sectors which are closely and directly related to it will have to be taken for an in-depth analysis and the available alternatives be carefully weighed upon. Only such efforts will enable to find sustainable cost-effective solutions to problems in water resources development. Planning of water resources can have an impact on planning of development of other sectors. The planning should incorporate exposition as to these possibilities and suggest remedial measures therefor. Every micro-watershed area should be considered as an independent unit (especially in the context groundwater planning) in planning of sub-basins.

3.3.4 Pursuance of all principles of comprehensive planning of water, which are stated in the National Water Policy (1987), will have to be followed while accomplishing planning of a sub-basin. For example:

1. (Para 10. I) Irrigation Planning either in an individual project or in a sub-basin as a whole should take into account the irrigability of land, cost-effective irrigation options possible from all available sources of water and appropriate irrigation techniques. The irrigation intensity should he such as to extend the benefits of irrigation to as large a number of farm families as possible, keeping in view the need to maximise production.
2. (Para 3.1) The water resources available in a sub-basin should he brought within the category of utilisable resources to the maximum possible extent. The resources should be conserved and the availability augmented by measures for maximising retention and minimising losses.
3. (Para 3.5) Recycling and reuse of water should be an integral part of water resources development.
4. (Para 15) The efficiency of utilisation in all the diverse uses of water should be improved and an awareness of water as a scarce resource should be fostered. Conservation consciousness should be promoted through education, regulation incentives and disincentives.

3.3.5 Three types of challenges will be required to be faced during the forthcoming century.

1. Water scarcity resulting due to various factors;
2. Pollution arising from various sources;
3. Diminution in water-related productivity because of various reasons.

Besides these three challenges, the financial challenge is also there. The basinwise planning may help face those challenges effectively.

The planning of water resources development will have to be accomplished by respecting the national, provincial and local perspectives. The planning should be realised in the framework of today’s objectives and also by considering the prospective status and needs.

Besides this, coordination in the management of projects in a sub-basin will have to be achieved. Irrigation area can be enhanced through such a coordinated management. Also, the overall reliability of irrigation can also be increased thereby. While selecting new projects, the formulation will have to be carried out by taking into consideration the coherence of the system as a whole. Isolated thinking is not going to help resolve meeting the competing demands.

3.3.6 The extents of major river basins in Maharashtra are quite sizable from the planning and regulation point of view. The areawise distribution is like this: Tapi Basin - exceeding 50000 km^2, Krishna - 69000 km^2 , Godavari Main (excluding Wainganga) - 78762 km^2 whereas exclusive Wainganga-Pranhita - 74049 km^2. To maintain an account of surface and groundwater of such a large region and to accomplish regulation thereof is practically difficult though not impossible. Especially, to infuse an organisational coherence in all the aspects such as changing flows in rivers during post-monsoon period, fluctuations in groundwater table, water being lost from tanks due to evaporation and from other area through use, and economy measures to be employed, etc., on such a large area are also difficult scientifically. Moreover, every main basin is studded with 100-150 large dams. To systematically account for water use of reservoirs impounded by those dams, to extend guidance to them regarding seasonal water use are also tasks beyond capacity. Therefore, it will practically be more proper to establish a procedure of accomplishing planning and regulation of sub-basins extents of which are generally around 10000 km^2. The division of Maharashtra into 25 different sub-basins is suggested from this viewpoint only. Barring the need of keeping separate identify of a few very small sub-basins so identified for the sake of interstate implications, the other 19 sub-basins are within 6000 to at the most 22000 km^2 areal extent. It is felt that maintaining scientific and detailed accounts and accomplishing planning and regulation thereof will be a practical possibility, if efforts are exercised. It will be desirable to set up a sub-basinwise planning and regulation committee for each of the sub-basins by enactment and entrust it with all the functions of planning and regulation of water as mentioned in the foregoing para.. A single joint planning and regulation committee for 2 or 3 sub-basins will initially do for Middle Wainganga, Lower Wainganga (Indravati) sub-basins full development of which has not so far been accomplished. Nevertheless, appointing immediately planning and regulation committee with full responsibility is necessary for most of the sub-basins (12 sub-basins including Upper Godavari, Lower Godavari, Upper. Krishna-West, Upper Krishna-East, etc.).

This committee should necessarily be of an interdisciplinary nature. It would be headed by an officer who is expert and trained in hydrology. The full-time members to be included in the minimum will be from experts in agriculture, irrigation, groundwater economics disciplines. Moreover, representatives from the existing water users' organisations and bodies will be inducted in that committee. By conducting atleast one meeting in two months, the committee will shoulder the responsibility of maintaining an account of all water and accomplishing planning and regulation thereof that is compatible to the respective seasons. An independent post of the Chief Engineer, Hydrology Project has already been created at Nashik in the Irrigation Department. The offices of this committee can function under the technical guidance and administrative control of that Chief Engineer. The office of this committee will be that of the Executive Engineer who is functioning as its Secretary. The committee will convey its views to the Chief Engineer by holding deliberations over the whole development scenario of a sub-basin whenever proposals as to new water uses in the respective sub-basin are received by the committee. The same will also be informed by it to the organisations and departments which accord approval to the concerned projects. Exposition as to this very purport will be found further in Topic 3.4.

One statutorily invested standing set-up designated as *'Maharashtra Jal Aayog'* is necessary at the State level also to help evolve a proper procedure of accomplishing such sub-basinwise planning and regulation, to extend guidance thereto and to keep a watch on the work of the committee.

Integrated Management of Water & Land

3.3.7 Soil conservation is already implied in water conservation. Soil is a non-renewable resource. Moreover, appropriate management of land and soil, to a large extent, leads to water conservation also. Therefore, more attention is required to be paid to the good management of land and soil. Therefore, watershed development works, afforestation in waste and other lands and adequate provision in commands for drainage are the important ingredients of basinwise planning. The management of both the resources in a sub-basin - land and water - should be an integrated one. In the National Water Policy, emphasis is laid on close integration between water and land uses.[4] The resource strategy of the development should undertake an integrated consideration of land productivity and water resources. The planing and management should be such as to enable continual enhancing of land productivity. Accomplishing optimum use of water and land or optimum combination of diverse uses will be the main objective of planning. Both types of needs - short-term as well as long-term - will have to be coped with. The optimum use of water and land should involve consideration of interests and well-being of all people. Care will have to be exercised to retrain from making use of resources for few people and entailing loss to more Care will also have to be exercise in resource use planning which will not compromise the interests of common people.

Water Conservation

3.3.9 Scarcity of water is being experienced even today in several sub-basins in Maharashtra. The population growth will lead to experience water scarcity in a few more basins during coming 10-15 years. Water will have to be guarded as a scarce resource from the viewpoint. Its use will have to be entailed in an economic way. Refraining from all types of wastage of it is called for. Adoption of irrigation methods entailing economical water use like drip or sprinkler will have to be insisted upon. There is now a dearth of new sources which can he tapped for obtaining water. Their development will be more capital intensive now on. Comparatively more technology and experience will also be necessary therefor. In that context, it will now be mistaken to assume that water is a resource of meagre value. The future human life will beset with a never-failing effect of adverse effect of misuse or wastage of water. The development process of people in drought-prone area will see by far the greatest importance attached to water during the coming 25-30 years. Therefore, people will have to adopt techniques which will entail maximum use out of a small quantum of water. Agriculture is, by far, the highest (80 to 90%) user of water. Water use efficiency is low. It is foremost necessary to improve it.

Pollution

3.3.9 The irrigation boosts up foodgrain production. The prices come down. Employment is increased.. However: problems detrimental to land and environmental pollution arise if sufficient care is not taken. Land becomes waterlogged. Soils are rendered saline. Groundwater is contaminated. By considering all these in the basinwise planning, both types of measures and controls - short-term and long-term - should be suggested to overcome the impending dangers. Planning and management of water should lend an equal importance or rather more to the water quality than the measurement of water. Quality of water and purity of environment call for far more importance from the public health point of view. Therefore, amongst all other factors foremost priority will have be given to it. Unless environmental pollution and especially water pollution is avoided, no development that is going to take place will be sustainable. Both, the surface

4. National Water Policy. 1987. Para 10.2.

as well as groundwater will have to be regularly monitored for quality. Wherever pollution is manifested phased programme of improving water quality will have to be undertaken. Its action plan will be based on modern science and technology. The effluent and wastewater resulting from the increased industrial development are polluting the available water sources. Wholly untreated or partly treated sewage, chemicals used in farming and industrial wastewater are the reasons to which that is attributed. If quality of water is adversely affected, its ill effects can take place on lives of millions of people and the society has to pay a very high price therefor. Especially, if groundwater is once polluted, it is very difficult to eradicate it. Moreover, the technique of getting rid of pollution is also cost-prohibitive. Water scarcity, water pollution, declining water-related land productivity and other various factors will, therefore, have to be paid a vigilant attention.

The process of achieving economic development through water resources management should incorporate a clear set-up which ensures protection of tanks and lakes. Unlike rivers, the tanks possess a closed system. Once they are subjected to pollution, it takes several years to remove it. As the water quality of tanks as such is fragile, its management will have to be accomplished more carefully as compared to that of rivers/*nallas*. All processes taking place in their catchment areas will have to be vigilantly kept watch on.

Capable Management

3.3.10 The management of water will have to be capable to ensure saving in water, making optimum use thereof, obviating wastage, avoiding pollution and so on. It is estimated that effective management will save at least 25% water. The cost of saving will amount to billions of rupees if compared with the capital expenditure being incurred on storages in new projects. Besides the optimum use of water will increase the pace of agricultural and economic development-an added advantage of an effective management. From that viewpoint, programmes of entailing economical use of water in a sub-basin should be framed and it be accepted as an important basic element of future effective management of water resources. The sub-basinwise planning should lay emphasis on the creation of auxiliary public organisations for its effective implementation and increasing efficiency thereof. The increasing responsibility of management of water resources at local level should have been allowed to rest with the local functionaries by providing encouragement to them. Such local public bodies should have an active liaison with The departmental management and only through that a long-term developmental resource strategy should be found and an action framework be evolved.

The sub-basin specific planning of various measures to be undertaken to enhance productivity of irrigation water will have to be accomplished by considering the local priorities. It will be of foremost importance to minimise the loss taking place through evaporation in deficit sub-basins. Instead of going in for low-value crops, it is urgently necessary in all the sub-basins to produce high-value crops which are amenable to the climate and water availability of respective sub-basins. Incorporating changes in the cropping pattern in different basins from that viewpoint will have to be paid an immediate attention. Various methods and techniques of irrigation are now at hand. Enhancing productivity of water through that is possible. The productivity can be enhanced also through conjunctive use, of canal and groundwater, a good water management, adoption of drip-sprinkler irrigation, genetic improvements in crops, etc. Similarly, new varieties of crops which are highly drought or salinity tolerant will also improve the productivity once they are brought in practice.

Drought Proofing

3.3.11 Several sub-basins encompass extensive drought-prone areas. Large scale water conservation works will be required to be undertaken to reduce the degree of drought-proneness and to preserve soil moisture. Moreover, less water-intensive fodder, pastures, forests or other means of development in lieu of conventional crops will have to be promoted there. While undertaking planning of projects for water resources development, the needs of drought prone area will be the priority. Industries and works which will not especially suffer due to water deficit will have to be taken up to provide permanent employment to people in drought prone area. The Sukathankar Committee in 1973 and the Subramhanyam Committee in 1981 have suggested numerous measures for drought proofing. An emphasis thereon will have to be given for drought prone area in a sub-basin. Such works were continued to be executed for last several years in drought prone *talukas* of Pune and Sangli Districts.

Criteria of Water Availability

3.3.12 The extent of scarcity can be determined by viewing the existing supply and the capacity for supply or by considering today's and tomorrow's demands. A pilot study carried out on an international level in this respect has suggested norms for scarcity of water. Scarcity of water adversely affects the well being of people if per capita annual availability of water falls below 1000 m^3. Per capita annual availability of even lower than 500 m^3 basically causes hardship to living beings. These norms of water availability will have to be used in sub-basinwise planning as standard indicators. A study conducted for the UNO in 1997 named World Water Demand and Supply (1990-2025) revealed that if annual withdrawal happens to be more than 40% of the available water, water scarcity starts experiencing in that area Judging the scenario in Maharashtra, most of the sub-basins have already reached this stage. Therefore, it is urgently necessary to bring into action sub-basinwise planning and regulation committee there.

Statutory Provisions

3.3.13 In Maharashtra, people's local organisations which are vigilant about water management are far less in number. Inventory of water resources or information / statistics pertinent to that is also not available locally. Therefore, the social organisations are incapacitated to assist in designing or policy making at local level or to keep a vigilant eye on water resources use Secondly, no legislative provisions to exercise control on use of water resources are at hand today. The provisions for planning, effective management and effective control should therefore be got incorporated in the acts. The sub-basinwise planning and regulation committee shouldering that responsibility should be legally empowered for carrying out those works. Powers as to undertaking planning, gathering information, verifying demands of private farms/factories, etc., will have to be invested. Powers as to inviting comments of people or objections on proposals forming a part of planning by making its draft public, instituting hearing therefor, if necessary and taking decision thereon will also be required. Once the planning or proposals contained therein are approved within the powers conferred by an act, they should be binding on all people and those whose interests are at stake. The provisions in the act will have to incorporate amongst others powers which would enable to exercise control on the quality of surface or groundwater, constraints on use, constraints on crops or drainage system and also the provision to appoint an officer to exercise the same. The orders issued by those officers using powers of exercising control will have to be binding on those concerned. Powers to undertake action necessary to implement those orders will have to be conferred by the act. A system to go in for an appeal against such orders should also be there. A detailed exposition as to this will be found further in Chapter 8.

Sub-basinwise planning and regulation is not that way an easy task. Retrospection of experiences in water management practised especially in Maharashtra so far reveals that projectwise planning is still in practice in the State. The regulation also is left with numerous shortcomings. Considerable scope is there to enhance efficiency pertinent thereto.

Similarly, several shortcomings are there in watershed areawise planning and regulation of groundwater. It is an urgent necessity to improve upon it. Under such circumstances, a switch over from the confined unit of a project or watershed, to a more extensive and wider sub-basinwise planning is required to be effected due to the pressure of lastly taking place development. But before aggravating the disorderliness in use and development of water resources, it is necessary to urgently take steps from that viewpoint. Therefore, it is very necessary to set up forthwith sub-basin specific planning and regulation committees as suggested in the foregoing para.

3.4 Management of a Sub-basin

3.4.1 The total irrigation potential of Maharashtra State Has increased 12 fold during the post-independence period. The development of irrigation potential that has taken place in Maharashtra during the 50 years period from 1947 to 1997 is indicated in Annex 3.4.1.

The total territory of Maharashtra is divided into 5 major river basins in undertaking basinwise consideration. The basinwise irrigation potential created is shown in Annex 3.4.1.

Existing Management in Maharashtra

3.4.2 The highermost share in the created irrigation potential goes to the schemes of the Irrigation Department. The growth of that department has also taken place on a large place therefor. At present the following establishment is functional in Maharashtra to carry out investigation construction and operation / management of irrigation projects:

Sr. No.	Establishment	Number	Controlling officer
1	Regional offices	11	Chief Engineer
2	Circle offices	56	Superintending Engineer
3	Division offices	292	Executive Engineer
4	Sub Divisional offices	2100	Sub Divisional Engineer

The Irrigation Department at Mantralaya level, basinwise irrigation development corporations and organisation such as Maharashtra Engineering Research Institute (MERI), Central Designs Organisation (CDO), Water and Land Management Institute (WALMI) and Directorate. Irrigation and Research and Development are all functioning independently to exercise control and to assist these field offices. Besides the *Zilla Parishads* execute the construction and management of minor irrigation schemes. One Irrigation Division under the control of an Executive Engineer is functioning thereunder for irrigation and other water-related development. The powers of according administrative approval to percolation tanks and village tanks being constructed through Employment Guarantee Scheme rest with the Revenue Department whereas reservation for drinking water through tanks under the control of the Irrigation Department is being managed by the Collectors only. Besides, the control on water in tanks constructed merely to meet the drinking water and industrial needs is exercised by *Maharashtra Jeevan Pradhikaran*, Maharashtra Industrial Development Corporation, municipal corporations or private organizations like Maharashtra State Electricity Board; Tata Hydro Electric Company, etc. The works of watershed development area are being handled by the Rural Development and Water Conservation Department. The planning and control of groundwater development works are being independently carried out by the Groundwater Surveys and Development Agency. As such the powers of according approval for creating new tanks / water storages and exercising control on water therein or groundwater recharge and utilization thereof have been dispersed amongst officers and organizations of different departments. Lack of coordination amongst them appears to be quite conspicuous. Powers of according administrative and technical sanctions to new works appear to be dispersed all over in Maharashtra. A few works are being administratively approved by *Zilla Parishads* whereas a few fall within the purview of Collectors or Revenue Commissioners. The competency of existing powers of according administrative and technical sanction is indicated in Annex 3.4.2. Besides, the powers of giving permission for lifting water from river courses are being availed of by the Irrigation Department in the notified areas of irrigation or other projects and by the Revenue Department in other cases.

Different organizations as such are functional in the same sub-basin. A good dialogue amongst them in respect of tendering approvals to new works or the cumulative use of water is called for.

Exigency of a Well-controlled Basin Management

3.4.3 As the stress of water is going to be on an increase, the need of a strong set-up creating new water storages and controlling uses thereof by maintaining a comprehensive account of water availability is going to be felt more acutely here-in-after. While small and big darns are being constructed, watershed area development is being accomplished and groundwater draft is being increased in different basins/sub-basins in Maharashtra, a realistic and consolidated account of water use will have to be maintained in detail. Out of 125.94 billion of total water that is available for use in Maharashtra, planning and use of 69.16 billion m^3 (through completed, on going, under construction and planned in future projects) water has so far been ensured. The storage capacity of tanks has also been planned upto 58 billion in Therefore, the creation of new water storage schemes or an appropriate regulation of water use in respective seasons by ascertaining availability of water in different seasons every year is going to be more cumbersome. A few watershed areas have been rendered overdeveloped besetting difficulties. If the use of water goes on increasing without paying any heed to water that is available and to the need on count of various uses, the management will be reduced to chaos. While entailing use of water and accomplishing planning the yearwise and seasonwise planning, and management of water will have to be carried out by maintaining a proper account of needs and use of water taking place on u/s and d/s of the same river or tributary. Moreover, there is a great danger of becoming the atmosphere there to be one of suspicion and uncertainty about various works and undertakings because the residents in basin are not having a clear idea about the consolidated scenario of the basin while creating new storages or establishing new systems of water use in the same basin. All planning and management of water should necessarily be transparent therefor.

Basin Control Set-up

3.4.4 (1) Formation of basinwise development corporations: It is necessary to have an effective set-up undertaking planning and exercising control over water in each of the sub-basins in Maharashtra so as to obviate the situation leading to chaos and confusion in planning and management of water. Such type of sub-basinwise control set up should be entrusted with the responsibility of maintaining an entire account of the water availability and use thereof in respective basins. No powers as to entailing use of water for whatsoever purpose or creating any new system entailing water use without its consent should be there.

Of late, the Government had constituted irrigation development corporations for Krishna, Godavari & Tapi Basins and Konkan & Vidharbha Regions in Maharashtra. These corporations are, entrusted with the responsibility of accomplishing development of water resources of respective basins for irrigation. Under such circumstances either they will be devolved on the responsibility of accomplishing appropriate planning and regulation of water in respective basins by inducing changes in their jurisdictions and responsibilities and vesting them with wider objectives and powers or an independent agency may be set up which will look after sub-basinwise planning and management of water. If it is intended at all to widen the responsibility of basin development corporations, the most important amendments will pertain to jurisdictions and functional ambits of these basin development corporations.

In case it is decided to devolve the entire responsibility of water in basins on respective basin development corporations, the responsibility of maintaining whole account of water availability and use thereof and regulating water use in every season will have to be entrusted to them. Powers according approval to new small or big projects will also have to be vested- in them. The existing functions of the corporations will have to be made wider as outlined in what follows:

1. To maintain projectwise tally and account of overall availability of water and use in a basin.
2. To regulate creation of small or big tanks, wells, tube wells, etc., by maintaining their account and to accord sanctions to new water uses.
3. To properly regulate use of water in different seasons by keeping a record of all water storages in a basin.
4. To arrange for reservation of water for drinking and industrial uses by comprehensively considering its availability and demand every year and to make available the same through a - well-provided system.
5. To give permission to new sugar factories or to enhance capacity of existing sugar factories by taking decision as to whether water is sufficiently available in the basin for the production of sugarcane needed therefor.
6. To achieve equitable water distribution from storages to all projects in basins during a deficit year.
7. To ensure use of available water in a basin and its reuse in an appropriate manner.
8. To look after maintenance, repairs and safety of all dams in a basin.

As the foregoing functions are not presently included in the enactments of irrigation development corporations, a comprehensive amendment to that effect will have to be carried out by an act. The present formation of corporations has been effected by keeping in view some limited objectives. There works have also not yet gained momentum by following these objectives entirely all over The overall working system of corporations has yet to be stabilised by having to, undergo a difficult process like that of capital raising and its repayment. Therefore, instead of thrusting them now with some additional involved responsibilities anew, it will be desirable to go in for the alternative of entrusting the more intricate responsibility of integrated planning and regulation of water with an independent set-up by keeping aside at present there characteristics of specified constructions and project management. It will be desirable to set up a different system progressively for the sub- basin wise coordination work during coming ten years instead of engaging in this new system just now the corporations formed basically to impart momentum to construction of new projects. The basinwise corporations entrusted with the responsibility of creation and management of irrigation projects and the water management set-up established for sub-basinwise planning - development - regulation can be amalgamated in due course thereafter.

(2) Basinwise Water Management Set up: There are five major basins (including Konkan basin groups) in Maharashtra. Water management set up in each of these basins will he necessary hereafter on the line which prompted to establish the new 5 basinwise irrigation development corporations to give impetus to their water and irrigation development. Such a set-up in these basins should be under the control of officers of the rank of a Superintending Engineer. All these officers should be under the administrative control of Water Resources Investigation and Planning Wing within the Irrigation Department of the Government. The Chief officer of this set-up at Maharashtra level should be of the rank of a Chief Engineer. This Chief Engineer will be a permanent invitee of the proposed *Maharashtra Jal Aayog* (=Commission). One *Jalsampatti Pradhikaran* (= Authority) is already functioning under the chairmanship of the Chief Minister at the State level. The responsibility of formulating a plan of overall water use in Maharashtra should be entrusted to it. The chairman of the *Maharashtra Jal Aayog* should be an ex-officio member of this authority.

(3) Maharashtra Jal Aayog : These 5 irrigation development corporations have basically emerged from the already existing establishment in Maharashtra and it does not appear desirable to introduce radical changes in its working method just now. No set-up at present exists which ascertains whether a systematic account of water is being maintained or not. In order to exercise caution for ensuring meticulous basinwise accounting by getting rid of the chaotic situation in annual water availability and use thereof, it appears necessary to have an independent and standing set up at the State level on the line of the Central Water Commission. This set up can be called as ***'Maharashtra Jal Aayog'***. This commission should scrutinise whether concerned organizations are properly observing their assigned functions or not by keeping a watch on water availability and use thereof in sub-basins and the consolidated scenario of water status in the State should be submitted to the Legislative Assembly every year by way of a report. No water use be approved anew in any of the basins or no changes in it be introduced without the prior approval of this commission.

The nature of this commission should be independent like that of the Public Service Commission. The members of the commission should not hail from politics or administrative services. Reputed, experienced and non-governmental persons who are knowledgeable in the concerned subjects & experts of well standing should be members of the commission. The secretary of this commission should be a full-time officer of the rank of a Secretary of the State. He should be assisted by requisite number multi-disciplinary expert officials & staff. The chairman and members of the commission should provide services as a - part time-advisors and need not be full-time functionaries. This commission should convey its counsel to the Government pertinent to the changes in new or existing water uses undertaking scrutiny of various basinwise proposals received regarding the water use. The commission should also undertake scrutiny whether use of water and utilisation of irrigation potential in each basin in the State is being achieved properly and in an integrated manner. By holding a meeting once in two months this commission should undertake a review of the water status and proposals pertinent to that and convey its views to the Government.

The function of presently existing Maharashtra Water and Irrigation Commission will soon be over. If the Commission's Office is converted into an office of *Maharashtra Jal Aayog* it will be possible to get benefit of its works experience by way of ensuring continuity - in the information and statistics gathered by the existing Commission. By gathering painstaking information as to water availability, its use, etc., in the State, the Maharashtra Water and Irrigation Commission has conducted an in-depth sub-basinwise study of issues related thereto. The task carried out by it is complementary and supportive to the work of *Maharashtra Jal Aayog.* If conversion of office of the Maharashtra Water and Irrigation Commission is effected in that of *Maharashtra Jal Aayog* by incorporating necessary changes and strengthening it to maintain the continuity of that study, it will be useful for the long term and broader interests of the State. Also its importance and status will be maintained and smoothness and continuity in its work will be imbued if the *Maharashtra Jal Aayog* is conferred with statutory status.

Transfer of Minor Projects to *Grampanchayats and Taluka Panchayats*

Villages in a *taluka* are situated within 20 km radius from the *taluka* headquarter. Barring those whose works area is confined to a single village, nobody associated with the technical or wider administrator set-up desires to reside in a village. They prefer to dwell at a *taluka* place. Therefore it seems proper to have the cell of actual coordinated implementation related to water at the *taluka* level only. The watershed area committee will function for achieving coordination and offering technical advice. Presently, a district is the unit of planning and implementation as far as economic and administrative considerations are at stake. Though it be retained to the extent of those limitations, the accounting of water, planning and regulation are, however, required to be carried out watershedwise only from the scientific point of view. Therefore, that responsibility will have to be devolved on the watershed area committee at a *taluka* level.

Minor tanks with command upto 100 ha are presently with the *Zilla Parishads*. But they are controlled from a district level. No participation of *grampanchayats* is there in construction, maintenance, repairs and water management. It is going to be desirable to transfer them to *grampanchayats* to invoke their participation. The Commission is offering a suggestion that irrigation tanks upto 100 ha irrigation should be transferred to *grampanchayats* and those beyond that (100 to 1000 ha only) be to the *taluka panchayat samitis.* By doing this the local set-up in the Panchayat System will acquire a status and it will go on progressively becoming stronger and competent to shoulder the responsibility. As the watershed area committee at *taluka* level possesses a technical support, it will function to offer technical advice to a *panchayat samiti or grampanchayat.* It is necessary to entrust all the responsibilities such as carrying out entire survey of these tanks, formulating their project layouts, executing the construction thereof, forming water users' organisation thereon and to establish a system of water distribution to a *grampanchyat/panchayat samiti.* This way inculcate in therm a feeling of ownership and they will take care of safety of the system. All these works will be taken up by seeking approval in the gramsabha after full deliberations as to where the village tanks of lower than 100 ha irrigation be sited, which land will have to be acquired, in what manner its compensation be arranged for and so on Today, works of minor tanks at local level (percolation tanks, K. T. weirs, cement *bandharas,* storage tanks, minor tanks, etc.), are being executed without apprising views and without invoking participation of local people. Therefore, no feeling of intimacy/ownership about those works exists in local people. After construction, the local bodies do not therefore evince readiness to look after the management of aforesaid works. The responsibility of mobilising financial & technical aid and making available technical & managerial skill to the villagers will rest with the *zilla parishads.*

There will be 3 set-ups of power in the context of irrigation:

1 Grampanchayat	Upto 100 ha irrigation
2 Taluka panchayat samiti	Irrigation 100 to 1000 ha
3 State level	Project larger than 1000 ha irrigation

Water users' organisations will be formed at all these places and irrigation management will fall within the purview of WUAs. The WUAs of irrigation tanks upto 100 ha and those with between 100 to 1000 ha will enter into management agreement with the *taluka panchayat samitis.* The WUAs on the rest of the projects will enter into an agreement with the authorised officers of the State Government.

In case of major projects, the State Government will create an infrastructure in the form of darns and canals (including distributaries). The works of minors and construction beyond that, maintenance and irrigation management thereof should, however, be entrusted with the WUAs only. The *taluka panchayat samiti* will undertake construction of minor tanks upto 1000 ha irrigation by standing on its own feet, by raising capital (borrowing loans from NABARD, etc.), and also accomplish further irrigation management thereof through the. WUAs. Similarly the *gram-panchayats,* either through its own grants or borrowing loans from NABARD, will execute construction of these schemes by raising capital and accomplish further maintenance and irrigation management thereof through the WUAs. The cost of storage (dam/rehabilitation) will be met form Government grants. The economic set-up of the distribution system will be managed through WUAs.

District shall be the centre mainly for financial and administrative planning. Powers as to actual field implementation, however, need to be vested with *taluka panchayat samiti.* (Block Development Officer). Water users' associations will thus be in liaison with village, *taluka* and the State in respect of maintenance, water charges, irrigation management, cropping pattern, etc. Responsibility for preserving quality of water alongwith that of maintaining statistical account of water will rest with the very three agencies in the foregoing set-up.

3.5 Interstate River Water Allocations

3.5.1 Geographical area of Maharashtra is 307713 sq. km. It is divided into five major river basins - Godavari, Krishna, Tapi, Narmada and Konkan. Area of Mahanadi Basin admeasuring 290 sq. km lies in the eastern part of Maharashtra. However, due to its comparatively insignificant extent it is kept out of consideration in the context of water availability. Geographical & cultivable area, water availability and water allocated for use as per interstate tribunals in each of the basins are as per the Annex 3.5.1.

There is a large variation in the natural availability of water in the major basins of Maharashtra. In Tapi basin, water availability per lakh hectare is hardly 244 Mm^3 whereas that in Konkan it is 3713 Mm^3. It means it is roughly 15 times that in Tapi Basin. Water availability in Krishna Basin is 605 Mm^3 which is nearly 1/6 that of Konkan. Water availability in Godavari Basin is 452 Mm^3 which is 1/8 that of Konkan. The variation in water availability in these different basins stems, it appears, from their geographical setting and topography and the rainfall deviation arising out of that. These variations in rainfall and availability of water are not confined to major basins only but there are also areas of low and high rainfall within each basin. There are 148 *talukas* (identified by the Central Government) out of which 340 *talukas* in Maharashtra are drought prone. It is, therefore, warranted to transfer water from surplus water regions to water-short regions in the State to overcome the situation. It is necessary to consider interbasin transfer of water at the interstate level as well as within-the-State.

Barring that of Konkan, all the 4 basins in Maharashtra are interstate. Geographical area of various states encompassed by these river basins, availability of water in their areas and water allocated to them by the river water dispute tribunals are shown in a compiled form in. Annex 3.5.2. The foregoing information in general reveals that in case of all the four basins - Godavari, Krishna, Tapi and Narmada - percentage share of water allocated to Maharashtra is less than that of geographical area of those basins and the percentage water availability.

Whereas 75% dependable water availability in Maharashtra in all the four interstate basins taken together is 72395 Mm^3 (in 75% successful years), water allocated for use to Maharashtra is only 50972 Mm^3 which is only 70% of the water that is available here. The water !located is short in comparison with the availability by 21423 Mm^3.

Share of Maharashtra in Interstate River Basin Water Allocation

3.5.2 Water that is available for use in proposed sub-basins within the Godavari, Krishna and Narmada Basins in accordance with the water allocated there by the interstate water dispute tribunals and in case of Tapi Basin as per the decision on recommendation of the Ukai Technical Committee is indicated in Statement 3.5.1. In sub-basins where there is a constraint on water use for a particular area as per the tribunal, utilisable ground water is shown separately to the extent of that area. Diminution / addition in the benefited water use by virtue of location of large reservoirs, also decrease / increase in available water resulting from water transfer - either interbasin or within-the-basin - has been worked out. As such; how much water is available for planned use in each of the sub-basins has been computed in detail in Appendix 3.5.1 titled 'Calculations of Water Availability'. Findings regarding share in allocated water in respect of major basins are presented for the comprehensive exposition on this topic in what follows:

The 75% dependable yield within-the-State's area in Godavari Basin is 37826 Mm^3. Water allocated to it, however, is 29394 Mm^3. Though 40% of the total water in Godavari Basin is produced in Maharashtra's area, the State has, however, received only 30% share in water allocation.

The requirement of 2464 and 3448 Mm^3 water of Manjra and Sina Basins respectively does not seems to be met with within the constraints of the present interstate water allocations. The requirement of additional water of this area can be fulfilled through the water from Upper Krishna Basin. But to realise that, it is necessary to have an additional share of water in Krishna Basin to be allocated to Maharashtra. Though the 47% yield of Krishna Basin is resulting from Maharashtra's area, only 27% (15855 Mm^3) water is allocated to the State. It seems that if an additional 5912 Mm^3 water is allocated to it by increasing the present allocation, the requirement of water of Manjra and Sina Basins can be coped with by transfer of water. A study in this respect is warranted.

Water Allocated for Use to Maharashtra as per the Interstate River Water Dispute Tribunals and Actual Requirement of Water

3.5.3 To facilitate the exposition in this topic, the 25 sub-basins proposed by the Commission are grouped in 10 sub-basin groups. The sub-basins falling accordingly in these planned sub-basin groups, the corresponding population, cultivable area, surface water allocated for use therein are shown in Annex 3.5.3.

The State's share of water that is allocated for use in Godavari, Krishna and Narmada Basins as per the interstate river water tribunals and in case of Tapi Basin in pursuance to the decision taken during the meeting of the Inter State Control Board on the recommendation of the Ukai Technical Committee, in general, relegates Maharashtra to the 'normal' planning category (Para 3.2.4. Statement 3.2.1). However, around 38% area of Maharashtra falls in deficit area (per ha water availability for use being less than 3000 m^3). The Annex 3.5.3 shows per ha availability based on water that is available for use.

To support a reasonably comfortable living, it is necessary for a farmer to harvest at least one irrigated crop other than that of *kharif* during a year For that, per ha (of cultivable area) water availability other than the natural rainwater should ordinarily be 3000 m^3. If considered from this viewpoint, the West Godavari (Marathwada), Manjra, Tapi and Sina sub-basin groups fall in deficit area (per ha availability being less than 3000 m). The total cultivable area of this deficit zone is 98.16 lakh ha which is approximately 44% of that of Maharashtra (225.42 lakh ha). The deficit in water often leaves this zone of Maharashtra in the shadow of a drought. If increased standard of living by accomplishing development of this zone is intended, it appears necessary to make available water from other parts of Maharashtra or from other states where water is available in surplus by interbasin transfer. Total 29448 Mm^3 water is required to make available 3000 m^3 water per ha of all cultivable area in this zone whereas all water that is available is-hardly 11641 Mm^3. It is revealed from this that roughly 18000 Mm^3 water is required to be supplied to this zone by bringing from outside.

The requirement of additional water in deficit basins of Maharashtra is as per the following:

(Requirement of additional water = water that is short by 3000 m^3 per ha)

Sr. No.	Sub-basin group	Requirement of additional water (Mm^3)
1.	West Godavari: Marathwada (Sub-basins 2,3,5)	6116
2.	Manjra (Sub-basin 4)	2464
3.	Tapi (Sub-basin 10 to 13)	5779
4.	Sina (Sub-basin 19)	3448
	Total:	17,807

There is 54298 Mm^3 surplus water available in water-abundant Konkan basin group of Maharashtra. This is nothing but the surplus water that is available in sub-basin groups in which more than 8000 m^3 per ha surplus water exists.

Planning for Increasing Surface Water Availability in Deficit Area

3.5.4 Though the figures in Para 3.5.3 apparently indicate that surplus water is more than the deficit in Maharashtra, the zones where water is abundant are situated at considerably lower altitudes wherefrom it is cost-prohibitive to lift water to convey to higher zones.

Notwithstanding this, the following interbasin water transfer proposals as worth studying in this context:

No.	Possible donor sub-basins	Possible benefited sub-basins
1	Vaitarna	Darna
2	Upper Krishna	Bhima
3	Par (including Nar)	Girna
4	Damanganga	Godavari
5	Par (including Nar).	Godavari
6	Middle Wainganga	Godavari

N.B. - The indicative names of sub-basins are not as proposed by the Commission.

In course of time, these alternatives will have to be considered as per the necessity. Therefore, it is going to be useful to undertake a continued study of such alternatives.

There is 3681 Mm^3 water available in the west-flowing river basin of Vaitarna. All that water is presently reserved for supply to Mumbai City. In fact, water supply for Mumbai City can adequately such managed through other rivers in Konkan, viz., Bhatsa, Surya, Kalu, Shai, Pinjal, etc. In such a circumstance, the problem of water deficit in Godavari Basin can be resolved to some extent by diverting water from Vaitarna Basin to Godavari Basin. The geographical configuration is also favourable to such a type of diversion, because water released from the saddle on east of the Upper Vaitarna Dam can straightway join by gravity to the Mukne Reservoir (Darna Sub-basin) in Godavari Basin. It is necessary to immediately undertake a detailed study, investigation and formulation of a detailed plan of the project envisaging this scheme.

If water in Konkan Basin of Maharashtra is diverted eastwards in Krishna / Godavari Basin by bringing it on the *ghatmatha,* the water problem of Maharashtra can be resolved. Prima facie, though appear to be difficult and costly, such schemes will have to be contemplated though in a smaller measure to cope with the increasing demand for water in future It feels necessary to have a continued study of ambitious proposals like that of eastward diversion of water from Konkan Basin during the off-peak period by converting the schemes like Koyna into storage reservoirs. It is essential to undertake on priority the work of searching such pumped storage schemes in the Western *ghats* by conducting a detailed survey. Examples which incorporate lifting of water upto 1000 m height and conveying the same to hundreds of kilometres by transfer for agricultural and industrial use come across in California in the U.S.A. and in Korea also Therefore, it will prove useful from the long-term progress of Maharashtra in particular and that of country in general to undertake the continued investigation, survey and study of such schemes. For such type of schemes, a far larger requirement of power is going to be felt. Therefore, such type of making water available can be only when power is made available on a large scale & at a cheaper rate and the financial capability Of society to purchase such a water is increased. These very limits are applicable to the transfer proposals indicated in Para 3.5.4. At least at present, a few of these schemes appear to be economically infeasible. As far as water use during the coming 30 years is concerned, attention will have to be focused at least for the present to ensure optimum use of other conventional alternatives at disposal.

Alongwith this, it is necessary to go in for larger storages of water to ensure fullest use of water allocated by the tribunals. On the basis of experience so far gathered by us, it appears several reservoirs do not get filled up all over in the same measure owing to the want of sufficient inflow. If consolidated water use thereof is seen, it doesn't cross the 50 to 60% mark of the projected use. But the interstate account, however, takes into account the water use that is at par with the one envisaged in project planning against the name of Maharashtra. It is far from correct. The interstate water allocation is not only confined to project planning but it has also a close bearing with the water use to be entailed in practice year to year. Therefore, it is necessary to have at hand at least 1.5 times more storage arrangements than the actual water use envisaged from the angle of ensuring fullest use of water allocated by tribunals. Wherever such a storage can possibly be increased in tune with average availability of water, it will be desirable to undertake fresh planning of that basin from that viewpoint.

3.6 Interstate Projects - Planning and Management

3.6.1 A good number of rivers originating in Maharashtra territory flow through the states of Gujarat, Andhra Pradesh, Karnatak and Goa. Similarly, some rivers rising in Madhya Pradesh flow through Maharashtra. Therefore, interests of more than one states are involved in several irrigation and multi-purpose projects being proposed across these rivers. It is difficult to accomplish investigation, planning or construction and operation of such projects without cooperation of the concerned states. Such projects are identified as interstate projects.

Maharashtra State has contemplated in all 45 joint interstate projects with the states of Gujarat, Rajasthan, Madhya Pradesh, Andhra Pradesh, Karnatak and Goa. The Annex 3.6.1 presents details pertinent to these projects. The total water use likely to be entailed through all these projects is 11574 Mm^3 whereas area of Maharashtra going to be irrigated through that is 5.4 lakh ha. Area of Maharashtra that is going to be submerged is around 1.82 lakh ha. Also, power benefit of more than 1250 MW is going to be accrued through these projects by Maharashtra.

Interstate Projects to be Provided with Special Attention by Maharashtra

3.6.2 A large share of water development in Maharashtra is going to be achieved through these projects. Therefore, a specially persistent attention to planning, construction, management of theirs is required. Especially for not losing the sight of those border regions of Maharashtra the development of which is dependent on these projects, a system should have been there which will pay special attention to them. The main projects out of those which are required to be pursued during the coming 30 years are:

1) Damanganga Irrigation Project (Maharashtra- Gujarat, Daman, Dadra, Nagar Haveli)

This is a joint project proposed across Damanganga River with the states of Gujarat, Dadra, Daman and Nagar Haveli. About 43 ha submergence of this project falls in Maharashtra, the area being benefited by way of irrigation is approximately 550 ha. The canal - System of this project in Maharashtra is still lingering at The investigation stage only It is necessary to pursue this project for the development of tribal area in Peth and Surgana *Talukas* in Nashik District.

2) Inchampalli Project (Maharashtra - Madhya Pradesh, Andhra Pradesh)

By preparing the report of this project, the state of Andhra Pradesh had sent the same for clearance in October 1988 to the Central Water Commission. However, basically on the issues of environment and forest land, it received setback. Of late, no action appears to have taken place in respect of this project. It is forthwith essential to form a study group of officers of the concerned states to remove shortcomings in the report. Irrigation benefits by way of lifts to 11000 ha area in Maharashtra are envisaged through this project whereas the State's Share in the installed hydropower capacity is going to be 231 MW. It will be desirable on the part of Maharashtra to take up this project forthwith by taking a lead in initiating an action.

3) Lendi Project (Maharashtra - Andhra Pradesh)

The construction of this project is going on near Gojegaon in Mukhed *Taluka* of Nanded District. The total irrigation potential of this project is envisaged to be 28665 ha of which 19758 ha belongs to Maharashtra and 8907 ha to Andhra Pradesh. No outlays out of the cost of project have so far been made available from the Andhra Pradesh. As the dam site and the entire right bank canal of this project falls within the territary of Maharashtra, the Maharashtra will accrue irrigation benefits and no water apportioned to it will be allowed to go waste. If this project is completed by imparting momentum to its work. Therefore, it is necessary to undertake completion of this project at the earliest if the interests of Maharashtra are to be safeguarded by not relying on Andhra Pradesh. Without waiting for the outlays to be appropriated on count of share of Andhra Pradesh, Maharashtra should use the water by completing the project. When Andhra Pradesh will make available its share of costs, the apportioned water of that state can be released.

4) Lower Painganga Project (Maharashtra - Andhra Pradesh)

As per the award of Godavari Water Dispute Tribunal, all water upto the Chikhal wardha Dam site under the Lower Painganga Project is allocated to Maharashtra. However, in order to realise it, a condition as to undertaking the Lower Painganga Project as joint interstate project has been laid down. The share of Andhra Pradesh in water use in proportion to the cultivable area is 4.66 TMC (132 Mm^3) whereas that of Maharashtra is 34.20 TMC (968 Mm^3).[5] Generally it appears that the State of Andhra Pradesh is neither enthusiastic nor is pressing for this Project. Therefore, the Government of Maharashtra itself is required to undertake implementation of this project in a more cautious manner. As suggested above in case of Lendi Project, this project is also necessarily to be completed by Maharashtra initially at the sole cost so as to reap maximum possible benefits from the project.

5) Upper Tapi Project Stage-II: Kharia Gutighat (Maharashtra - Madhya Pradesh)

This joint multipurpose project between the states of Maharashtra and Madhya Pradesh is going to be constructed in Melghat Dhatni *Taluka* (Dist. Amravati). One reservoir across Tapi River in Dhatni *Taluka* and one weir at Nawatha in Madhya Pradesh across the same river is going to be constructed. The left bank canal off-taking from the Kharia Gutighat Dam and the right bank canal from the Navatha are going to benefit the lands in Maharashtra and Madhya Pradesh by way of irrigation. In order to entail use of water from this project, the right bank canal off-taking from Hatnoor is going to be extended further so as to irrigate additional 59849 ha land in Maharashtra. Total 30 MW electricity is also going to be generated at the left bank canal off-taking from Kharia Gutighat Dam and the Nawatha weir combinedly.

The construction of this project has not been started yet. Discussion had taken place in this regard during the meeting of the interstate committee between. Maharashtra and Madhya Pradesh in July 1994. The then Chief Minister of Maharashtra had suggested at that time to take up this project early. However, the Chief Minister of Madhya Pradesh expressed inability to undertake any action owing to the paucity of funds. No momentum has since then appeared to have gained by the work. The Maharashtra is being deprived of the available water in Tapi Basin for want of completion of this project and the water is being wasted without entailing any use. Therefore, it will be desirable to mobilise requisite funds by Maharashtra so as to complete the project early and take timely action. Especially, the availability of water in Tapi Basin which is experiencing extreme water deficit is going to, be increased due to this project. Therefore, this project is required to be pursued on top priority.

6) Bhopalpattanam Hydroelectric Project (Maharashtra - Madhya Pradesh)

This is a joint interstate project between the states of Maharashtra and Madhya Pradesh proposed to be constructed across Indravati River in Vijapur *Taluka* in Bastar District (Madhya Pradesh). Hydropower generation of 1000 MW

The Government of Maharashtra has approved this allocation through the letter dated 31.1.1992.

can be possible because of this. This project is still pending at survey and, investigation, stage only. After power generation, it is to impound water in the Inchampalli. Reservoir proposed across Godavari River on downstream, hydro-power generation and irrigation therethrough being proposed thereafter. In view of the power requirement of the concerned states and the overall benefits of irrigation, it is necessary to undertake joint efforts, to give momentum to this project by all the three states - Maharashtra, Madhya Pradesh and Andhra Pradesh.

Future Course of Action Pertinent to Interstate Projects

3.6.3 The foregoing information reveals that out of 45 interstate projects, nearly 32 projects are yet to be taken up for construction. Five projects, have so far been completed whereas construction of 8 projects is underway. The rest of the projects are still lingering for last several years at investigation stage only. A considerable loss is being entailed by Maharashtra in power and irrigation sectors because of non-completion of projects like Inchampalli, Bhopalpattanam. Upper Tapi Stage-II, Dhapewadi, etc. Maharashtra is facing acute shortage of hydropower in recent times. In future this shortage is going to be aggravated. Interstate projects envisaging hydropower generation are, therefore, required to be completed early. A large quantum of water from the share of Maharashtra is being lost in Godavari, Tapi and Damanganga Basins because of non-completion of these interstate projects. Though some projects are proposed to be constructed in a territory of Madhya Pradesh across rivers originating from that state, it will be worthwhile for Maharashtra to contemplate entailing use of available water by constructing dams across those rivers within its territory until the same are constructed by Madhya Pradesh. The cost of dams so constructed by us will also be repaid by that time through benefits accrued therefrom.

Maharashtra is having a good number of interstate projects concerned with several states surrounding it. However, barring Madhya Pradesh, there do not exist at present independent organisations with other states to pursue them all. One Inter State Control Board for the joint irrigation & hydropower projects with Madhya Pradesh has been formed on 28-10-1970. The said Control Board undertakes review of in all 13 projects - 11 for joint construction and 2 for commissioning subsequent to the construction. Besides this decision regarding water use and exchange of submerged areas in respect of 26 projects belonging to both the states is being taken through the Inter State Control Board.

No interstate committees so far have been constituted for joint projects with the states of Andhra Pradesh, Karnatak, Gujarat and Goa. The interstate body which pursues the interstate projects brings in its fold the representatives of Government but non-representation of area which is going to be benefited is a lacuna therein. It is, therefore, going to be useful to induct the local representatives, (e.g., president of *zilla parishad*) in this interstate venture by undertaking restructuring of interstate board /committee. Participation of local representatives in management of a project even after its construction should also be there. If the same can be ensured right from the phases of investigation, planning, etc., it will prove useful to impart momentum to the project.

3.7 Interbasin Water Transfer

3.7.1 The rivers in our country are closely related with the cultural life of the society. The rivers like Ganga, Godavari, Narmada; Krishna, Kaveri have a very revered place in the people’s minds. People in northern part of the country undertake pilgrimage of southern part whereas those in southern part visit pilgrimage centres in northern part. While returning from pilgrimage, the devotees take with them the sacred water of rivers in which they use to enjoy holy dips. Intermixing of waters of different rivers is obviously the intention behind such an act, As such, this token intermixing of river waters has since long remained a part and parcel of cultural heritage of the nation. Probably this very religious bent might have led the Indians to contemplate the joining of Ganga-Kaveri Rivers.

Water Resources of Maharashtra

3.7.2 An exhaustive exposition of Maharashtra's water resources is the subject matter of Topic 2.8. The average annual availability of water resulting from rains in Maharashtra is 164 billion m^3 which is nearly 9% of the corresponding availability (1869 billion m^3) of the country. The per-capita water availability in Maharashtra is 2076 m^3 (based on 1991 Census), the same in case of the country happens to be 2200 m^3. When per capita water availability in sub-basins of Maharashtra is gleaned through, it is observed that it is highermost (8009 m^3) in Wainganga (Pranhita) Sub-basin whereas the same is lowermost (1551 m^3) in the Remaining Bhima (d/s of Ujjani including Man).[6] Generally, per capita water availability of less than 1000 m^3 is an indication of long-term scarcity - an acknowledged concept on an international level. Planning of remedial measures is, of course, the necessity of such a region.

The geographical area of Godavari Basin encompassed by the State is divided by the Commission into 9 sub-basins. The per capita water availability in this basin appears to be ranging from 8009 m^3 (Lower Wainganga - Prahnita) to 1048 m^3 (Purna - including Duhana). The overall per capita availability in Godavari Basin is 1756 m^3. The division of Krishna Basin is proposed to be in 5 sub-basins the per capita availability in case of which ranges from 4255 m^3 (Upper Krishna: West-North) to 240 m^3 (Remaining Bhima - d/s Ujjani including Man). The area occupied by Tapi Basin in Maharashtra is divided into 5 sub-basins. The range of per capita availability is from 1569 m^3 (Middle Tapi Satpuda) to 579 m^3 (Girna) The overall per capita availability of Tapi Basin is 803 m^3. Per capita availability in the Konkan belt which is endowed with abundant water resources happens to be 3497 m^3. Per capita availability of the North Konkan Basin group appears to be 1351 m^3, the Mumbai Metropolitan City being situated in this very basin. A very small part of Narmada Basin lies in Maharashtra. Per capita availability of this sub-basin is 3602 m^3.

Future Developmental Stage

3.7.3. If broadly considered, the resource availability in various sub-basins of Maharashtra appears to be less than 500 m^3 per capita or less than 1000 m^3 per ha in case of sub-basins of Upper Krishna (East) - Yerala, Upper Krishna (East) - Agrani, Remaining Bhima (d/s Ujjani including Man), Sina. The following basins will present the future scenario to be a cause of concern: Upper Godavari (upto Paithan), Purna (including Dudhana), Purna (Tapi), Girna, Panzra, Middle Tapi (South), Upper Bhima (upto Ujjani), Bori-Benetura, North Konkan. These basins are going to present difficulty as far as planning is concerned. It will, therefore, be proper to accomplish their planning carefully and foresightedly. The state of Manjra Sub-basin is also going to be almost similar.

National Perspective Plan of Interbasin Water Transfer

3.7.4 One National Perspective Plan envisaging interbasin water transfer at national level has been proposed in August 1980. It mainly comprises two components:

1. Development of Himalayan rivers.
2. Development of peninsular rivers.

6. Sub-basins encompassing less than 10000 sq. km area are meant for detailed planning. The broader discussions are based on that of sub-basins stretching across area exceeding 10000 sq. km.

Under the development of peninsular rivers component, it is proposed to divert surplus water from Mahanadi and Godavari River basins to the water-short region of Krishna, Pennar, Kaveri River basins. This link is taken as Mahanadi to Godavari and along eastern coast as Godavari to Krishna. This water transfer is going to benefit the drought-prone area oil u/s lying in upper reaches in the states of Maharashtra and Karnatak by way of accruing more share in interstate water allocations resulting from supply of water effected to, the eastern coastal area in Andhra Pradesh via Mahanadi. The Krishna Basin in Maharashtra will be allocated more water for use in pursuance to the existing agreement pertinent to this amongst Andhra Pradesh - Maharashtra - Karnatak. Anticipating this surplus water, it is desirable for Maharashtra to go in for completion of planning and storages. Another link envisages interlinking of-rivers on south of Tapi and the small rivers, viz. Damanganga and Par flowing north of Mumbai. The objective of, it will be to cope up with the increasing water requirement of future in case of Mumbai Metropolitan City and also to extend irrigation facilities to the coastal area of Maharashtra.

The Central Government constituted the National Water Development Agency, New Delhi in 1982. The objective is to pursuade various states in the country to realise the National Perspective Plan. The NWDA has indicated 19 interbasin water transfer links under the Himalayan component whereas the same in case of Peninsular component is 17. They are meant only for undertaking an in-depth study thereof. The work of preparing the prefeasibility reports of all these schemes and to bring out feasibility reports of some of the attractive ones is going to be accomplished during the 9th and 10th Five Year Plans. Owing to the joining from east of Shabari-Indravati Rivers having abundant water, the net surplus water that is estimated to be there in Godavari Basin will be 21500 Mm^3. This implies transfer of 8000 Mm^3 water from the Mahanadi-Godavari link.

The regions of water abundance do not readily accept the water surplus state of theirs over and above their requirement without being apprehensive. Therefore, unless protracted discussions and exchange of information is continued on a continuing basis in this respect, no consensus about the proposal of interbasin water transfer is likely to be made. The feasibility reports being brought out by NWDA are going to be especially useful to receive approval and consent of the concerned states. Therefore, it is essential for Maharashtra to properly pursue the works of this Agency.

There will be an interstate dissention in transferring surplus water from one basin to a distant one. There is no formal provision to redress this situation and to bring out an all-acceptable solution concerning it in the Constitution of India or legislation. The provision under Clause 262 in the Constitution is regarding the disputes arising out of water allocation of interstate rivers and use thereof. It doesn't contain a concept which envisages linking of different rivers. Therefore, this concept can only-be realised through a mutual understanding to be cultivated by regarding the country as a single unit and for that only the National Water Development Agency has been constituted as a 'society' on the principle of partnership of all states. It is in the joint interests of all to duly pursue the works of the Agency.

Godavari is one of those few river basins amongst those of peninsular rivers component wherein water has been shown to be surplus in the study of the National Perspective Plan. The source of this surplus state lies in rivers joining Godavari in Andhra Pradesh which have abundant water. As far as Maharashtra is concerned, the notion that overall availability of water in

Godavari Basin is surplus is an illusive one. Because the sub-basins of abundant water in east Maharashtra, viz. Wainganga, Indravati are instrumental in raising the values of per capita (1756 m^3 as per the 1991 Census) and per ha (4520 m^3 of Cultivable area) water availability in total area of Godavari in Maharashtra. This is clear from the following table:

Sub-basin group	Availability of water (m^3)	
	Per capita	per ha
Godavari (excluding Wainganga-Indravati)	1278	3087
Wainganga-Indravati	2280	6334

The links with which Maharashtra is concerned among those which are proposed by the autonomous organisation, viz., NWDA under the title 'National Perspective for Water Resources Development' which conceives the linking up of all interstate rivers in the country are indicated in the Diagram No. 3.7.1.

Social, Political, Environmental, Legal and Financial Aspects of Interbasin Water Transfer

3.7.5 The majority of interbasin water transfer schemes are possible only through forms such as building large reservoirs, taking long-distance canals or lifting water to a great height. Submergence of farm land, forest land and urban & rural habitats on a large scale and making it imperative to accomplish rehabilitation of people thereat are inevitable. It is likely that submergence may fall in one region whereas benefited area may lie in other region. Scheme involving Such a water transfer naturally invokes an adverse reaction from the general public The interbasin transfer schemes will materialise in proportion to such projects which, will prove acceptable in the national context from social and sentimental points of view. A large-scale enlightenment and spadework are needed therefor.

Organisational Facilities

3.7.6 As long as the irrigation potential created a new in deficit basins is not stabilised and its utilisation is not accomplished in a skillful manner, it will remain difficult to get convinced or even convince others of the necessity of interbasin water transfer. Only after accomplishment in its fullness in regard to improved agricultural practices, an optimum use of available water resources in deficit basins, irrigation, watershed area management is ensured, the economic and practical capability of using costly water to be brought from a distance would be created in these deficit basins. Therefore, it is-necessary to focus on most skillful use of available water.

Notwithstanding this, functioning of one special unit to undertake an in-depth study of State's water resources development and to accomplish the foresighted planning of especially that part where shortage of water is being / will be experienced now or in future by keeping in view the long-term needs will be going to be useful in Maharashtra. This unit will have to undertake studies in regard to the sub-basins which are or will be causing a concern now or in future also those sub-basins where a drought prone situation occurs frequently owing to paucity of rains, their developmental programme and alternatives envisaging export of water. The work of studies alongwith those of within-the-State interbasin transfer schemes, e.g., Krishna-Koyna (Takari), Koyna-Krishna (Mhaisal) lift irrigation schemes and so on; also schemes contemplating diversion of water from basins of west-flowing rivers to those on the east, e.g., Damanganga-Godavari, Par-Girna, Vaitarna-Mukne, Par-Godavari and so on, pursuing possibilities and schemes which are beneficial to Maharashtra in the context of National Perspective Plan will also be with this unit. It will be necessary on the part of this unit to extend cooperation to the NWDA in its effort to implement schemes of long-distance transfer (where within-the-basin water transfer is not possible) benefiting deficit basins in Maharashtra from the interstate river basins.

Constituting such an independent unit within the organisation under the control of Chief Engineer (Hydrology Project), Nashik will be useful.

Perspective of Interbasin Transfer in the State

3.7.7 The Annex 3.7.1 exhibits the probable schemes involving interbasin water transfer in Maharashtra. Information as to costs and B.C. ratios of the schemes is not available presently. Similarly, information regarding other economy measures possible in respective deficit basins and costs likely to be incurred therefor is also not available. What other alternatives are at disposal in the basin, a detailed study thereof will also have to be accomplished. Either the need of interbasin water transfers will be obviated as a result of availability of other alternatives such as control on population growth, changes in foodgrain consumption styles, increased productive potential, increased irrigation areas as a result of water conservation, advances in biotechnology, crop genetics, etc., or it may be possible to prolong for some time its adoption as the water to be brought by interbasin transfer is going to be extremely costly, there is a possibility of employing economy measures at many places costs of which will be lesser than the per m' cost of such water. It will have to be got verified beforehand. Moreover, which use of water is economically more viable that can afford excessively rated water that is being made available by transfer, will also have to be properly ascertained. Proposals of such schemes can be undertaken only thereafter.

Though interbasin water transfer practically is not entirely impossible, it is certainly not easier to realise and cheaper. More the distance at which transfer takes place more will be the problems likely to be met with. While executing them several technical and practical difficulties will have to be overcome. How much and at what cost water is to be made available by transfer on the background of demand in respective basins and socio-economic conditions therein will have to be decided upon. It will be desirable on the part of proposed planning and regulation committee of respective sub-basins to initiate the study and investigation in order to impart a proper knowledge of possibilities in this regard to the community in deficit sub-basins. This committee should undertake beforehand a comparative study of increase in demand for water in every decade and alternatives to fulfil it during the coming three decades and place before the Government a proposal of exporting water where adoption of only that alternative appears to be inevitable. Very comprehensive office studies, field survey and foresightedly planning are expected for executing proposals of transfer. An all-out advanced study will be required therefor. Therefore it is desirable on the part of sub-basinwise committees to undertake such studies timely. Apprising the current status of the Godavari (upto Paithan) sub-basin, it is revealed that stress of water is being encountered there in a highest degree. Therefore, to undertake such a study for such sub-basins immediately is called for. Similarly, it will be useful to undertake such studies timely in respect of Puma (including Dudhana) and Middle Tapi Sub-basins.

Limitations of Interbasin Water Transfer

3.7.8 The interbasin water transfer has some natural limitations on the background of Maharashtra. Those will have to be kept in mind while accomplishing overall planning of Maharashtra. The water deficit sub-basins in Maharashtra (Manjra, Sina, Upper Godavari, Upper Krishna - East, etc.,) are situated on higher altitude than the sub-basins / regions which are water-abundant (Wainganga, Konkan, etc.). Beside these water-short drought-prone sub-basins (Sina, Manjra, Man) are distantly situated with respect to basins which are endowed with surplus water. The intermittent geographical region is undulating, ridge plateau and hilly. Under such circumstances, the lift stages of water transfer are increased and water will have to he conveyed through pipeline which is going to make it cost-prohibitive. It is, therefore, desirable to ascertain beforehand cost-effectiveness of modernisation and economy measures of internal water rise of sub-basins in, comparison and to pursue them promptly as a project in case they appear to be of more practical benefits.

Annex: 3.2.1

Correspondence between Sub-basins Delineated by the Commission and Those Designated by Various Tribunals and Committees

Sub-Basin No.	Sub-basin as described by MWIC	Sub-basin as designated by tribunals / committees
1A	Upper Godavari (Upto Paithan Dam) (A) Godavari (Excluding Mula and Pravara)	G-1 Part 1
I B	(B) Mula and Pravara	G- 2
2	Lower Godavari (D/s of Paithan Dam)	G-1 Part 2
3	Puma (Including Dudhana)	G-3
4	Manjra	G-4
5	Godavari-Sudha-Swarna	G-5
6	Painganga	G-7
7	Wardha	G-8
8	Middle Wainganga	G-9 (Part 1)
9A	Lower Wainganga (A) Pranhita	G-9 (Part 2)
9B	Lower Wainganga (B) Inchampalli	G-10
9C	Lower Wainganga (C) Indravati	G-11
10	Purna (Tapi)	Purna (Tapi)
11	Girna	Girna
12	Panzra	Panzra
13A	Middle Tapi (A) (Satpuda)	Tapi (Part 1)
13B	Middle Tapi (B) (South)	Tapi (Part 2)
14	Narmada	Narmada
15A	Upper Krishna (West) (A) (North-West)	K-1 Part-1 (KV, ICD,KW, KKY, KR)
15B	Upper Krishna(West) (B) (South-West)	K- 3
16A	Upper Krishna(East) (A) Yerala	K-1 Part 2 {KY}
16B	Upper Krishna(East) (B) Agrani	K-2
17	Upper Bhima (Upto Ujjani)	K-5 Part 1 {BH (Part 1), BMM, BG}
18A	Remaining Bhima (A) Neera	K- 5 Part 2 {BN}
18B	Remaining Bhima (B) D/s-of Ujjani including Man	K-5 Part 3 {BM ,BH (Part 2)}
19A	Sina-Bori-Benetura (A) Sina	K- 5 Part 4 {BS}
19B	Sina-Bori-Benetura (B) Bori-Benetura	K- 6 {BB}, K-5 Part 5
Damanganga - Par North Kon-kan	Damanganga - Par	Datnanganga, ParNorth Konkan
21	North Konkan	Vaitarna,Ulhas,Patalganga
22	Middle Konkan	Amba, Kundalika, Savitri, Bharja, Mhasala
23	Vashishti	Vashishti
24A	South Konkan (A) Ratnagiri	Shashtri,Kajvi,Muchkundi
24B	South Konkan (B) Sindhudurg	Karli, Gad, Achara, Devgad, Wagho-tan, Kodavali, Rivers joining sea near Vengurla
25	Terekhol - Tillari	Terekhol - Tillari

Reference Paragraph: 3.2.2

Annex: 3.2.2
Districts Sub-divided into Sub-Basins

Sr.No.	District	Sub-basin No.	Sub-basin	Part	Geographical Area
1	Greater Mumbai	21	North Konkan	100.00%	603
					603
2	Thane	21	North Konkan	93.62%	8948
		20	Damanganga-Par	6.38%	610
					9558
3	Raigad	21	North Konkan	31.02%	2219
		22	Middle Konkan	68.98%	4933
					7152
4	Ratnagiri	22	Middle Konkan	10.58%	868
		23	Vashishti	27.20%	2233
		24A	South Konkan A) Ratnagiri	57.69%	4735
		24B	South Konkan B) Sindhudurg	4.53%	372
					8208
5	Sindhudurg	24B	South Konkan B)Sindhudurg	75.15%	3913
		25	Terekhol-Tillari	24.85%	1294
					5207
6	Nashik	1A	Upper Godavari (Upto Paithan Dam) A) Godavari (Excluding Mula & Pravara)	46.40%	7206
		1B	Upper Godavari (Upto Paithan Dam) B) Mula & Pravara	1.20%	186
		11	Girna	35.22%	5470
		12	Panzra	0.25%	39
		13B	Middle Tapi (B)(South)	3.54%	550
		20	Damanganga-Par	12.22%	1898
		21	North Konkan	1.17%	182
					15531
7	Dhule	12	Panzra	19.15%	2518
		13A	Middle Tapi (A) (Satpuda)	29.41%	3867
		13B	Middle Tapi (B)(South)	43.47%	5716
		14	Narmada	7.97%	1048
					13150
8	Jalgaon	10	Purna (Tapi)	5.79%	681
		11	Girna	35.11%	4131
		12	Panzra	1.46%	172
		13A	Middle Tapi(A)(Satpuda)	25.32%	2979
		13B	Middle Tapi(B)(South)	32.32%	3802
					11765

(Contd.)

Annex: 3.2.2 ***(Contd.)***

Sr.No.	District	Sub-basin No.	Sub-basin	Part	Geographical Area
9	Ahmadnagar	1A	Upper Godavari(Upto Paithan Dam) A) Godavari (Excluding Mula & Pravara)	22.21%	3786
		1B	Upper Godavari(Upto Paithan Dam) B) Mula & Pravara	36.87%	6286
		2	Lower Godavari (D/s of Paithan Dam)	3.96%	675
		4	Manjra	0.77%	131
		17	Upper Bhima(Upto Ujjani)	16.85%	2873
		19A	Sina-Bori-Benetura A) Sina	19.34%	3297
					17048
10	Pune	1B	Upper Godavari(Upto Paithan Dam) B)Mula & Pravara	0.62%	97
		17	Upper Bhima(Upto Ujjani)	69.58%	10884
		18A	Remaining Bhima A) Neera	28.26%	4421
		21	North Konkan	0.71%	111
		22	Middle Konkan	0.82%	128
					15643
11	Satara	15A	Upper Krishna (West) -A) (North-West)	56.91%	5964
		16A	Upper Krishna(East)-A) Yerala	12.97%	1359
		18A	Remaining Bhima- A) Neera	16.56%	1735
		18B	Remaining Bhima B) D/s of Ujjani including Man	13.56%	1421
					10480
12	Sangli	15A	Upper Krishna (West) -A) (North-West)	19.24%	1649
		15A	Upper Krishna (East)-A) Yerala	30.54%	2618
		16B	Upper Krishna (East)A) - B) Agrani	15.25%	1307
		18B	Remaining Bhima B) D/s of Ujjani including Man	34.97%	2998
					8572
13	Solapur	17	Upper Bhima(Upto Ujjani)	6.41%	955
		18A	Remaining Bhima A) Neera	5.72%	852
		18B	Remaining Bhima B) D/s of Ujjani including Man	40.36%	6012
		19A	Sina-Bori-Benetura A) Sina	36.56%	5446
		19B	Sina-Bori-Benetura B) Bori-Benetura	10.95%	1631
					14895

(Contd.)

Annex: 3.2.2 *(Contd.)*

Sr.No.	District	Sub-basin No.	Sub-basin	Part	Geographical Area
14	Kolhapur	15A	Upper Krishna (West) -A)(North-West)	74.93%	5758
		15B	Upper Krishna (West)-B)(South-West)	22.71%	1745
		25	Terekhol-Tillari	2.36%	181
					7685
15	Aurangabad	1A	Upper Godavari (Upto Paithan Dam) A) Godavari (Excluding Mula & Pravara)	47.37%	4788
		2	Lower Godavari (D/s of Paithan Dam)	6.08%	615
		3	Purna (Including Dudhana)	36.04%	3643
		11	Girna	5.88%	594
		13B	Middle Tapi (B)(South)	4.63%	468
					10108
16	Jalna	2	Lower Godavari (D/s of Paithan Dam)	22.85%	1764
		3	Purna (Including Dudhana)	76.99%	5942
		13B	Middle Tapi- B) South	0.16%	12
					7718
17	Parbhani	2	Lower Godavari (D/s of Paithan Dam)	33.45%	3693
		3	Purna (Including Dudhana)	50.01%	5522
		6	Painganga	16.54%	1826
18	Beed	2	Lower Godavari (D/s of Paithan Dam)	67.06%	7171
		4	Manjra	17.86%	1910
		19A	Sina-Bori-Benetura- A) Sina	15.08%	1613
19	Nanded	2	Lower Godavari (D/s of Paithan Dam)	34.50%	3632
		4	Manjra	24.83%	2614
		5	Godavari-Sudha-Swarna	6.58%	693
		6	Painganga	34.09%	3589.
					10528
20	Osmanabad	4	Manjra	40.63%	3075
		19A	Sina-Bori-Benetura- A) Sina	31.52%	2386
		19B	Sina-Bori-Benetura- B) Bori-Benetura	27.85%	2108
					7569

(Contd.)

Annex: 3.2.2 *(Contd.)*

Sr.No.	District	Sub-basin No.	Sub-basin	Part	Geographical Area
21	Latur	2	Lower Godavari (D/s of Paithan Dam)	0.92%	66
	.	4	Manjra	99.08%	7091
					7157
22	Buldhana	3	Purna (Including Dudhana)	21.41%	2068
		6	Painganga	20.34%	1965
		10	Purna (Tapi)	56.90%	5497
		13A	Middle Tapi- A) Satpuda	0.82%	
		13B	Middle Tapi- B) South	0.53%	51
					9660
23	Akola	3	Purna (Including Dudhana)	0.73%	77
		6	Painganga	33.17%	3507
		7	Wardha	ı4:0.46%	472
		10	Purna (Tapi)	61.64%	6518
					10574
24	Amaravati	7	Wardha	33.17%	4050
		10	Purna (Tapi)	39.96%	4879
		13A	Middle Tapi- A) Satpuda	26.87%	3281
					12210
25	Yavatmal	6	Paingangaa	73.66%	9923
		7	Wardha	26.94	3659
					13582
26	Wardha	7	Wardha	100.00%	6309
					6309
27	Nagpur	7	Wardha	32.28%	3193
		8	Middle Wainganga	67.72%	6699
					9892
28	Bhandara	8	Middle Wainganga	100.00%	9321
					9321
29	Chandrapur	6	Painganga	5.70%	652
		7	Wardha	40.45%	4629
		8	Middle Wainganga	13.99%	1601
		9A	Lower Wainganga A) Wainganga-	39.86%	4561
					11443
		8	Middle Wainganga	26.53%	3824
30	Gadchiroli	9A	Lower Wainganga A) Wainaganga-	29.62%	4269
		9B	Lower Wainganga B) Inchampalli	2.18%	314
		9C	Lower Wainganga C) Indravati	39.67%	5717
			Mahanadi (Unspecified)	2:00%	290
					14414
			Maharashtra Total		307713

Reference Paragraph: 3.2.2

Annex : 3.2.3. Sub-basins Sub-divided into Districts

Area-sq.km

Sub-Basin	District	Part	Geographic Area
I (A) Upper Godavari (Upto Paithan Dam)	Nashik	45.67%	7206
(A) Godavari (Except Mula & Pravara)	Ahmadnagar	23.99%	3786
	Aurangabad	30.34%	4788
			15780
1(B) Upper Godavari (Upto Paithan Darn)	Nashik	2.83%	0.186
(B) Mula & Pravara	Ahmadnagar	95.69%	6286
	Pune	1.48%	97
			6569
2) Lower Godavari (D/s of Paithan Dam)	Ahmadnagar,	3.83%	675
	Aurangabad	3.49%	615
	Jalna	10.01%	1764
	Parbhani	20.96%	3693
	Latur	0.37%	66
	Nanded	20.62%	3632
	Beed	40.71%	7171
			17616
3)Purna (Including Dudhana)	Aurangabad	21.12%	3643
	Jalna	34.44%	5942
	Parbhani	32.01%	5522
	Akola	0.45%	77
	Buldhana	11.99%	2068
			17252
4) Manjra	Ahmadnagar	0.88%	131
	Nanded	17.64%	2614
	Osmanabad	20.75%	3075
	Latur	47.84%	7091
	Beed	12.89%	1910
			14821
5) Godavari-Sudha-Swarna	Nanded	100.0%	693
			693
6) Painganga	Parbhani	8.51%	1826
	Buldhana	9.16%	1965
	Akola	16.34%	3507
	Chandrapur	3.04%	652
	Nanded	16.72%	3589
	Yavatmal	46.24%	9923
			21462
7) Wardha	Amaravati	18.15%	4050
	Yavatmal	16.40%	3659
	Wardha	28.28%	6309
	Nagpur	14.31%	3193
	Akola	2.12%	472
	Chandrapur	20.75%	4629
			22312

(Contd.)

Annex: 3.2.3. ***(Contd.)***

Sub-Basin	District	Part	Geographic Area
8) Middle Wainganga	Nagpur	31.24%	6699
	Bhandara	43.46%	9321
	Chandrapur	7.47%	1601
	Gadchiroli	17.83%	3824
			21445
9A) Lower Wainganga (A) Wainganga-Pranhita	Chandrapur	51.65%	4561
	Gadchiroli	48.35%	4269
			8830
9B) Lower Wainganga (B) Inchampalli	Gadchiroli	100.0%	314
			314
9C) Lower Wainganga (C)Indravati	Gadchiroli	100.0%	5717
			5717
10) Purna (Tapi)	Jalgaon	3.87%	681
	Akola	37.09%	6518
	Amaravati	27.76%	4879
	Buldhana	31.28%	5497
			17575
11) Girna	Nashik	53.65%	5470
	Jalgaon	40.52%	4131
	Aurangabad	5.83%	594
			10195
12) Panzra	Dhule	92.27%	2518
	Nashik	1.43%	39
	Jalgaon	6.30%	172
			2729
13A) Middle Tapi (A) Satpuda	Jalgaon	37.89%	3867
	Amaravati	29.19%	2979
	Buldhana	0.77%	79
	Dhule	32.15%	3281
			10206
13B) Middle Tapi (B) South	Nashik	5.19%	550
	Jalgaon	35.87%	3802
	Buldhana	0.48%	51
	Aurangabad	4A2%	468
	Jalna	0.11%	12
	Dhule	53.93%	5716
			10599
14) Narmada	Dhule	100.0%	1048
			1048
15A) Upper Krishna (West) (A) North-West	Satara	44.60%	5964
	Sangali	12.33%	1649
	Kolhapur	43.06%	5758
			13371

(Contd.)

Annex: 3.2.3. ***(Contd.)***

Sub-Basin	District	Part	Geographic Area
15B) Upper Krishna(West) (B) South-West	Kolhapur	100.0%	1745
			1745
16A) Upper Krishna(East) (A)Yerala	Sangali	65.83%	2618
	Satara	34.17%	1359
			3977
16B) Upper Krishna(East) (B) Agrani	Sangali	100.0%	1307
			1307
17) Upper Bhima (Upto Ujjani)	Ahmadnagar	19.53%	2873
	Pune	73.98%	10884
	Solapur	6.49%	955
			14712
18A) Remaining Bhima (A) Neera	Pune	63.09%	4421
	Satara	24.76%	1735
	Solapur	12.16%	852
18B) Remaining Bhima (B) D/s of Ujjani including Man	Satara	13.62%	1421
	Sangali	28.74%	2998
	Solapur	57.64%	6012
			10431
19A) Sina-Bori-Benetura (A) Sina	Ahmadnagar	25.88%	3297
	Solapur	42.74%	5446
	Beed	12.66%	1613
	Osmanabad	18.73%	2386
			12742
19B) Sina-Bori-Benetura (B) Bori-Benetura	Solapur	43.62%	1631
	Osmanabad	56.38%	2108
			3739
20) Damanganga-Par	Thane	24.32%	610
	Nashik	75.68%	1898
			2508
21) North Konkan	Mumbai City & Suburbans	5.00%	603
	Thane	74.18%	8948
	Pune	0.92%	111.
	Raigad	18.40%	2219
	Nashik	1.51%	182
			12063
22) Middle Konkan	Raigad	83.20%	4933
	Pune	2.16%	128
	Ratnagiri	14.64	868
			5929

(Contd.)

Annex: 3.2.3. *(Contd.)*

Sub-Basin	District	Part	Geographic Area
23) Vashishti	Ratnagiri	100.0%	2233
			2233
24A) South Konkan (A) Ratnagiri	Ratnagiri	100.0%	4735
			4735
24B) South Konkan (B) Sindhudurg	Ratnagiri	8.68%	372
	Sindhudurg	91.32%	3913
			4285
25) Terekhol-Tillari	Sindhudurg	87.73%	1294
	Kolhapur	12.27%	181
			1475
Mahanadi (Unspecified)	Gadchiroli	100.0%	290
			290
Maharashtra Total			307713

Reference Paragraph: 3.2.2

Annex: 3.2.4
Broad Outline of Sub-basinwise Chapters contained in Volume II

1.	Geography 1.1 Extent 1.2 Boundaries
2.	Climate 2.1 Evaporation
3.	Availability of Water Resources 3.1 Surface Water Resources 3.2 Geological Formation 3.3 Groundwater Resources 3.4 Drought prone Area
4.	Soil Classification
5.	Land Use
6.	Population and Live Stock 6.1 Population 6.2 Live Stock 6.3 Other Data
7.	Water Use 7.1 Irrigation Use 7.2 Non-irrigation Use 7.3 Water Account 7.4 Command Area Development 7.5 Projects completed before 1970
8.	Cropping Pattern
9.	Industries
10.	Hydroelectric generation
11.	Transport
12	The Planning Perspective

Reference Paragraph: 3.2.2

Annex: 3.2.5
Features Depicted on Sub-Basinwise Maps Contained in Volume-V

Map-1: Climate and Water Use
l Surface Geology
2 Raingauge Stations
3 Monthly Average Rainfall
4 Isohyets
5 River Gauging Stations
6 Watersheds
7 Wells
8 Industrial Areas
9 Industrial Growth Centres
10 Population/density - City classification
11 Total Availability of Water Resources
12 Storages Created
13 Canal Irrigation Potential
14 Sugar factories
15 Over Exploited Mini Watersheds
16 Hot Springs

Map-2: Land and Irrigation Projects

1 Canals, Command, Submergence
2 Contours (g 100 m interval)
3 Soil Types
4 Project Category/Status: Major/ Medium/ Minor/ K.T. Weirs -Completed/ Under construction/ Planned

Reference paragraph: 3.2.2

Annex: 3.4.1
Development of Irrigation Potential in Maharashtra (1947-97)

Irrigation Potential: Lakh hectares

Period	Irrigation potential (cumulative)	Percentage of irrigation potential to cultivable area
1951 (Pre-Plan period)	2.74	1.22
1956 (By first Plan)	3.14	1.39
1961 (By 2nd Plan)	3.98	1.77
1966 (By 3rd Plan)	5.70	2.53
By 1990	26.31	11.67
By 1995	29.42	13.05
By 1996	31.20	13.84
By 1997	32.28	14.32

Reference Paragraph: 3.4.1

Basinwise Irrigation potential created in Maharashtra (1995)

Geographical Area Thousand sq.km.
Cultivable Area: Lakh hectares
Irrigation potential: Lakh hectares

Sr.No.	Basin	Geographical Area	Cultivable Area	Irrigation potential created by 1995	Percentage of Created Irrigation Potential to Cultivable Area	Ultimate Irrigation Potential (Basic Area)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	Godavari	152.81	112.56	14.67	13.03	26.01
2	Krishna	69.03	56.27	10.69	19.00	9.20
3	Tapi	51.30	37.31	3.47	9.30	3.29
4	Narmada	1.05	0.64	-	-	0.22
5	Konkan	33.23	18.64	0.59	3.17	17.86
	Total	307.42	225.42	29.42	13.05	56.58

Reference Paragraph : 3.4.1

Annex: 3.5.1. Areas of Main River Basins in Maharashtra, Natural Water Availability and Water Allocated for Use

Geographical Area: Thousand sqkm
Cultivable Area: Lakh hectares
Water quantum : Mm^3

Basin	Geographical Area	Percent of Area of Maharashtra (w.r.t. col.2)	Cultivable Area	Percent of Area of Maharashtra (w.r.t. col.4)	Average Water Availability	Allocated for Use (Surface Water)	Allocated Water as Percentage of Availability
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Godavari	152.81	46.71	112.56	49.94	50880	34185	67.19
Krishna	69.03	22.45	56.27	24.96	34032	16818	49.42
Tapi	51.30	16.69	37.31	16.55	9118	5415	59.39
Narmada	1.05	0.34	0.06	0.28	580	308	53.1
Konkan	33.23	10.81	18.64	8.27	69210	69210	100
Total	**307.42**	**100**	**225.42**	**100**	**163820**	**125936**	**76.87**

Note: The meagre area of Mahanadi Basin falling within Maharashtra is disregarded as it is hardly 290 sqkm. Reference Paragraph: 3.5.1

Annex: 3.5.2. Statetwise Geographical Area, Cultivable Area, Water Available and Water Allocated by Tribunals in Respect of Interstate River Basins

Geographical Area: Thousand sqkm
Cultivable Area: Lakh hectares
Water Quantum: Mm^3

(Note: Percentage based on corresponding total of the basin)

Sr. No.	State	Godavari Basin		Krishna Basin		tapi Basin		Narmada Basin		Total Quantity	
		Quantity	Percentage	Quantity	Percentage	Quantity	Percentage	Quantity	Percentage	Quantity	Percentage
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	Maharashtra										
	Geographical Area	152199	49	69398	27	51254	79	1482	2	274333	37
	Cultivable Area	11307200	63	5609060	28	3626000	82	55000	1	20597200	42
	Water Available	37826	40	27238	47	7023	62	308	1	72395	36
	Allocated by Tribunal	29394	31	15855	27	5415	48	308	1	50972	26
2	Andhra Pradesh										
	Geographical Area	73201	23	76131	29	--	--	--	--	149332	20
	Cultivable Area	2830779	16	5257000	26	--	--	--	--	8087789	16
	Water Available	25575	27	9541	16	--	--	--	--	35116	18
	Allocated by Tribunal	28048	30	24050	39	--	--	--	--	50698	26
3	Karnataka										
	Geographical Area	4405	1	113419	44	--	--	--	--	117824	16
	Cultivable Area	382669	2	9276000	46	--	--	--	--	9658669	20
	Water Available	522	1	21546	37	--	--	--	--	22068	11
	Allocated by Tribunal	503	1	19620	34	--	--	--	--	20323	10
4	Madhya Pradesh										
	Geographical Area	65255	21	--	--	9634	15	85953	87	160842	22
	Cultivable Area	2632000	15	--	--	633000	14	5820000	87	9085000	18
	Water Available	20744	22	--	--	1646	15	22514	65	44904	23
	Allocated by Tribunal	26168	28	--	--	1986	18	22514	65	50668	26

(Contd.)

Annex: 3.5.2. *(Concld.)*

Sr. No.	State	Godavari Basin		Krishna Basin		tapi Basin		Narmada Basin		Total Quantity	
		Quantity	Percen-tage	Quantity	Percen-tage	Quantity	Percen-tage	Quantity	Percen-tage	Quantity	Percen-tage
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
5	Orissa										
	Geographical Area	17752	6	--	--	--	--	--	--	17752	2
	Cultivable Area	694293	4	--	--	--	--	--	--	694293	1
	Water Avail-able	9554	10	--	--	--	--	--	--	9554	5
	Allocated by Tribunal	10108	11	--	--	--	--	--	--	10108	5
6	Gujarat										
	Geographical Area	--	--	--	--	4257	7	11361	11	15618	2
	Cultivable Area	--	--	--	--	169000	4	837000	12	1006000	2
	Water Avail-able	--	--	--	--	2654	23	11720	34	14374	7
	Allocated by Tribunal	--	--	--	--	3922	35	11103	33	15025	8
	Total										
	Geographical Area	312812	100	258948	100	65145	100	98796	100	735701	100
	Cultivable Area	17846941	100	20142000	100	4428000	100	6712000	100	49128941	100
	Water Avail-able	94221	100	58325	100	11323	100	34542	100	198411	100
	Allocated by Tribunal	94221	100	58325	100	11323	100	33925	98.21*	197794*	99.69*

Notes: 1) Water availability is at 75% dependibility

2) The data drawn is as assumed by the Tribunals /Committees as a basis for consideration.

3) *Water amounting to 617 Mm^3 is allocated to Rajastan seeking joint consent of the concerned States though no area of Narmada Basin lies in that State.

Reference Paragraph: 3.5.1

Annex: 3.5.3 Sub-basin Groupwise Population, Cultivable Area and Water Availability

Water Allocated for Use: Mm^3
Population : Thousand
Cultivable area : Thousand hectare
Availability per capita, per hectare: Cubic meter

Sub-Basin No.	Sub-basin Group	Component Sub-basins	Allocated for use	Population (1991)	Cultivable Area	Availability per capita	Availability per hectare
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	West Godavari (North Maharashtra)	1) Upper Godavari (upto Paithan Dam)	7267	5443	1719	1335	4227
2	West Godavari (Marath-wada)	2) Lower Godavari (D/s of Paithan Dam) 3) Purna (Including Dudhana) 5) Remaining Godavari	3576	6729	3231	531	1107
3	Manjra	4) Manjra	1547	3010	1337	514	1157
4	East Godavari	6) Painganga 7) Wardha 8) Middle Wainganga 9) Lower Wainganga	21795	13799	4969	1579	4386
5	Tapi	10) Puma (Tapi) 11) Girna 12) Panzra 13) Middle Tapi	5415	11355	3731	477	1451
6	Narmada	14) Narmada	308	161	64	1913	4813
7	Upper Krishna	15) Upper Krishna (West) 16) Upper Krishna (East)	7718	6293	1542	1233	5031
8	Bhima	17) Upper Bhima (Upto Ujjani) 18) Remaining Bhima	7957	8604	2268	925	3508
9	Sina	19) Sina-Boti-Benetura	1103	3734	1517	295	727
10	Konkan	20) Damanganga-Par 21) North Konkan 22) Middle Konkan 23) Vashishti 24) South Konkan 25) Terekhol-Tillari	69210	19794	1864	3497	37130
		Maharashtra	125936	78922	22542	1596	

Notes : 1) The Sub-basins are grouped on (solely for the purpose) of this topic the basis of climate, rainfall, deficit/ surplus water availability.

2) The water allocated for use in respect of component of Sub-basin Groups (No. 7,8,9) of Krishna Basin be treated merely for planning water use.

Reference Paragraph: 3.5.3

Annex: 3.6.1. Interstate Projects

Water Use: Mm^3, Submergence: hectare
Hydroelectric Generation Potential: MW, Irrigation Area: hectare

Sr.No.	Project	Other Concerned States	Water Use in Maharashtra	Submergence in Maharashtra	Maharashtra's share in the Installed Hydro-electric Generation Potential	Irrigation Area in Maharashtra
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	Lendi	Andhra Pradesh	100		0.35	19758
2	Lower Painganga	Andhra Pradesh	968			
3	Ambapata	Madhya Pradesh		5055		195
4	Satnoor	Madhya Pradesh				299
5	Umari	Madhya Pradesh	6			
6	Pendhari Nala	Madhya Pradesh	8			1837
7	Shekdari	Madhya Pradesh	5	76		1340
8	Upper Wardha	Madhya Pradesh	586	9748	2.25	75000
9.	Wai	Madhya Pradesh	3			536
10	Nagathana	Madhya Pradesh	2	63		212
11	Pat Nala	Madhya Pradesh	1			150
12	Pench	Madhya Pradesh	954	2973	53	104476
13	Bagh	Madhya Pradesh	215	2834		28218
14	Bawanthadi	Madhya Pradesh	181	3477	1.30	27708
15	Dhapewada	Madhya Pradesh	41			5000
16	Ease Bagh	Madhya Pradesh	45	108	2.65	6347
17	Kalisarar	Madhya Pradesh	34	3477		3522
18	Teliya	Madhya Pradesh				
19	Kanhan	Madhya Pradesh	714	2537		2800
20	Mongra (Shivonath)	Madhya Pradesh		7		
21	Kathani	Madhya Pradesh	294	1460		22847
22	Inchampalli	Madhya Pradesh Andhra Pradesh	112	33614	231.00	11000
23	Bandiya	Madhya Pradesh	50	53803	6.35*	
24	Bhopalpattanam	Madhya Pradesh	4500	43803	450.00*	39540
25	Kotri-Nibra	Madhya Pradesh	156		99.70*	
26	Nugur-2	Madhya Pradesh	28		25.00*	
27	Chargad	Madhya Pradesh	10			1595
28	Bhokar River	Madhya Pradesh	5			1729
29	Chhindwadi	Madhya Pradesh				
30	Gondvihir	Madhya Pradesh	3	55		417

(Contd.)

Annex: 3.6.1. ***(Concld.)***

Sr.No.	Project	Other Concerned States	Water Use in Maharashtra	Submergence in Maharashtra	Maharashtra's share in the Installed Hydro-electric Genera-tion Potential	Irrigation Area in Maharashtra
(1)	(2)	(3)	(4)	(5)	(6)	(7)
31	Khurshi	Madhya Pradesh				
32	Purna	Madhya Pradesh	49			9815
33	Karwand	Madhya Pradesh	37			4534
34	Aner	Madhya Pradesh	65			6320
35	Bokad Nala	Madhya Pradesh	5			1897
36	Gomai	Madhya Pradesh	29			4484
37	Matrala	Madhya Pradesh				
38	Pimpri (Pancham)	Madhya Pradesh	2			172
39	Sukhi	Madhya Pradesh	35			6275
40	Upper Tapi-2 (Khariya Gutighat)	Madhya Pradesh	1283	7999	30.00	59849
41	Sardar Sarowar	Gujarat, Madhya Pradesh, Rajasthan	120	6570	391.50	37500
42	Jalshindhi	Madhya Pradesh				
43	Dudhganga	Karnatak	664	2812	24.00	46948
44	Damanganga	Gujarat, Daman, Dadara, Nagar Haveli	6	43		550
45	Tillari	Goa	158	1763		6676
	Total					

Source : I) Note received from Govt. Irrigation Department. Water Resources Cell.)
2) Projectwise Chronological Record of Agreements and Decisions of the Board.
'ISCB, Nagpur (Probably 1990).
Notes: 1) The Madhya Pradesh Government through its letter No.S/21/94/MI/11. dated 1-11-94 consented to the full water use of the Bewartola Irrigation Project by Maharashtra. This prompted its deletion from the list of Interstate Projects.
2) The resolution in the Interstate Central Board's meeting led to delete the Arna Irrigation Project from the list of Interstate Projects.
3) Command to the extent of 975 ha out of 1160 ha of Narpa Project falls within the submergence of-Upper Tapi Stage-II (Khariya Gutighat). This prompted the Chief Engineer, Tapi-Narmada Basin, Bhopal (Madhya Pradesh) to recommend its exclusion during the deliberations of Board's 25th meeting held @ Pune on 19-7-94. The recommendation was accepted. Which resulted in dropping the project from the list of joint ventures.
4) Both the Mona and Utavali Irrigation Schemes are proposed solely for the benefit of Madhya Pradesh. No information about submergence in and liabilities of Maharashtra is available.
5) Not applicable columns are kept blank. Similarly, columns are left blank where information could not be obtained.
6) The indicated hydroelectric generation potential is joint for both the States. No information about the Maharashtra's share could be obtained.
Reference Paragraph: 3.6.1

Annex: 3.7.1. Inter-basin Water Tranfer Schemes in Maharashtra

Water Use: Mm^3, Lift: m

Sr.No.	Name of Scheme	Donor Basin	Benefited Basin	Quantum of water use	Mode of transfer	Lift	Status
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	Mula Irrigation Project	Upper Godavarl-Upto Paithan (Mula and Pravara)	Upper Godavari-upto Paithan (Excluding Mula and Pravara)	215	canal		Already functioning
2	Bhandardara Project	Upper Godavari-Upto Paithan (Mula and Pravara)	Upper Godavari-upto Paithan (Excluding Mula and Pravara)	135	canal		Already functioning
3	Bhojapur Irrigation Project	Upper Godavari-Upto Paithan (Mula and Pravara)	Upper Godavari-upto Paithan (Excluding Mula and Pravara)	5	canal		Already functioning
4	Vaitarna-Alwandi-Mukane	North Konkan	Upper Godavari-upto Paithan (Excluding Mula and Pravara)	1133	canal		Already functioning
5	Par/Datnanganga-Godavari lift Irrigation Scheme		Upper Godavari-upto Paithan (Excluding Mula and Pravara)		canal		Already functioning
	i) Nar (Milan)	Damanganga-Par	Upper Godavari-upto Paithan (Excluding Mula and Pravara)	166	lift		Already functioning
	ii) Par	Damanganga-Par	Upper Godavari-upto Paithan (Excluding Mula and Pravara)	261	lift		Already functioning
	iii) Mamda	Damanganga-Par	Upper Godavari-upto Paithan (Excluding Mula and Pravara)	93	lift		Already functioning
	iv) Damanganga (Ekdare)	Damanganga-Par	Upper Godavari-upto Paithan (Excluding Mula and Pravara)	255	lift		Already functioning
	v) Wal River (Adgaon)	Damanganga-Par	Upper Godavari-upto Paithan (Excluding Mula and Pravara)	207	lift		Already functioning
6	Damanganga (Godavari)	Damanganga-Par	Upper Godavari-upto Paithan (Excluding Mula and Pravara)	1021	lift		Proposed
7	Par-Godavari	Damanganga-Par	Upper Godavari-upto Paithan (Excluding Mula and Pravara)	305	canal		Proposed
8	Katak (Vaitarna)-Mukane (Darana) Gated spillway	North Konkan	Upper Godavari-upto Paithan (Excluding Mula and Pravara)	72	canal		Proposed
9	Par/Damanganga-Godavari Gravity Transfer Scheme						
	i) Payarpada	Damanganga-Par	Upper Godavari-upto Paithan (Excluding Mula and Pravara)	1	canal		Proposed

(Contd.)

Annex: 3.7.1. *(Contd.)*

Sr.No.	Name of Scheme	Donor Basin	Benefited Basin	Quantum of water use	Mode of transfer	Lift	Status
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	ii) Palasvihir	Damanganga-Par	Upper Godavari-upto Paithan (Excluding Mula and Pravara)	2	canal		Proposed
	iii) Dhondalpada	Damanganga-Par	Upper Godavari-upto Paithan (Excluding Mula and Pravara)	2	canal		Proposed
	iv) Natiashi	Damanganga-Par	Upper Godavari-upto Paithan (Excluding Mula and Pravara)	1	canal		Proposed
	v) Chillarpada	Darrianaanaa-Par	Upper Godavari-upto Paithan (Excluding Mula and Pravara)	1	canal		Proposed
	vi) Chimanpada	Dainanganga-Par	Upper Godavari-upto Paithan (Excluding Mula and Pravara)	2	canal		Proposed
	vii) Mahaje	Damanganga-Par	Upper Godavari-upto Paithan (Excluding Mula and Pravara)	2	canal		Proposed
	viii) Amboli	Damanganga-Par	Upper Godavari-upto Paithan (Excluding Mula and Pravara)	4	canal		Proposed
	ix) Kalmuste	Danaanganga-Par	Upper Godavari-upto Paithan (Excluding Mula and Pravara)	11	canal		Proposed
	x) Kapwadi (Talegaon)	North Konkan	Upper Godavari-upto Paithan (Excluding Mula and Pravara)	5	canal		Proposed
	xi) Hiwara Nala	North Konkan	Upper Godavari-upto Paithan (Excluding Mula and Pravara)	15	canal		Proposed
	xii) Samrad	North Konkan	Upper Godavari-upto Paithan (Excluding Mula and Pravara)	12	canal		Proposed
10	Purna Irrigation Project	Purna (Including Dudhana)	Lower Godavari	434	canal		Already functioning
11	Wainganga-Godavari Scheme	Lower Wainganga (Pranhita)	Lower Godavari	7078	lift & river		In view
12	Jayakwadi Irrigation Project (Stage-II)	Lower Godavari (Godavari)	Lower Godavari (Sindphana)	251	canal		Already functioning
13	Lower Manar Project (Branch Canal 1,2)	Manjra	Lower Godavari	132	canal		Already functioning

(Contd.)

Annex: 3.7.1. ***(Contd.)***

Sr.No.	Name of Scheme	Donor Basin	Benefited Basin	Quantum of water use	Mode of transfer	Lift	Status
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
14	Upper Painganga (Stage-I)	Painganga	Lower Godavari	655	canal and tunnel		In view
15	Upper Manar Project	Manjra	Lower Godavari	42	canal		Already functioning
16	Jayakwadi Project (Stage-I)	Lower Godavari	Purna (Including Dudhana)	405	canal		Already functioning
17	Bhima-Terra (via Sina)	Remaining Bhima (Below Ujjani including Man)	Manjra	28	lift and canal		In view
18	Khadakpurna Irrigation Project	Purna (Including Dudhana)	Painganga	15	lift	134.35	In view
19	Pentakli Irrigation Project	Painganga	Purna (Tapi)	26	canal and tunnel		In view
20	Upper Wardha Project	Wardha	Purna (Tapi)	681	pipe line		Already functioning
21	Diversion Project for Gima				canal		Proposed
	i) Chirai	Damanganga-Par	Girna	2			
	ii) Haran Tekdi	Damanganga-Par	Girna	1			
	iii) Rasha	Damanganga-Par	Girna	1			
	iv) Araspada	Damanganga-Par	Girna	1			
22	Lower Tapi-Boti-Girna -LiftIrrigation Scheme	Middle Tapi (Satpuda) (*Tapi*)	Middle Tapi (South) *(Bori)* Girna	34 287	lift lift	259	Proposed Proposed
23	Par-Girna	Damanganga-Par	Girna	337	canal		Proposed
24	Prakasha-Malangaon Lift Irrigation Scheme	Middle Tapi (South)	Panzra	28	lift		Proposed
25	Sarangkheda-Gomai Lift Irrigation Scheme	Middle Tapi (Satpuda) *(Tapi)*	Middle (Satpuda) *(Gomai)*	28	lift		Proposed
26	Sarangkheda-Shewadi-Akkalpada	Middle Tapi (Satpuda) *(Tapi)*	Middle (Satpuda) *(Burai)*	17	lift	282	Proposed
			Panzra	40	lift		Proposed
27	Prakasha-Burai Lift Irrigation Scheme	Middle Tapi (Satpuda) *(Tapi)*	Middle(Satpuda) *(Burai)*	17	lift	340	Proposed
28	Sulwade-Jannphal-Kanoli Lift Irrigation Scheme	Middle Tapi (Satpuda) *(Tapi)*	Panzra	21	lift	279	Proposed
			Middle Tapi (South)	28			

(Contd.)

Annex: 3.7.1. ***(Contd.)***

Sr.No.	Name of Scheme	Donor Basin	Benefited Basin	Quantum of water use	Mode of transfer	Lift	Status
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
29	Sulwade-Karwand Lift Irrigation Scheme	Middle Tapi (Satpuda) *(Tapi)*	Middle Tapi (South) Arunawati	28	lift		Proposed
30	Par-Tapi-Narmada Link (NWDA)	Damanganga-Par	Narmada*	1350	lift and tunnel		In view
31	Gaibi Tunnel	Upper Krishna(North-West) *(Dudhganga)*	Upper Krishna (North-West) *(Panchganga)*	275	tunnel		Already functioning
32	Urmodi Irrigation Project	Upper Krishna(North-West)	Upper Krishna (East) Yerala	105	canal and tunnel		
			Remaining Bhima (D/s of Ujjani including Man)	105		136	
33	Tembu Lift Irrigation Project	Upper Krishna(North-West)	Upper Krishna (East) Yerala	286	lift		Under construction
			Upper Krishna (East) Agrani	55	lift	385	Under construction
			Remaining Bhima (D/s of Ujjani including Man)	282			Under construction
34	Krishna-Koyna Lift Irrigation project (Takari)	Upper Krishna (North-West)	Upper Krishna (East) Yerala	711	lift	209.42	Under construction
			Upper Krishna (East) Agrani	136	lift		Under construction
35	Krishna-Koyna Lift Irrigation project (Mhaisal)	Upper Krishna (North-West)	Remaining Bhima (D/s of Ujjani including Man)	66	lift	252.20	Under construction
			Upper Krishna (East) Agrani	66	lift		Under construction
36	Tarali Irrigation Project	Upper Krishna (North-West)	Upper Krishna (East) Yerala	48	canal		Under construction
			Remaining Bhima (D/s of Ujjani including Man)	48	lift	50	Under construction
37	Purandar Lift Irrigation Scheme	Upper Bhima (Upto Ujjani)	Remaining Bhima (Neera)	103	lift	299	Under construction
38	Janai-Shirsai Lift Irrigation Scheme	Upper Bhima (Upto Ujjani)	Remaining Bhima (Neera)	105	lift	42.4 & 58.2	Under construction
39	Sansar Link Canal	Upper Bhima (Upto Ujjani)	Remaining Bhima (Neera)	110	canal		Under construction

(Contd.)

Annex: 3.7.1. ***(Contd.)***

Sr.No.	Name of Scheme	Donor Basin	Benefited Basin	Quantum of water use	Mode of transfer	Lift	Status
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
40	Dhom-Balakwadi Tunnel	Upper Krishna (North-West)	Remaining Bhima (Neera)	95	canal and tunnel		Under construction
			Remaining Bhima (D/s of Ujjani including Man)	15	lift	69	Under construction
41	Jihe Kathapur Lift Irrigation Scheme		Upper Krishna (East) Yerala	38	lift	263.92	Under construction
			Remaining Bhima (D/s of Ujjani including Man)	22	lift		Under construction
42	Sangola Branch Canal	Remaining Bhima (Neera)	Remaining Bhima (D/s of Ujjani including Man)	42	canal		Already functining
43	Neera Right Bank Canal No. 3&4	Remaining Bhima (Neera)	Remaining Bhima (D/s of Ujjani including Man)	174	canal		Already functioning
44	Ujjani Canal (Bhima Project)	Upper Bhima (Upto Ujjani)	Remaining Bhima (D/s of Ujjani including Man)	60	canal		Already functioning
45	Kukadi-Sina Series i) Choundi K.T. Weir	Upper Bhima (Upto Ujjani)	Sina	28	canal and river		Under construction
	ii) Mangi Tank	Upper Bhima (Upto Ujjani)	Sina	28	canal and river		Under construction
	iii) Pimpalgaon Joge to Sina	Upper Bhima (Upto Ujjani)	Sina	17	canal and river		In view
46	Sina-Madha Lift Irrigation Scheme	Upper Bhima (Upto Ujjani)	Sina	106	lift	48	Under construction
47	Bhima-Sina Link Canal	Upper Bhima (Upto Ujjani)	Sina	109	canal and tunnel		Under construction
48	Shirapur Lift Irrigation Scheme	Upper Bhima (Upto Ujjani)	Sina	49	lift	74.4	under construction
49	Ashti Lift Irrigation Scvheme (Devdimal)	Upper Bhima (Upto Ujjani)	Sina	44	lift	40.9	Under construction
50	Barshi Lift Irrigation Scheme	Upper Bhima (Upto Ujjani)	Sina	73	lift	83.3	Under construction
51	Dahigaon Lift Irrigation Scheme	Upper Bhima (Upto Ujjani)	Sina	51	lift	91	Under construction
52	Kukadi-Sina-Mehkari Link Canal	Upper Bhima (Upto Ujjani) Sina	Sina	20	canal and tunnel		Under construction

(Contd.)

Annex: 3.7.1. *(Concld.)*

Sr.No.	Name of Scheme	Donor Basin	Benefited Basin	Quantum of water use	Mode of transfer	Lift	Status
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			Sina	14	lift		Under construction
53	Bhima-Sina	Upper Bhima (Upto Ujjani)	Sina	57	lift and canal		In view
54	Bhima(Ujjani)-Sina Kolegaon	Upper Bhima (Upto Ujjani)	Sina	57	lift and canal		In view
55	Ekrukh Lift Irrigation Scheme(Darganhalli)	Sina	Bori-Benetura	37	lift		Under construction
56	Ekrukh Lift Irrigation Scheme (Harni)	Sina	Bori-Benetura	54	lift	63.85	Under construction
57	Bhima-Benetura(via Sina)	Remaining Bhima (D/s of Ujjani including Man)	Bori-Benetura	84	lift and canal		In view
58	Tata Hydro-electric Project						
	i) Shirwata, Walwan, Lonawala (Khopoli)	Upper Bhima (Upto Ujjani)	North Konkan	180	tunnel		Already functioning
	ii) Andhra (Bhivpuri)	Upper Bhima (Upto Ujjani)	North Konkan	341			Already functioning
	iii) Mulshi (Bhira)	Upper Bhima (Upto Ujjani)	Middle Konkan	680			Already functioning
59	Damanganga-Pinjal Link (NWDA)	Damanganga-Par	North Konkan	1504	lift and tunnel	510	In view
60	Koyna HydroElectric Project (Stage I to IV)	Upper Krishna (North-West)	Vashishti	1911	lift and river		Already functioning
61	Schemes for Westward Diversion of water from Krishna Basin for Hydro Electric Generation						
	i) Kasari	Upper Krishna (North-West)	South Konkan (Ratnagiri)	974	under study		In view
	ii) Kumbi	Upper Krishna (North-West)	South Konkan (Ratnagiri)	297	under study		In view
	iii) Kadvi	Upper Krishna (North-West)	South Konkan (Ratnagiri)	258	under study		In view

Notes: 1) The scheme are arranged in the order of serial numbers of benefited basins.
2) The benefited basin in respect of scheme @ Sr.No. 11 is in fact Upper Godavari Upto Paithan. However the benefit is accruable in the Lower Godavari Sub-basin by virtue of the location of the Paithan Reservoir in which the actual transfer is proposed.
3)* The Narmada Basin in Maharashtra is no longer benefited from this scheme.
4) The donor basin in respect of schemes @ Sr.No. 46 to 51 is physically Upper Bhima (Upto Ujjani). However by virtue of the location of the Ujjani Reservoir under Bhima Project 1760 Mm^3 water quantum from it stands transferred to the Remaining Bhima (D/s Ujjani including Man) from the benefit point of view (Statement 3.5.1 or Appendix 3.5.1). Water use envisaged in the foregoing schemes is already contained in that quantum. In view of this the donor basin may be treated as the Remaining Bhima (D/s of Ujjani including Man).

Source: 1) The lifts are as informed by the field officers from the Irrigation Department.
2) Head for lift for project in Sr.No. 59 above is as per the study of NWDA.
3) Lifts in respect of schemes in Sr.No. 22,26,27,28 the lift height is as per preliminary survey as informed by the field officers.
Reference Paragraph: 3.7.7

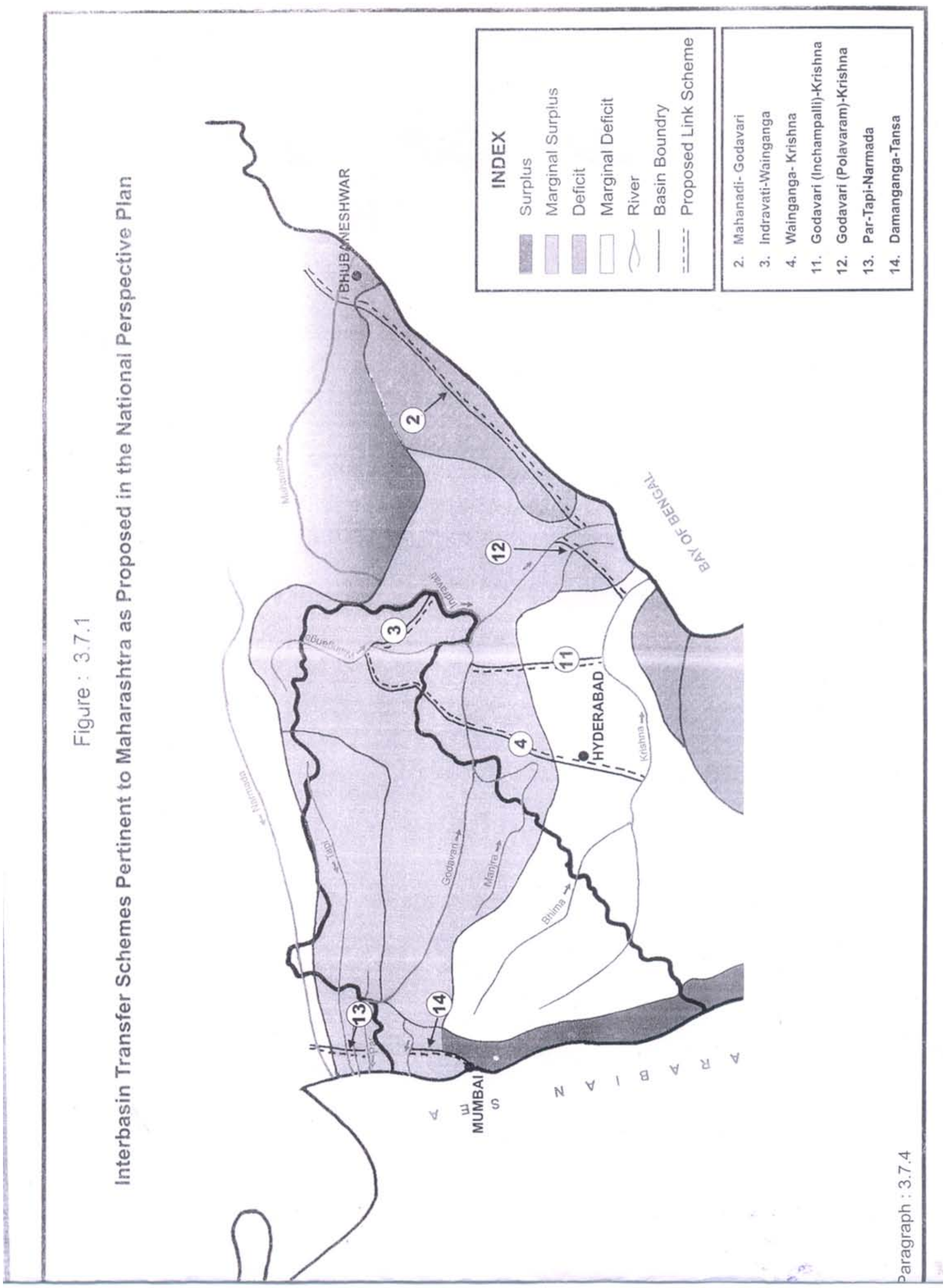
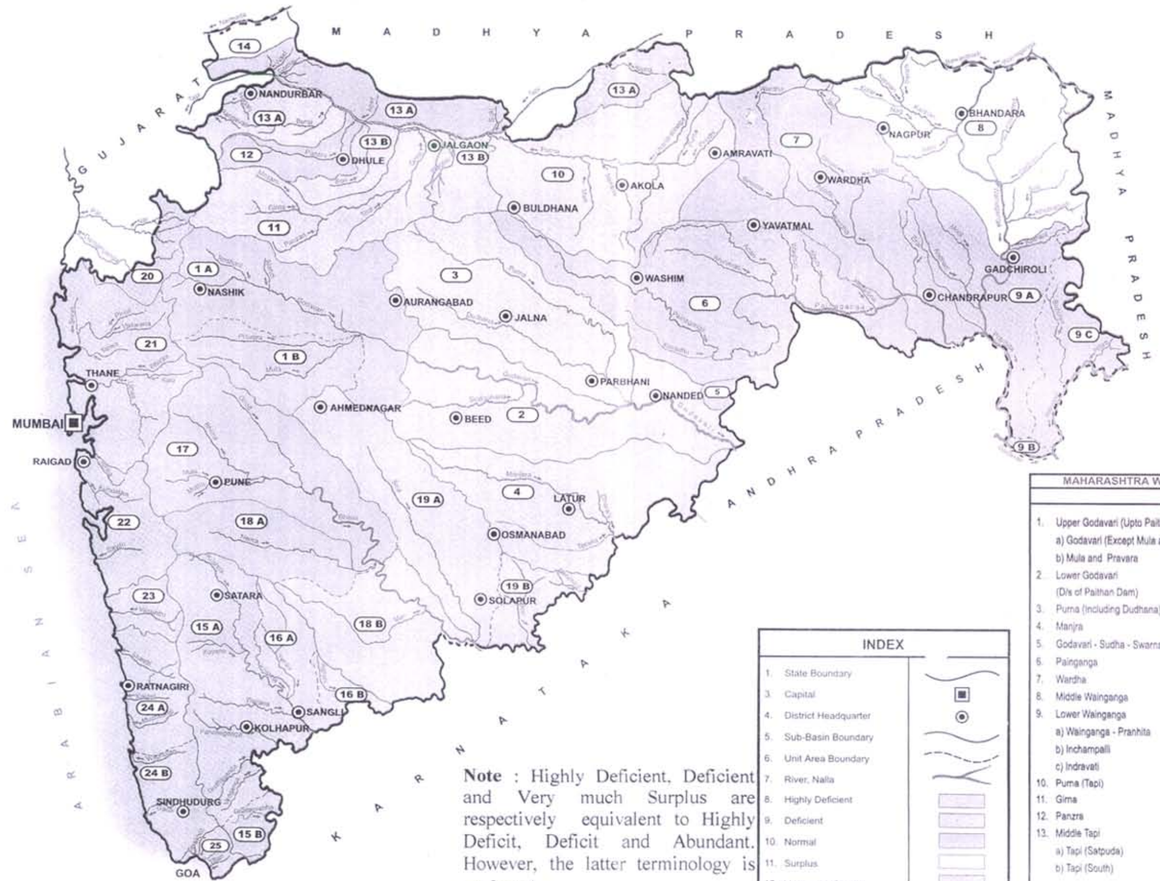


Figure : 3.7.1

Interbasin Transfer Schemes Pertinent to Maharashtra as Proposed in the National Perspective Plan

SUB - BESINS IN MAHARASHTRA AS PROPOSED BY THE COMMISSION & CATEGORIZATION THEREOF IN PLANNING GROUPS

Map NO. : 3.2.1
Paragraph Ref. : 3.2.1



Note : Highly Deficient, Deficient and Very much Surplus are respectively equivalent to Highly Deficit, Deficit and Abundant. However, the latter terminology is preferred.

INDEX

1. State Boundary
3. Capital
4. District Headquarter
5. Sub-Basin Boundary
6. Unit Area Boundary
7. River, Nalla
8. Highly Deficient
9. Deficient
10. Normal
11. Surplus
12. Very much Surplus

MAHARASHTRA WATER & IRRIGATION COMMISSION

Sub Basin

1. Upper Godavari (Upto Paithan Dam)	14. Narmada
a) Godavari (Except Mula and Pravara)	15. Upper Krishna (West)
b) Mula and Pravara	a) North - West
2. Lower Godavari	b) South - West
(D/s of Paithan Dam)	16. Upper Krishna (East)
3. Purna (Including Dudhana)	a) Yerala
4. Manjra	b) Agrani
5. Godavari - Sudha - Swarna	17. Upper Bhima (Upto Ujani)
6. Painganga	18. Remaining Bhima
7. Wardha	a) Neera
8. Middle Wainganga	b) D/s of Ujani Including Man
9. Lower Wainganga	19. Sina - Bori - Benetura
a) Wainganga - Pranhita	a) Sina
b) Inchampalli	b) Bori - Benetura
c) Indravati	20. Damanganga - Par
10. Purna (Tapi)	21. North Konkan
11. Girna	22. Middle Konkan
12. Panzra	23. Vashishthi
13. Middle Tapi	24. South Konkan
a) Tapi (Satpuda)	a) Ratnagiri
b) Tapi (South)	b) Sindhudurg
	25. Terekhol Tillari

CHAPTER 6
Distribution and Management of Water
6.1 Maintenance and Management of Projects

6.1.1 At the outset, it has to be mentioned that the zeal with which large projects are undertaken and built, is seldom noticeable in their maintenance. It is observed that their maintenance is more or less, a neglected aspect. Negligence regarding maintenance is not confined to Irrigation Projects alone or limited to Maharashtra state only but it pervades among Government buildings, roads and even among other states of India also. The Tenth Finance Commission has expressed a grave concern about it.

6.1.2 The main components of an Irrigation Project are main dam, main canals, major and minor distributaries and the further distribution network. The nature of maintenance necessary for all these components is different from one another and, therefore, the maintenance set-up and criteria therefor for all these components are necessarily spelt out differently.

Maintenance of Dam

6.1.3 The consequences of failure of a dam are quite catastrophic as compared to the failure of other structures. Such a failure can result in enormous loss of life and property. Damage worth crores of rupees is imminent. Even if the dam does not actually fail, but only gets distressed making it functioning impaired by preventing from achieving full impoundment, then also a considerable economic loss is entailed. It is, therefore, utmost necessary to pay careful attention to the safety of dam before the commencement of construction, during the course of construction and after its construction.

Proper investigation (especially geological and hydrological), designs (with the helping hand of research institute may be sought, wherever necessary), proper specifications, meticulous supervision and rigorous quality control are essential as a precaution during both before and during the construction.

Proper maintenance prompt repairs as well as proper operation as well are essential precautionary measures in pos- construction phase.

If the probable consequences of poor maintenance are always kept in view, the importance of laying down extremely stringent standards for maintenance and scrupulous observance thereof need not be emphasised.

Scope of the work: The International Commission On Large Dams (ICOLD) has defined a 'large dam' as:

1) A dam having height 15 m or more from the deepest foundation
2) A dam between 10 to 15 m in height and fulfilling any one of the following criteria:

* Length 500 m or more
* Storage 1 Mm^3 or more
* Maximum spillway discharge 200 cumecs or more
* Weak foundation
* Unusual design.

According to the foregoing definition Maharashtra has (till end of 1997) a total of 1392 large dam.[1] Maharashtra is the foremost in this respect. India has a total of 4291 such large dams.[2] Thus Maharashtra has to shoulder a proportionately greater responsibility as far as safety of dams is concerned.

1. As furnished by the Dam Safety Organization, Nashik.
2. National Register of Large Dams (December 1994).

Maintenance Organization

6.1.4 To ensure safety of dams, one organization has been established in 1980 in Maharashtra within the Irrigation Department. Also, it has been made obligatory by the Irrigation Department on the part of all officers in-charge of dams to carry out detailed inspection of every dam at least twice (pre and post - monsoon) in a year.

6.1.5 For the purpose of maintenance, large dams have been classified according to their height, maximum spillway discharging capacity etc. It is like this.

Category	Criteria	No. of dams
I	a) Height exceeding 30 m or b) Gross storage capacity exceeding 60 Mm^3 or c) Dams having gated spillway d) Spillway discharging capacity exceeding 2000 cumec	106
II	Height exceeding 15 m, storage exceeding 15 Mm^3, Spillway discharging capacity exceeding 2000 cumec, length exceeding 2000 m	737
III	Height between 10 to 15 m and fulfilling any one of the following conditions: a) Storage capacity exceeding 1 Mm^3 b) Length exceeding 500 m	549
	Total	1,392

Inspection of dams belonging to category I, II & III type dams is carried out by Superintending Engineer, Executive Engineer and Deputy. Engineer respectively. However, test inspection of large dams belonging to category I is carried out by the Chief Engineer himself.

6.1.6 A detailed questionnaire has been evolved by the Irrigation Department specifying the various points to be observed while carrying out the inspection. The answer to the questionnaire reveal whether the maintenance is being carried out satisfactorily or otherwise.

6.1.7 The primary responsibility for the safety of a dam rests with the engineer who is in-charge of its operation & maintenance. However, the Government established a special Dam Safety Organization at Nashik in 1980 to monitor whether detailed safety inspections of these dams are carried out systematically and to undertake and overview of the inspection reports. It scrutinizes the inspection reports received from various officers who are made competent to conduct such inspections and draws attention of the Regional Chief Engineers to the points which need immediate compliance. In addition, the Organization independently carries out inspections of some selected dams from of category I. Besides this, the Organization brings out a Health Status Report of dams in the State and submits the same to the Government. But merely submitting the report to the Government should not be an end. It is desirable to lend it more formal statutory status. With this in view, the said report should be submitted annually to the *Maharashtra Jal Aayog* formation of which is suggested in Chapter 13. The latter, in turn, should present it before the *Maharashtra Adsampatti Pradhikaran* alongwith an indication of proposed action in this regard.

6.1.8 In order to enable the DSO to carry out works entrusted to it in a proper manner, the Government has put a restriction on the workload to be shouldered by that Organization. The Organization is entrusted the monitoring of about 700 out of the 1392 large dams. The Government has also laid down the criteria for selecting these

700 dams.

6.1.9 The Dam Safety Organization draws the attention of the Regional Chief Engineers and the Government of Maharashtra towards the short-comings or other matters of serious concern indicated in inspection reports. None the Jess, sufficient attention is not being paid to ascertain whether proper remedial measures having undertaken or not These shortcomings will be got rid of if the aforementioned modus operandi is followed and the serious shortcomings will be independently pursued.

6.1.10 Out of the various various instruments installed on dams, more than half are out of order. These instruments are presently being installed by the concerned construction wing and, therefore, the method of their installation as well as quality thereof is varying. The information on measurements obtained from various instruments installed on dams is not properly accrued. The consolidated data in respect of various projects is devoid of any unification. Difficulties are experienced in drawing inferences therefrom so as to suggest remedial actions. The work of installation of various instruments on dams should, therefore, be got coordinated through the existing Dam Safety Organization.

6.1.11 The data, as may be available from instruments those are in working condition, needs to be analyzed properly and promptly. The instruments are indispensable to ascertain the health status of the dams. It is vitally important to keep them in working order as well as analyse and put to use the data obtained there from. It is imperative that the data be analysed in time bound manner and the inferences drawn therefrom be incorporated in the annual report. If the present establishment is inadequate to carry out this job, it will have to be strengthened in time. The Commission recommends the formation of an independent unit under this Organization for those sub-basins which may have more than 50 large dams.

6.1.12 For facilitating maintenance during emergency, emergency gates are either not in place or if they are, no trial thereof has ever been conducted. This is a matter of grave concern. Standby generators, necessary to operate the gates in case of power failure, are not in working state on several dams. It is necessary to highlight the deficiencies in the annual reports being brought out by the Dam Safety Organization.

6.1.13 The Darn Safety 0rganization is mainly concerned with major dams. It cannot attend to the maintenance of minor irrigation projects and percolation tanks. There is even no set procedure for the maintenance of the percolation tanks. It is true that a breach in such an embankment is not likely to ,cause even a moderate loss of property. Nevertheless, it is definitely going to adversely affect the local population as well as the agriculture along the banks. Thus a procedure to ensure proper maintenance essentially be laid down even for such dams. The Dam Safety Organization should bring out a manual therefor early. Particulars of large and medium projects completed as well as under construction, discharging into any one given river of the major rivers in the State, are given in Annex 6.1.1. It is clear from the same that the number of large and medium projects discharging into the river Pranhita is higher than that for any other river. This is closedly followed by the river flows in Wainganga and Godavari.

6.1.14 No adequate grants for maintenance of irrigation projects are being made available. This constant grievance of engineers is by far the most justified also This outlay has been regarded as apart of ‘Non-plan’ class expenditure as the present working system goes; and it is a principle always being followed that the non-plan expenditure be kept as minimum as possible. Because of this, even the improvements directly related with safety tend to be neglected. A remaining shortcoming related to safety cannot be said to be a form of normal maintenance, but in fact a new addition and a capital intensive mode of removing the shortcoming. Therefore, it will be proper to bring forth this expenditure under plan provisions rather than regarding it as non-plan.

6.1.15 Maintenance of dams involves a number of different types of works. Such works are not required to be undertaken more often or frequently. Nevertheless, skilled artisans are required for executing such works. As these maintenance works on different, dams tend mostly to be of similar nature and of minor quantum, central mobile maintenance unit should be created so that maintenance works could be done more easily with attendant saving in time and money as well; and it will not be necessary to maintain separate staff for these works on every darn. If a mobile unit is created, the officers staff will be able to camp at a given dam site and finish the work speedily and properly leading to saving in costs. Keeping the technical control of this with the Dam Safety Organization, proper information pertinent to maintenance works as well as ground realities on dam sites will be immediately available to it. However, the responsibility of safety of dams will rest with the field officers only. Canal Maintenance And Management

6.1.16 The gross capital investment on major, medium and minor irrigation projects in Maharashtra upto 1996 (as per the 1996 prices), is Rs. 21477 crores and the expenditure incurred per m3 of water stored is Rs. 8.53 (as per the 1998 price level). Water thus being a valuable and essential ingredient of agricultural production, it is a need of time that it not only be used economically, justifiably and in a manner conducive to the growth of crops, but it is also necessary to have an irrigation management which will keep a meticulous account thereof. The State should, therefore, aim at a target of achieving maximum possible agricultural productivity per unit quantum of water and adopt the principle of output-oriented management. A system of assessing whether the expected goal has been realised or not, seems to be wanting in the irrigation management of the State. To have such a system is very essential. The system should assess the extent to which targets are achieved by undertaking evaluation from time to time and publish the findings.

6.1.17 A method of assessing the requirement for water in project planning based on modern analysis has been in practice since 1980 on account of guiding principles of planning laid down by the Central Water Commission. The same meticulousness, however, is not being followed thereafter in actual practice and hence planning and execution cannot be compared on a common basis.

6.1.18 Information as to water that is being made available for managing irrigation can only be realistically had only if measurement of discharge passing through a canal is undertaken. The head regulators on canals also have to be necessarily in proper working condition. A study of 29 standing wave flames carried out by the Maharashtra Engineering Research Institute (MERI) revealed that the designed standing wave had not been formed at 19 .sites and at 23 sites, the calibration had not been readily available whereas the gauges were out of order at 17 sites. Under such circumstance incorrect estimation of the discharge is obtained. It is therefore, essential that the flow measurement apparatus is kept in order consistent with the hydrodynamic laws, without which no accounting of water can be correctly carried out.

6.1.19 The transit losses in a canal are not necessarily based upon appropriate principles/inspections or, measurements. Therefore, planning the distribution of irrigation water as well as its actual implementation in practice has to be accomplished rather roughly and an accurate accounting of water is far from realisable. Therefore, a separate cell is needed under a central organization such as MERI to determine water losses. It should lay down projectwise standards regarding the losses in major/medium canals, at least once in ten years, based upon field measurements. It should also evolve norms for precisely estimating transit losses on minor canals.

6.1.20 It is necessary to install an evaporimeter on every dam to measure the evaporation losses in a reservoir. It is observed that such devices are available on a few major projects only. But here too, it is noticed that information accrued out of these observations, its compilation, analysis and findings have not been correlated with the annual account of water in the reservoir. It is essential to install evaporimeters on all major as well as medium projects and even on a few chosen minor projects to measure the evaporation in reservoirs. It is also essential to devise and lay down a system to carry out the measurements, compile the data, analyse the same and streamline the procedure ensuring its use in its management.

6.1.21 In irrigation management an important link between the farmer and the Governmental set-up, is the outlet. It is impossible to correctly tally the account of distribution of water when the outlet is not in a good working condition. It is observed that half or even lesser number of outlets are in good working condition. It is necessary to clearly point out the condition of the outlets in the annual irrigation report of a project, without which the factual status of the distribution of water cannot be properly understood.

6.1.22 The irrigation report, which is being prepared at the end of a season and at the end of an irrigation year, is still based upon the conventional old (prescribed in the 19th century) method. A radical change is called for, and a report adopting modern monitoring and assessment techniques bringing out the entire status clearly needs to be prepared: To sum up, the various types of forms and applications used in the Irrigation Department were based on the practices prevailing in the 2nd decade of this Century and are now mostly obsolete. They need to be thoroughly revised and a new practice needs to be established forthwith. In fact, the National Irrigation. Commission (1972), as well as the Maharashtra High Power Irrigation Committee (1981), have at least made recommendation about this much earlier. They need to be implemented at, an early date.

6.1.23 It has been observed that most of the canals do not carry the designed discharge. There could be many reasons for this. The cross section and slope of the canal is decided as per the Manning's Formula. The coefficient of friction between the water and the sides of a canal is assumed in this formula. There is an urgent need to ascertain the precise value of this coefficient. It appears the formula needs modification taking into consideration the physical condition of the canal that is lining of the canal, the C. D. works there across etc. The reason is assumed in the formula that water flows only through the cross section of the canal over long reaches. However, number of C.D. works like siphons, aqueducts, bridges, etc., which are components of the flow system, have to be constructed across the canals due to the undulating topography of Maharashtra. They tend to hinder the water flowing process. Therefore, this flow formula needs to be restated by taking into overall consideration the entire conveyance system.

6.1.24 As the prevailing practice goes, the distribution of water to crops on the field is planned to be achieved by the *shejpali* method except in case of paddy. However, it does not become possible in practice to use this system due to several shortcomings and difficulties. The *Shejpali* method cannot be implemented in its true sense, unless these obstacles are overcome. The discharge flowing thorough a canal system in often determined on the basis of guess because of several reasons such as the discharge capacity of the main canal, distributaries, minors and field channels not being according to the designed capacity, the canal system not being in order due to lack of maintenance and the resulting toss in its carrying capacity, the discharge measuring device being either not installed at the heads of the main canal, distributaries, minors, etc., and on the downstream of the outlets or, if they exist, their being out of order, etc. Water is let into the main canal by just counting the number of threads of the gate. The discharge in the field channel is just assumed as there is either no measuring device provided on, the downstream of outlets or, even if one is provided, it is out of order. This requires to extra time to supply a predetermined quantum of water to the crops and the rotation time also increases thereby.

6.1.25 The Commission observed during its visit to Hatnoor. Project in Khandesh that water in the main canal was totally covered by weeds in same parts. Similar situation may possibly exists elsewhere also Hayasinth is a difficult problem in the management of canals. But there seems to be no research being undertaken nor any thought given for the solution of the problem. The expectations of the beneficiaries about the efficiency of canals are now going to rise. Therefore, it will be advisable to take up some concrete experimental/research program to solve this intricate problem.

6.1.26 The attention being paid to the quality control and safety in the construction of a canal and distribution system is never the same as that for constructing a dam. Therefore, attention has to be paid to the maintenance of canal while operating it, leading to extra expenditure. Thus, it will be helpful to improve the quality of these works as well as to retain their discharging capacity, if an exclusive guiding manual is evolved for the construction as well as the maintenance & repairs of such works. The absence of such a guide is quite apparent.

6.1.27 It is seen from the information received by the Commission, that about 30% to 50% of the available grants are spent on desilting of canals. A general impression prevails that there is widespread corruption in the works of canal desilting, grass cutting, cleaning up etc. In order to bring transparency in this, it may be useful to form a joint committee comprising of representatives of water distribution societies in the command area and the Government officers to allot such works as well as to inspect the supervision of such works by taking decision.

Maintenance And Management of Distribution System

6.1.28 The care being exercised in the construction of the distribution system can not be at par with that in case of the main canals. Therefore, many shortcomings are observed in its design and construction. This affects the irrigation management and thereby water distribution is not carried out properly. Water does not reach the tail end of a distributary / minor in adequate quantum or sometimes adequate quantity of water is not discharged through the outlets on the minors whereupon an, attempt is made by the beneficiaries to beget water by blocking the flow by putting obstacles like boulders, etc. At such places either the level of the outlet is higher than that of the distributary / minor or the water level in the minor is raised by putting in obstacles in order to irrigate the land in command area situated at a higher level. Permission may be granted to lift water by pumping from a distributary, if water cannot reach the land situated at a higher level. But cross regulators may be constructed across the distributaries / minors, if water does not pass through the outlet in proper quantities. Presently no cross regulators are constructed on minors. Water will easily flow through the outlet by virtue of the cross regulators.

6.1.29 Black cotton soil occurs in Vidarbha area in high proportion and the quantity of rainfall received there is also high. The summer is more intense and more dry there. Therefore the volume of silt in the distribution system is also higher here as compared to other irrigation projects in Maharashtra. The same problem is experienced even in Konkan area due to very heavy rainfall coupled with steep mountain slopes. The distribution system does not remain in a satisfactory condition though per hectare expenditure required to be incurred on maintenance is higher and in practice that does not happen. This affects water use as well A the response to be sought from new beneficiaries. It is, therefore, necessary to spend an adequate amount on periodic maintenance for at least a few years (five years) after the completion of a project. Even though irrigation is not fully developed during this time, it is necessary to maintain the distribution system in order, so that the beneficiaries who are newly introduced to irrigation should get encouragement. But generally the maintenance budget is provided for by adjusting the expenditure against the irrigation cess recovery. It is necessary to think differently about project where irrigation is newly started. It will be useful if the grant required for maintenance of the distribution system is made available fully without linking it to the possible revenue.

6.1.30 The yardsticks for the maintenance of dam, main canal and distribution system should be different. Also, the rates should change in consonance with the regional and geographical setting while deciding the yardstick for maintenance. Particularly, it seems necessary to keep .50% extra provision for the distribution system in regions having black cotton soil with rainfall exceeding 800 mm than in case of other regions. A similar provision is needed in Konkan also. Moreover, basic facilities of agricultural transportation in command area, for example, roads and even maintenance & repairs thereof are necessarily to be provided; and an exclusive provision for its expenditure will have to be there. As the current practice goes, no exclusive provision for the maintenance of roads in command areas is made. But these roads have to face a saturated or waterlogged condition twice a year or throughout the year and require more repairs. The traffic in the command area is also relatively heavier. Hence, it is necessary to lay down separate maintenance norms for such roads.

Present Condition of Establishment of Management

6.1.31 Essential posts in irrigation management, e.g., canal inspectors, surveyor/clerks etc. are vacant on a large scale. Thus, there is a shortage of experienced hands in Irrigation Management. Particularly there has been a considerable negligence regarding establishing a good set-up of irrigation management on new projects, as even the posts necessary as per the Kapoor Committee norms, were not filled up in time. Works under irrigation management are being got carried out from untrained and inexperienced workers. Therefore the management does not get rightly moulded in the early period of a project. This has affected the entire irrigation management quite adversely, and at many places the situation is not under control. Thus it is essential that an irrigation branch based on the newly created irrigation potential be sanctioned and start functioning before water supply for irrigation purpose is actually commenced.

6.1.32 For the distribution operation to be successful, the administration calls for, besides other technical matters, the cooperation of the beneficiaries as a group. But a number of difficulties come in the way of such a cooperation being extended and much of the time of the administration is wasted in sorting out the difficulties. If instead, the maintenance of the distribution system and the operation of water distribution is handed over to the beneficiaries as a whole, the water distribution will be better and at the same time, the entire operation will be much more convenient for the administration. The minor irrigation projects can be completely handed over along with the distribution system to the water users' societies of the beneficiaries. However, in case of major projects, it will be convenient to hand over the distributaries having a discharge capacity of 1 cumec or less, to the water users' societies of the beneficiaries. From this point of view, it is necessary to render the distribution system of the major and medium projects fit for distribution of water by removing the technical deficiencies by the year 2010 so that there may not be any difficulties in handing over the distribution system and the irrigation management of the command area to the water users' societies. Thus, the work should be so planned that the distribution system of major and medium projects having capacity upto 1 cumec as well as the command area and the entire minor project along with the distribution system should be handed over to the water users' societies of the beneficiaries for irrigation management from the year 2010.

6.1.33 During the next two decades thereafter, the need to emphasize piped irrigation in lieu to flow irrigation will be felt at many places due to shortage of water and changing cropping pattern. The system of distributing water through pipes will be found useful to avoid wastage and evaporation losses of water and to give impetus to pipes, sprinkler and drip irrigation. However, these systems being capital-intensive, they will have to be promoted by raising financial assistance through the collective efforts of the water users' societies and sanction partial grants. The grants can be finalised by considering the amount of reduced annual expenditure on maintenance and operation. A clear provision of this nature is required to be made in the set of rules to be framed for the water users' societies.

6.2 Reservoir Quality Management

6.2.1 Maharashtra has a long standing heritage of village tanks. Lakes seem to have been created from ancient time in villages / towns to cater for the daily needs of the dwellers, such as water for drinking, bathing, washing of 'domestic cattle etc. The size and number of such lakes depended upon the size of the village/town. A series of lakes was in turn developed to supply water for irrigating crops and increasing agricultural production. Many such cakes seem to have been constructed in Bhandara, Chandrapur, Gadchiroli, Nagpur and Nanded Districts.

From ancient days to the beginning of the British era the village tanks or irrigation lakes in Maharashtra were constructed primarily through the efforts of the local beneficiary community as well as through the encouragement of aid from the then rulers. Maintenance was taken care of locally only. Cleaning and desilting the tanks as well as repair works were carried out periodically at the time of annual festivals. These lakes thus were the mainstay of the life of the community. The tradition of participation of local population gradually broke during the foreign rule and the entire system and responsibility were shifted to the Governmental set-up. The principle of participatory approach is not evident anywhere in the creation or maintenance of tanks built during the British period.

During the post-independence era, 9600 small or large tanks, were constructed anew for irrigation through the Governmental set-up till the year 1996. Although most of these tanks were primarily constructed for irrigation purpose they were also used to cater to water supply for industry & municipal use and power generation according to the locations. The people who depend on these tanks do not participate in the management of reservoirs even now. No clear system has yet been evolved to keep the reservoir waters clean and pure. A grave danger, therefore, seems to loom large over these reservoirs as far as water quality is concerned.

Slit Deposition

6.2.2 The Maharashtra Engineering Research Institute (MERI), Nashik has undertaken from the year 1983 a detailed study of the process of siltation in the reservoirs in Maharashtra. They have inspected all the three types of reservoirs - major, medium and minor (Statement 6.2.1). This not only includes Ekruk Medium Tank in Solapur District completed in 1871, Mhaswad Medium Tank in Satara District completed in 1888 Mukti Minor Tank in Dhule District completed in 1893 but also brings in its fold the more recent Yeldari Major Reservoir in Parbhani District completed in 1963 and Nazare Minor Reservoir in Pune District completed in 1974. The data thus includes the effects of existence of dams over a maximum of 120 years to a minimum of 12 years age.

If a comparative study of silt deposition in reservoirs is made, it is observed that the silt deposition in smaller reservoirs through their small catchment area is faster. Therefore, it is necessary that an impetus should be given in a specific manner to soil conservation and forest conservation works in order to check soil erosion in the catchment areas of all the minor projects. In view of the guidelines[1] laid down by the Central Water Commission in 1993, the minor reservoir schemes will have to contemplate works of soil conservation in the catchment areas and creation of reservoirs to take place simultaneously. Similarly for large reservoirs, soil conservation in catchment area should be taken up simultaneously with reservoir creation. The concern to be shown about any system while building up new storage projects must also be shown about those reservoirs which are already in existence. Therefore, separate sub-basin wise projects should be conceived for such remaining works where the foregoing aim has not been kept in view; and these should be taken up immediately starting with the places where the annual silt deposition rate exceeds 1% of reservoir capacity. The silt &position in a reservoir can be seen and felt but a practice of its periodical measurement is not yet established. It should be put in practice now. The surveys carried out so far are basically sample surveys - not full scale surveys. The basinwise coordination committees proposed in this Report should pay attention to this necessity on a priority basis and arrange to get sedimentation surveys carried out. It is necessary to make a clear mention of this aspect in defining their scope of work and give them sufficient powers and adequat; grants for this purpose. A distinctly adverse effect is seen on the storage capacity and consequently the overall 'efficiency of wateruse in a sub-basin due to siltation over a span of 25 years. The useful storage is reduced by 5 to 10 percent and consequently the planning of water-use is also adversely affected. Therefore the basin planning and regulation committees will have to constantly persue the survey of and preventive action in this respect. These committees will also have to plan for an alternative storage capacity in time as 20 to 30 percent capacity is likely to be lost over 50 to 100 years of life span of a project. They will also have to encourage the desilting process locally, e.g., shifting brick kilns within the silt areas of the tanks. These committees will also have to take up such undertakings.

Water Distribution and Management
6.3 Land Preparation for Irrigation

Present Status of Irrigation Methods

6.3.2 It is expected that while selecting appropriate flow irrigation method for crops, it is to be ensured that the crop water requirement is met with, without entailing any wastage of water and causing damage to the land; and maximum production of good quality is achieved with minimum expenditure. From all these considerations,

1. Revised Guidelines for Treatment of Lands Likely to be Affected due to the Construction of River Valley Projects - CWC New Delhi, November 1993.

the adoption of drip irrigation method is beneficial for crops such as grapes, banana, orange, sweet lime, lemon, pomegranate, guava, sapota, sugarcane, cotton, etc. In future, there is a possibility of bringing under drip, sprinkler irrigation methods almost all area which is presently under well irrigation as well as that to be irrigated by water lifted from reservoir or various tanks. However, adoption of modern irrigation techniques for major crops such as paddy, sorghum, pearl millet, maize, wheat, gram, etc. which are being taken over large areas in the commands of old irrigation projects does not seem possible in the near future. In Maharashtra, as of June 1997, an irrigation potential of 32.28 lakh hectare has been created and water is being applied even by now to about 30.53 lakh hectare out of this by flow irrigation method. Therefore, allowing the efficient methods amongst those which are employed to fetch water inflow irrigation to conventionalise is going to be the major programme during the ensuing decade. Border method recommended for sorghum, wheat, pearl millet, soyabean, gram, mug, etc., and ridge and furrow methods recommended for crops such as cotton, brinjal, chilli, tomato, potato have their own advantages. Even then it is observed that the farmers apply water to seasonal crops like sorghum, pearl millet, gram, sunflower by wild flooding method. This results in a lot of wastage of water. From the above, it is seen that we have not so far been successful in bringing down the available modern technology to farmers. In fact, development of land for receiving irrigation in the form of borders, furrows, basins etc. is not difficult. This also does not require knowledge of any major and difficult technical details. Even then huge amount of water is being wasted due to water application by wild flooding or *phadki* method.

6.3.3 From the observation and evaluation of irrigation methods used by farmers on their fields, it is seen that farmers in command area do not carry out development of land for receiving irrigation assuming that water would not be required for kharif crops and they seem to apply water straightly by wild flooding method in case it becomes necessary to apply water in the event of drought. Even in *rabi* season, in many places farmers seem to irrigate sorghum, gram, sunflower, wheat by wild flooding method. In very few cases borders are seen prepared for sunflower and irrigation is catered on an extensive area to wheat by making *phadkis.* In hot weather, the situation with the major crop of groundnut is also not very different. If water is available for hot weather in command area of Jayakwadi Project, hot weather groundnut is taken on a large scale. Its yield is also good but at very few places are seen furrows or borders being prepared to apply water to this crop.

6.3.4 Farmers are seen developing land for receiving irrigation for taking crops like sugarcane, onion, potato, brinjal, ladyfinger, cauliflower etc. But this land development may or may not be of propel type. It is observed from several experiments that less water will be required for the highest water consuming sugarcane crop if the development of land for receiving irrigation is achieved by strip method with paired-row planting. Still it is seen that farmers prepare deep and long furrow-cum-basins for sugarcane and apply water from basin to basin As a result, the amount of water actually used up is almost twice its requirement. Requirement of water for sugarcane by scientific method is 2000 mm, but it is seen that in actual practice about 3500 mm water is used. If drip irrigation with twin row method is adopted, the entire field is not required to be wetted, and as a result even with only 1200 mm water 25% to 30% higher crop yield can be reaped For other crops also even if development of land for receiving irrigation is accomplished, it is not as per recommendations. Good yields are realised for creeper crops such as water melon, ridge guard, bitter guard with only 25 percent water (compared to usual practice) if the land preparation is done according to new techniques recommended.

In light of all these issues, the Commission feels that merely delivering measured quantity of water to users is not enough. Even after delivering water in that mode, if the water application method is going to remain the same, then the expected extent of area will-not come under irrigation and the objective of extending benefit of irrigation to large number of farmers is not attained. Concerted efforts to pave way for adoption of such flow irrigation method are called for This calls for disseminating to farmers detailed information regarding issues such as benefits of development of land for receiving irrigation, benefits of land levelling, adopting land slopes according to soil types, how much should be the length, breadth of borders and discharge to be let therein, duration of cut-off, etc., and also about other efficient flow irrigation methods. Furthermore, demonstration of development of land for receiving irrigation on farmers' fields be arranged. The farmers are required to be trained therefor continually on their fields only There is no provision of such an intensive training in the Training & Visit Programme of the Agricultural Extension Service that is in vogue. It is, therefore, essential to bring about the transformation of command area by undertaking persistent efforts through appointing 'irrigation squads' in various commands to impart scientific training of development of land for receiving irrigation, the appropriate cropping pattern under irrigation and rotations of irrigation water. Such types of irrigation squads have been formed in Maharashtra which, however, were closed down subsequently out of misunderstanding that they would no longer be requited now due to the launching of Training & Visit Programme. There is an urgent need of their resumption and extension to all new command areas. Without this, it will not be possible to increase irrigation efficiency.

Development of Land for Receiving Irrigation & Farm Iniplements

6.3.5 Discussions held with farmers in command areas revealed that suitable implements for development of land are not available with them. Reason for non-availability of implements is attributed to the fact that these are required only for very short period and the farmers are not aware of the utility of the implements for increasing irrigation efficiency. These implements, therefore, be purchased by water users' associations and lent to farmers on hire charges. Such an experiment was conducted by the Water And Land Management Institute. While handling the work of management of Loni Minor Irrigation Project, it was observed that in the first year farmers did not undertake land preparation for wheat, sunflower and gram. After harvesting the earlier crop, light ploughing was resorted to and pre-sowing irrigation is given on such ploughed fields without the development of land. Due to obstruction to water advance by soil clods, it took about 15 to 20 hours to accomplish irrigation on those fields where it was expected to do so within 10 hours. WALMI undertook discussions with farmers to remedy the situation. Two border-forming implements were purchased and made available to the farmers on hire. As a result, it was observed that next year 95 percent farmers, having prepared borders, applied water preparing borders for wheat, gram and sunflower. This experience led to contend that the implements should be made available to farmers; an awareness about their utility be created among them and practical demonstrations be arranged. It will be useful to offer partial grants to Water users' associations and arrange for them capital at concessional rates for such works.

Irrigation Rotation Period

6.3.7 In Maharashtra, water is stored in reservoirs during rainy season (June to September) and it is supplied to the crops in *rabi* and hot weather seasons through canals. In the event of paucity of rains in *kharif* season, protective irrigation is provided from the water so stored. Projects constructed in Maharashtra during the British period

(Pravara, Neera, Godavari) were mostly contemplated basing on the consideration as to how the stored water can largely be utilised for food crops by applying protective irrigation to *kharif* crops. Therefore, the rotation period in such projects was largely based on the soil moisture stress caused by inadequate rains. Irrigation water in the projects was used to be utilised as supplementary to rains.

In post-independence period, irrigation potential has been developed in Maharashtra with a large-scale capital investment. There is now growing awareness that the irrigation water be made available to crops according to their requirement, water holding capacity of soil and as per demands received from farmers considering the water available in the storage. If water is provided to crops in all the three seasons (*kharif, rabi* and hot weather) on a, scientific basis as above, then not only the area under cash crops (cotton, sugarcane, groundnut, turmeric) will increase, but also the crop yield will increase and as a result crop intensity will also increase. It is necessary for this not to decide the irrigation rotation period for protective irrigation but according to the consideration of yield-dominant season.

6.3.8 A research study has been accomplished in respect of projects (Kukadi, Painganga, Kanher, Jayakwadi, etc.), for determining irrigation rotation under normal conditions of water availability for irrigation considering the past experience in irrigation project management - especially regarding fixing of rotation and review of research carried out appertaining to irrigated crops. The findings lead to observe that in those command areas where (as per pre-irrigation soil survey) 75% to 80% area is under deep black cotton soil (soil depth more than 1m), notwithstanding that diversified irrigated cropping pattern exists, even if the irrigation is given at an interval of 21 to 25 days in *rabi* season (October to March), good crop yields are reaped in case of *rabi* and hot weather crops without experiencing water stress. In irrigation projects in Marathwada, considering total 7 rotations for irrigation (besides one for pre-sowing) of *rabi* and hot weather groundnut (January 15 to May 15) in medium to deep (45 to 90 cm) and medium to heavy textured (silty clayey) soils and considering irrigation requirement at the root zone of 700 to 800 mm estimated using scientific method, commensurate crop yield is obtained in 'commands of Jayakwadi and Upper Penganga Projects with 21 to 25 days rotation period during January to March and 12 to 14' days rotation during April to May. Plenty of water is available for irrigation in major reservoirs in those years when *kharif* crops are badly affected due to excessive rains. During such times it is possible to make good the loss of *kharif* crops due to crop yield in *rabi* and hot weather by planning irrigation rotations as in the foregoing thereby proving the utility of irrigation projects.

6.3.9 In irrigation projects where 75 to 80 % area is under shallow soils, (e.g., Kukadi Project), it is essential to have rotation period of 14 days in *rabi* season. Farmers having lands with light and shallow soils demand water for irrigating hot weather groundnut if water is available in the reservoir during hot weather season. In such cases it is beneficial to allow conjunctive use of well and canal water for only those cultivators who are having wells to fix irrigation interval of 14 days with one rotation on well water (at 7 days interval) followed by another on canal water (at 7 days interval). It is seen from the study conducted by WALMI in respect of Kukadi and Upper Painganga Projects that apart from the *rabi*-hot weather groundnut on shallow soils, this experience is also useful for *rabi*-hot weather onion and banana crop in hot weather as well. Those cultivators who do not have wells may grow crops suitable for shallow soils, (e.g., grape, pomegranate, guava, custard, onion, apple, groundnut, etc.), by utilising drip or sprinkler irrigation if water required for a period of 14 days in proportion to the area (about 500 m^3 per ha per fortnight at crop root zone) is delivered in measured quantity from farm ponds constructed and lined by farmers. From the point of view of scientific irrigation water management, it is essential to provide farm ponds as supplementary water storage and implementing drip irrigation system on shallow Soils in the irrigation project command. Provision for the expenditure required to be incurred therefor can be made through Maharashtra Land Development Corporation or as per other land development works.

Operating drip irrigation to the sugarcane crop is essential from the point of view of land, water and crop management. There is a need on the part of farmers of awareness about such an improved management. Instead of insisting upon an exclusive and single water distribution system, the farmers may go in for supplementary arrangement in different project areas compatible with the agro-climatic zones. In project command areas they may generally grow in *kharif* rainfed crops like *kharif* hybrid jowar, pigeon pea, sunflower, soyabean in medium deep to deep black cotton soils. But in case in *kharif* season, the rains suddenly cease and a dry spell of 20 to 30 days is the fate, there is a possibility of losing the crop due to stress caused by extreme depletion of soil moisture. In such a case, it is very essential to provide protective irrigation from the project in order to save the crop and increase its yield. It is observed that farmers keep waiting in the hope that rains may come and do not register demand for water even_though the crop is subjected to stress. They are unwilling to pay water charges, for only one rotation of water to crop in a *kharif* season. Therefore, if the assessment for *kharif* crops is made on the basis of water rates per rotation either 1 or 2 waterings provided as protective irrigation for assured and increased yield instead of seasonal rates, there will be a definite increase in *kharif* utilisation of water from irrigation projects and an increase in the productivity of the *kharif* crops. This will be in tune with the main objective of volumetric supply management.

If yield of *kharif* crops per m3 of water is considered, it is higher than that for other seasons. It is, therefore, essential to motivate the farmers to take water in one or two rotations in *kharif* by offering various attractive incentives. In those command areas where cultivators owning dug wells are attracted to take banana crop in deep soil and where good well water supply is available upto the end of *rabi* season, (e.g., Purna Project Command) but well water source is found to be inadequate during hot weather season and banana crop experiences water stress, for getting better yield of banana crop normally 10 and 7 days rotations in *rabi* and hot weather seasons respectively be provided and conjunctive use of well and canal water for banana crop for hot weather season only (one watering by well at 7 days interval followed by one through canal also at 7 days interval). With this, canal water rotation of 14 days can possibly be continued.

There may be an advisory committee consisting of an irrigation officer, an agricultural officer and agronomists from agricultural universities for every project for extending guidance to the cultivators' organisation on every project for deciding irrigation scheduling taking into consideration various project-specific, needs based on soil, water and crop parameters instead of adopting one uniform rotation period throughout the State. There is an urgent need of inducting agricultural experts, under the chairmanship of Executive Engineer. The rotation systems in a particular season proposed, by cultivators' organisation or the canal advisory committee should he deemed to be binding.

6.3.10 As proposed in the foregoing, no systematic handling of improvement in development of land for receiving irrigation and planning of irrigation scheduling is possible unless a good appreciation of farm .soil characteristics, agricultural techniques & a good knowledge of crop growth and proper information as to the details such as soil-water-plant relationship and crop-water requirement can be had. Training on these aspects does not fall within the scope of Civil Engineering but is being imparted however under the Agricultural Engineering stream. Therefore, graduates who have offered Agricultural Engineering will hereafter be required to be appointed on a large scale in the irrigation management in order to bring about a change in the current status of the command areas: With this in mind, the staff trained in Agricultural Engineering or one with Civil Engineering background after being given long-term training in WALMI should only be posted in irrigation management by forthwith changing the appointment and selection procedures with a special weightage to Agricultural Engineers. It will be desirable to gradually remove from management over the next five years those candidates who do not possess this type of basic qualification with a view to increase irrigation management efficiency and productivity.

6.4 On-farm Water Use

6.4.1 Water is a key input for agricultural production. For that, appropriate on- farm water management is called for. At present, the Government organisation is largely responsible for making water available from the project upto the fields for irrigation. The study of water use pattern revealed that per hectare yield of irrigated crops in Maharashtra is lower than the national and other states (Statement 4.4.5). It is attributed to improper on-farm water use. At present, water does not reach to the fields at the required time and in the required amount. In fact, water requirement depends on the type and growth stage of the crop. However, as the present practice goes, water is being supplied ordinarily at fixed time interval and in predetermined quantum. If there is a long interval between consecutive rotations, the farmer takes pain to apply more water as a result of which production decreases instead of increasing. There is basically lit) flexibility in flow irrigation distribution system. Increasing pr decreasing quantum and time of watering is not possible.

6.4.2 The international organisation of ICID has gathered information about efficiency of 54 irrigation projects from 29 countries. From this it is observed that average efficiency from the water source upto farms is 50 to 60% and average on-farm 'efficiency is 38 to 58%. It means the on-farm water use entails more wastage of water.

6.4.3 Different irrigation scheduling methods have come into existence for supplying water to crops on farms depending upon various geographical settings.

1. *Warabandi*
2. *Shejpali*
3. Localisation
4. Field to field (spill over method).

Among these, the two methods which are practised in Maharashtra are as follows:

Shejpali: In this method, every farmer is required to get sanction for irrigation areas for each season for accomplishing cropwise irrigation. Water is given only to the crops which are included in the approved cropping pattern in a given year. It gives assurance of water required for the areas under approved crops in a given season. This method was developed when there was no shortage of water. Now a days this method, however, is not being practised rigorously. With the encouragement of the Government of India, efforts were made during the period 1980-90 to popularise a modified form of *warabandi* of the North known as time-bound water distribution method. Imparting training for the same had also been arranged through WALMI. It was also financially supported by international financial institutions like the World Bank and USAID. However, no statutory rules have been framed for practising this method. As a result, in practice, neither fully *shejpali* nor fully the time-bound distribution method is followed completely, but some sort of mixed system is being followed under local influence. This has led to a disorderlyness of an extreme degree in the water distribution system.

Field to field irrigation method: In all the paddy farms, water reaches from one field to the other by spill over method. Field channel is not required on the farms. After getting stored in a field, the excess water spills over to the next lower field. Crop diversification is not possible in this system. It is only useful where paddy is grown everywhere. It is very difficult to bring about change in this system.

6.4.7 It has become clear from various studies that a large-scale misuse of water takes place during' its application on the farms. Only that much water needs to be given to crops as is required as per their growth stage. Crop yield does not increase by giving more water. Information about weekly and fortnightly actual water requirements of each crop and pertinent to different agro-climatic zones should be published forthwith by the Irrigation Department with the help of agricultural universities. Besides, farmers should be made to realise that it is necessary to give measured quantum of water to crops. A simple and handy booklet in Marathi about how to apply measured quantum of water to crops be made available to farmers. Once the farmer understands how many hours water needs to be applied to one hectare area, water application will become easy. It is desirable that farmers should use simple, convenient and handy discharge measuring devices for determining how much water is made available at the farm head. Information regarding how to install and how to use such devices (Replogle flume, broad-crested weir, V-notch) will have also to be incorporated in the, booklet.

6.4.8 Meteorological information is disseminated through media such as newspapers, radio, television etc. In addition to this, it is for these means of communications necessary to include information pertaining to irrigated areas on crop water requirements of various crops determined on the basis of daily pan evaporation and Modified Penman method which will be useful to the farmers in irrigation management. With this, farmers will be able to decide how much water is to be applied and thus economy in water use can be achieved. Besides, permission should also be granted to arrange for farm storage of water to facilitate use of drip and sprinkler irrigation. For this, necessary amendments in the present. Irrigation Act and bye-laws need to be brought out immediately.

As per the prevailing Act, farmers are required to use water made available to them only for approved crops and water is made available only after pre-determined intervals. As a result, there is no flexibility in water use Want of permission to store water in farm ponds or wells does not lend the use of sprinkler and drip irrigation methods. A system for on-farm storage of measured quantum of water supplied to the farmers as required should be encouraged by making appropriate amendments in the Act so that the water can be used as and when needed. For this, going in for development of a low cost water storage link between canal and farm land is essential.

It is also necessary to take up pilot projects in various commands for this purpose to facilitate speedy propagation of these appropriate methods.

6.5 Modern Methods of Irrigation

6.5.1 In traditional irrigation method water required for the crop growth is applied to the crops by free flow. While it may be possible to apply water to the field at 5 to 7 days interval or even earlier by lift or through wells, the canal water is ordinarily applied only at 14 days or even at longer interval. Considering this limitation usually water applied to the field in .one rotation is usually 7 to 10 cm. It is not practically possible to apply water which reduces to a depth lower than 10 cm though during a particular rotation period the actual crop water requirement is less (during initial and final growth stages of the crop) a conventional flow method.

When water is diverted from river to fields through a weir, it is not necessary to keep a precise water account because in absence of storage for excess water, it will flow down the river anyway if it is not diverted to the field. In case of storage irrigation schemes, it is possible to determine the efficiency of a project by water released in the canal from reservoir and water actually applied on the field. Following measures have been adopted in such schemes in Maharashtra during the last 3-4 decades to improve the irrigation efficiency by reducing water losses at different levels:-

1) Water loss has been reduced by lining the canals, distributories and field channels.
2) Unevenness in distribution is reduced by incorporating changes in water distribution system (RWS, six days on and six days off system, etc.).
3) More area has been brought under irrigation in less quantum of water by realising even distribution as a result of land levelling.

It has been observed that even after adoption of these measures there has been no significant increase in irrigation efficiency due to several constraints. An increase in distribution efficiency by 15 to 20% is expected by adopting the foregoing measures. If efficiency higher than this in, water distribution is desired, water losses occurring on land mainly on account of seepage and evaporation need to be prevented. Efficiency of prevailing irrigation method is quite low. On lighter soils it is particularly very low. Out of total water available at the canal head, only 35 to 40% is available for crop growth.

Old Recommendations

The Government of Maharashtra set out implementing State-sponsored drip irrigation scheme since 1986-87 and Centrally-sponsored drip irrigation scheme since 1991-92 to bring maximum possible area under irrigation within the limited irrigation potential of the State Under this scheme, a 50% subsidy limited to Rs. 20500 per ha for sugarcane and some other crops is offered upto 2 ha area farmerwise. Under another Centrally-sponsored scheme, a subsidy of 70 to 90% at the most Rs. 25000 per ha is extended to farmers towards cost of installing drip irrigation units for fruit crops, floriculture and vegetable crops. As of now (1998) total 120999 ha area under drip irrigation through both these schemes.

In Maharashtra, the Integrated Drip Units Scheme is going to be implemented from 1998-99 for all crops with a subsidy of 50 to 70% or maximum Rs. 25000 as, a grant-in-aid.

Similarly, programme of distribution of sprinkler irrigation sets is being implemented under the Centrally-sponsored scheme. A subsidy of 50-70% subject to a maximum of Rs. 15000 is offered under this scheme.

Till date, 47802 sets have been installed under this scheme.

Each set is normally capable of irrigating one ha. Accordingly, about 48000 ha area might be irrigated by sprinkler irrigation in Maharashtra at present. Thus, the modern irrigation facility with drip and sprinkler combinedly is extended to a total area of 168000 ha in Maharashtra. The number of sets installed devoid of any subsidy is not included in the above statistics.

Water Supply in Prevailing Irrigation System and Crop Water Requirement

6.5.3 Considerable research is conducted in the discipline of Agricultural Science on actual water requirement for growth of various crops and how it depends on various climatic parameters and soil characteristics. It is seen from this research that actual crop water requirement depends mainly on temperature, atmospheric humidity, sunshine, wind velocity and stage of crop growth.

Various formulas have been evolved by correlating actual water use for crop growth and evapotranspiration with various factors mentioned above. From this it is possible to estimate daily and total crop water requirement from sowing to harvesting at any place according to the climate during a crop season. This new research has radically changed the tenets of measuring efficiency of irrigation water. In future, efficiency would mean total water required for crop growth as estimated by above scientific formulas divided by water delivered in the distribution system. The real use of irrigation water is not for the field but for the crop grown thereon. In conventional flow method, entire water required by the crop for .15-20 days is applied together and in one application, which adversely affects the crop growth. Water is available for crop in excess of its actual requirement during the first 4-6 days after rotation and over the next 10-15 days the water availability will go on diminishing as compared to its requirement and during the last 3-4 days the crop has to survive stress which has an adverse effect on the crop growth and its yield. After rotation, the water in excess of its holding capacity percolates to lower strata. Water percolated beyond root zone can not be used by the crop and goes as waste as far as the farm crop is concerned.

Considerable wastage of water occurs in applying fixed water quantum during 3-4 weeks period since sowing till good development of roots takes place and during 2-3 weeks before harvesting even when crop water requirement is less.

Necessity of Modern Irrigation Method

6.5.4 Under these circumstances, if by some mechanism, we are able to apply water to meet just day to day water requirement of the crop, then not only meagre water is required as compared to conventional flow method but also the crop is subjected to no water stress at any time. As a result, sound growth takes place and production is increased and quality too is improved. Agricultural produce of improved quality fetches better market price. Increase in yield and saving in water becomes clear from the following details:

Sr. No.	Crop	Increase in crop yield (Percentage)	Saving in water (Percentage)
1	Banana	52	45
2	Grapes	23	48
3	Sweet lime	50	61
4	Pomegranate	98	45
5	Sugarcane	33	65
6	Tomato	50	39
7	Water melon	88	36
8	Cotton	27	53
9	Ladyfinger	16	40
10	Brinjal	14	53
11	Bitter gourd	39	53
12	Ribbed gourd	17	59
13	Cabbage	2	7
14	Papaya	75	68
15	Radish	2	77
16	Beat	7	79
17	Chilli	44	62
18	Sweet potato	39	60

Source: From the Report of INCID (1994), New Delhi.

Based on research conducted using various options available, following two methods have finally been accepted worldwide as modern irrigation methods:

1) Drip irrigation method
2) Sprinkler irrigation method.

Upon introduction of polyethylene into practical use as a result of various studies carried out it has become possible to make all material and equipment required for these two methods as needed. Use of these modern methods on a large scale has started taking place during the last 30-40 years. Nevertheless, high initial investment in distribution network and equipment has boosted up the use of these methods only there where acute shortage of water is felt and mostly for growing high value cash crops (fruit crops, floriculture, vegetables, grapes, banana, and sugarcane).

Where these systems are in use, it has been observed that water is used efficiently. Due to availability of water the land is used for a longer period. The lands required to be kept fallow have been brought under cultivation. Also, there has been an increase in the use of highly undulating hilly areas and salinity-affected lands due to these modern methods.

Drip Irrigation Method

6.5.5 Drip irrigation is a mechanism by which water required for a crop in a day is applied to its roots, drop by drop in 5-6 hours, to keep minimum essential moisture within the root zone. Water pumped from storage is filtered through filter unit and after required quantity of fertilisers and pesticides are added, passes through P.V.C. polyethylene laterals and is applied by emitters fixed on them drop by drop near the plant roots. Water is applied to small plants (cotton, lady-finger, brinjal, etc.), by single or a few drippers and by more number of drippers for big trees (orange, sweet lime, etc.). Water is applied to crops like sugarcane, through pipe with, dense network of holes. Discharge and operating time can be changed according to requirement of the stage of crop growth, soil texture and season. There takes place no weeds growth in intermittent space between adjoining rows or plants, as water is not delivered at that point. There will be appreciable saving in expenditure. As per current market rates, the expenditure for installing drip System will be about Rs. 40000 per ha depending upon the crop. Nevertheless, this expenditure is recovered soon due to saving in water, increase in yield and improvement in quality of farm produce achieved as a result of this method. This appears clear from the following, data:

Sr. No.	Crop	Investment (Rs./ha)	Benefit/cost ratio	
			Without saving in water	With saving in water
(1)	(2)	(3)	(4)	(5)
1	Coconut	11053	1.41	5.14
2	Grapes	19019	13.35	32.32
3	Banana	33765	1.52	3.02
4	Orange	19859	2.60	11.05
5	Lime	19859	1.76	6.01
6	Pomegranate	19919	1.31	4.04
7	Mango	11053	1.35	8.02
8	Papaya	23465	1.54	4.01
9	Sugarcane	31492	1.31	2.78
10	Vegetables	31492	1.35	3.09

Source: INCID (1994), New Delhi.

Sprinkler Irrigation Method

6.5.6 Water to the field under slightly higher pressure through P.V.C. pipes like that in drip sprayed over field like a fountain from sprinkler heads, attached to polyethylene pipes. The spacing between two nozzles and two distribution laterals can be adjusted according to water pressure and spraying range of nozzle. In some types the laterals are fixed while in others they are shifted to the next desired one after completion of irrigation on one strip. There is saving in investment in the shifting type system but labour cost will increase. After one sprinkler irrigation, the next turn is given after 5-7 days or earlier depending on the crop requirement and the soil fertility status. While with flow irrigation it is impractical to apply very small depth of water on the field, it is possible to do so with sprinkler irrigation. As per the current market status, the expenditure required to be incurred on this method is Rs. 20000 to 30000 per ha The common benefit in both these types is that not only water loss due to the deep percolation over the entire area occurring in conventional irrigation system is obviated but also the danger of land being rendered waterlogged is also rid of even if perennial crop is taken. Also, there will be saving in labour cost involved in supplying canal water, fertiliser application, land preparation for making borders, furrows, etc. There is saving in the cost of land levelling and least disturbance to the good textured soil on the surface by way of levelling.

On the other hand, the problem of this system is that if the complete system is not properly taken care of and maintained or if the manufacturer I supplier does not provide good after-sales-service, the yield of crop is adversely affected as a result of reliability of irrigation. Non availability or insufficient voltage of electricity also affects irrigation efficiency. Irrigation by this method does not produce much of return flow. Capital investment and recurring expenditure on account of this irrigation system is higher. It takes four to five years to recover the capital investment. As a result, the popularity gained by sprinkler irrigation three decades back is declined. In comparison, the use of drip irrigation is increasing among modern irrigation methods.

As water can be delivered under low pressure in drip irrigation, pumpset of smaller horse power can be used and consumption of electricity is also less. Since it is necessary to have smaller plant population per hectare from the point of view of expenditure, this method is feasible for widely spaced crops like fruit trees, grape, banana, cotton, brinjal, and also for sugarcane. As water is applied drop by drop to plant roots, saving in water is ensured. With drip irrigation, saving in water is upto 70% as compared to cannel (flow) and 40-50% as compared to well (lift) irrigation. Soluble or liquid fertilisers, insecticides and pesticides can be easily applied through irrigation water. As further improvement in drip irrigation method, sub-surface, in line, micro- sprinkler and bubbler water application methods are also in vogue. Similarly, travelling sprinkler, central pivot and linearly moving machines are also used as a part of sprinkler irrigation in some countries.[1]

In sprinkler irrigation method, comparatively higher horse power pumpset is required and since water is to be applied at higher pressure, this results in sizeable electricity consumption. Higher plant population and closer planting are all right but being unsuitable for very tall crops, this method is especially adopted for groundnut, soyabean, cotton, vegetables and lawn. Loss of water due to evaporation is more in this method. There is a possibility of weed growth in the field. Irrigation has to be stopped during high wind velocity. Considering relative efficiency, it appears, the efficiency of conventional irrigation is 35-45 percent, of sprinkler irrigation it is 60-65 percent and of drip irrigation it is 85-95 percent.

Water Distribution Through Closed Pipes

6.5.7 For irrigating contiguous large area by any of the aforementioned methods, it is necessary to distribute water through closed pipes. It will be more useful to distribute water received from canal or lifted from open well, bore well, river, reservoir etc. for irrigation through closed P. V. C. pipes and thereupon operate drip or sprinkler irrigation schemes. By this, the water loss through field channels is fully avoided. As distribution pip are laid underground, the entire land above can be cultivated and furthermore there will be no impediment in use of farm implements. Even though construction takes longer time than the construction of conventional field channels, they are more durable and its maintenance cost is quite low. Laying pipe lines on undulating and steeply sloping land does not involve much expenditure. In case of field channels, the cost increases if land levelling is done; and if the levelling is not done,

1. Gez Cornish (1998): Modern Irrigation Technologies for Small Holder in Developing Countries.

not only the flow irrigation is not accomplished properly but also extra expenditure is required to be incurred on account of providing falls across field channels.

Such schemes are required tobe operated only after undertaking an overall assessment as for how much minimum and maximum area the joint system of piped distribution and drip / sprinkler irrigation proves economically viable.

Regulation of Drip and Sprinkler Irrigation Systems through Computers

6.5.8 The efficiency in the foregoing two modern methods of irrigation can further be increased by regulating irrigation through the computer. In areas where due to acute water scarcity, the available water has to be used very economically or highly sensitive crops are to be grown, (e.g., nursery development), computer-controlled automatic operation of drip/sprinkler systems proves to be more effective and beneficial. The soil moisture status and temperature, electrical conductivity and pH, weather parameters (sunshine, wind, temperature and humidity) are measured and the quantum of water and doses of liquid fertiliser as determined from this data using computer can be applied automatically with the help of computer. Computer indicates if there is reduction in efficiency of pumps or sieves. It has been found to be more beneficial to tender computer-controlled irrigation to crops like grapes and floriculture. In Maharashtra, some progressive farmers have developed this type of management Especially, it is even more beneficial to irrigate crops by drip/sprinkler methods under controlled temperature and humidity conditions in glass houses with or without use of computer. As protection of crops from untimely rains, cold waves and high temperatures is ensured, the production of floriculture and other sensitive vegetables, fruits etc. is assured. When more than one source of water is to be used for irrigation, it can be employed effectively with the use of computers. Pump needs to be operated for short time. If there are more than one pump in operation, which pump is to be switched on can be decided more precisely leading to saving in electricity. Possible human delay or carelessness can be avoided. Due to limitations existing in other measures of reducing water loss in traditional irrigation methods, it will here-in-after be necessary in future to adopt on large scale the modern irrigation methods which can meet the water requirement of crops in a better manner and which obviate the water loss to a large extent.

Difficulties in Micro (Drip/Sprinkler) Irrigation Systems

6.5.9 The Government is putting in efforts since 1986-87 to increase Area under micro (drip/sprinkler) irrigation systems and as of now (1998), total 1.68 lakh ha area has been brought under irrigation - 1.2 lakh ha through drip and 2.48 lakh ha through sprinkler. On investigating the causes underlying the deficit in intended increase in spite of Government subsidy to the extent of 50 to 70 percent of expenditure, it is observed that many farmers are not yet convinced of, the importance of this system. The initial investment on account of this system is also high. Those farmers, who became convinced of the importance of the system, purchased the equipment either from their own resource or with Government subsidy. However, the problems of maintenance and repairs arose subsequently. At some places the drip / sprinkler units were not installed properly; at other the units installed were of not good quality. At some places it was observed that sufficient information as to how to maintain and repair the units once they would be installed did not seem to be provided. At some places it was observed that farmers had removed the installed drip sets due to problems of accumulation of algae, dried leaves, silt and bacteria present in water and they had again resorted to flow irrigation method. Although the Government offers 50 to 70 percent subsidy, loan is not easily available to farmers to meet the balance cost. Hence, the farmers used to deploy the old pumps only instead of using the required type of pumps. Sometimes, inferior quality parts (laterals, drippers, etc.), are used. The units are sometimes operated presuming that the filter is not necessary and an equal amount of water is not delivered by emitters at all places as a result of which uneven crop development takes place and finally the expected yield is not obtained in spite of incurring sizeable expenditure thereon. As a result of this, it seems, some farmers are losing faith in this method of irrigation.

The most important constraint in increasing the area under drip and sprinkler irrigation is the fact that from technical point of view the system is not yet properly developed for food crops like sorghum, pearl millet, maize, wheat and paddy. Under the present economic conditions, this system proves very costly in case of these crops. Therefore, it does not seem likely that large area under foodgrain crops will come under drip/ sprinkler irrigation. Hence the adoption of drip and sprinkler systems will essentially remain confined to cash crops other than foodgrain for forthcoming 30 years at least.

Modern Irrigation Techniques

6.5.10 The research on drip and sprinkler irrigation systems carried out has so far mainly addressed the issue of how to use these systems more efficiently on agricultural land. There is a considerable scope for research related to design and production of the material used in these systems. This needs to be undertaken here-in-after. Considering the increasing trend of adoption of modern irrigation systems, there is going to be an annual investment of Rs. 100 - 200 crores through sale of material pertinent to that irrigation system here-in-after. There is a need for continued research for developing new techniques and materials for economic production. Presently, such type of research centre does not exist anywhere in the country. It will be beneficial that Maharashtra should take initiative in this regard to establish a research and extension centre under the Directorate of Irrigation Research and Development and encourage new initiatives by keeping in touch with manufacturers interested in manufacture of these products.

The area under drip and sprinkler being about 5 percent of the total irrigated area in Maharashtra, micro-irrigation has now become an important and appreciable component of the total irrigation programme. It is an alternative, which ensures one and half times production with half the quantum of water and also three times productivity per cubic metre of water. Seeing the response received, by horticultural development programme all over, if such programme is formally linked up with the expansion of new system like drip irrigation, it will lead to rapid increase in area under such modern irrigation system. In Maharashtra, drip irrigation sets are generally being used for 30 different crops. Some of the important, crops (grape, banana, cotton and sugarcane) and areas thereunder are as follows:

Crop	Total area under the crop (ha)	*Area under drip (ha)	Percentage of drip area with respect to total area
(1)	(2)	(3)	(4)
Grape	31000	21821	70.39
Banana	64000	18720	29.25
Sugarcane	517500	16118	3.11
Cotton	2759900	3961	0.14

*Source:Drip Irrigation in Maharashtra- Agriculture Department, Government of Maharashtra.

In order to maximise the use of drip system for cotton and sugarcane crops hereafter; there is an urgent need to frame a concrete programme and formulate a plan. Since there is a lot of scope for irrigated cotton in undeveloped area of Marathwada and Vidarbha, special efforts be made for adoption of drip irrigation in these parts. From the district- wise area under irrigation (Annex 6.5.1), it is seen that more than half the area falls under Jalgaon; Nashik, Ahmadnagar, Pune, Sangli, Solapur, Aurangabad and Amravati Districts. Thus, the growth of drip irrigation is much faster in these 8 major districts as compared to other ones and it is very slow in districts like Beed, Osmanabad, Dhule and Wardha where there is acute shortage of water and there is scope for horticultural development. The area under drip at the end of year 1991-92 was 18034 ha and that at the end of 1996-97 was 103451 ha (Source: Drip Irrigation in Maharashtra, Agriculture Department, Government of Maharashtra) which means that the area under drip irrigation in Maharashtra has increased six folds during the past five years. Considering the pace of aforesaid development, the target set for the next 3 decades can be attainable. There is-no alternative to systematic planning for achieving 21 times increase in Maharashtra over the next three decades. In view of this, it will be very useful to establish the district wise modern irrigation service centres under the Agriculture Department for strengthening the service organ Of modern irrigation system. It will be inevitable to make new capital investment every year as use of modern irrigation system is going to be established on a large scale in future. During the last 3 years on an average Rs:41 crores have been invested annually on this system in Maharashtra from social funds. As a result, on an average every year 11000 ha new area could be benefited from this system. In order to bring a minimum of 1.17 lakh ha new area every year under this system, a capital investment of Rs. 436 crores will be required to be made annually. Assuming 50% of this amount to ,be borne by beneficiary farmers, the Government will still have to make a provision of about Rs. 218 crores in its budget every year.

It is not that the use of this system is useful merely to agricultural production. Beside that, drip and sprinkler systems are also suitable for the seed breeding centres and nurseries (including trees). However, no concrete programme of restructuring such centres / nurseries on modern lines from that angle is presently in existence. It is desirable to take up such concrete programmes through disrictwise modern irrigation extension centres proposed here-in-before.

Measures for Increasing Area under Modern Irrigation Method

6.5.11 The subject of micro-irrigation needs to be viewed from a foresightedly perspective. The available irrigation water needs to be supplied to maximum possible area and to maximum number of farmers considering water resources and geographic conditions of Maharashtra. One needs to think about improvements in this regard keeping in mind the national interest and to make all the irrigators aware of the advantages of this irrigation - method. Water for agriculture from wells / reservoirs, canal lifts and river should be used through drip or sprinkler methods only. Special efforts need to be made therefor through extension services for increasing area under micro-irrigation. It is necessary on the part of professional organisations to organise regular workshops on this topic at different places. The Government should offer concession in per cubic metre water rates to those who adopt modern irrigation methods. Maharashtra has achieve good progress in this sphere Out of total area under drip irrigation in the country, generally 60 percent area belongs to Maharashtra, Notwithstanding this, there is a tremendous scope for increasing area under drip and sprinkler irrigation in the State

Micro-irrigation involves high initial investment. Though 50 to 70 percent subsidy is available from the Government, it is necessary that adequate loans are available easily to meet the balance expenditure. In absence of sufficient loan availability, units (or some of its parts) of poor quality are used to be installed resulting in problems of maintenance and repairs from the very beginning. In one study carried out, opinions of 3500 farmers were assessed. According to them, getting loan from banks is a very time consuming process and non availability of loan in an adequate proportion is the main reason for dropping down area under drip irrigation than expected. It is, therefore, necessary that NABARD should extend concessional loan (at a lower interest rate) to the farmers. The Commission contends that this will be more practical than offering subsidy.

There is a need to improve the quality of drip and sprinkler irrigation units. This will obviate, various problems of maintenance and repairs. Presently, there are 5 major undertakings which manufacture about 78 percent of drip units out of which 59% units are manufactured by a single industrialist. Rest of the units are used to be manufactured by numerous petty industrialists. There are 25 such industrialists in Maharashtra, 12 in Karnataka and 4 in Tamilnadu. In a modern irrigation method such as drip / sprinkler, full impact is not discernible unless all components are of excellent quality Wider use of this irrigation system is, therefore, going to depend on the quality control being exercised in this industry. Therefore, while thinking of modernisation of irrigation hereafter, it is obligatory to give consideration to industries manufacturing these new types of equipment in planning. There is a considerable scope for improving the quality by increasing production efficiency by adopting modern techniques in the industry. If micro-irrigation industry is proposed to be promoted, several companies will enter into this industry, thereby creating competition in manufacturing drip/sprinkler units. As a result, continuous efforts will be made for quality improvement, which is utmost essential. Poor quality units will not come in the market. Care will have to be taken to ensure that BSI products are not put on sale without sufficient examination and testing. Keeping this requirement in mind, a laboratory has been set up at Vasant Dada Sugar Institute, Pune for arranging checking of components of drip units. BSI, New Delhi has given recognition to this laboratory. Hereafter, the examination of quality of components of drip units will have to be made obligatory before effecting sale thereof.

Farmers encounter several difficulties pertaining also to maintenance and repairs after installation of drip/sprinkler units. To overcome those difficulties, it is necessary that aftersales-services from suppliers of micro-irrigation units be easily available. Similarly, imparting training to farmers using these will also have to be arranged by the Agriculture Department. As it is expected to go in for large-scale adoption of micro-irrigation method in future, it will be desirable to extend concessions in the form of incentives by financial institutions like NABARD to enable the. 'Maintenance & Repairs Services Centres' to purchase necessary tools for undertaking place to place repairs of micro-irrigation units. Besides, it is necessary to have a trained person capable of undertaking such repairs by himself in villages where orchard schemes / drip schemes are to be implemented. It is, therefore, necessary to provide facility of training for the youth in those villages who wish to take up self-employment through associations of manufactures of such material. There must be one person in .each village who can carry out repairs. There are examples of ravine, hilly, saline, sodic and also fallow lands having been brought under cultivation by using modern irrigation methods. In some places, (e.g., Ankalkhope, Sangli District), the misnomer that higher yield of sugarcane can be obtained by supplying more water has led to application of the same far in excess of actual requirement and sugarcane had been grown continuously year after year. As a result, some area in Maharashtra today is affected and rendered infertile. Such lands have been brought back under cultivation by adopting modern irrigation method. A successful experiment of rendering raving lands on the bank of

Girna at Jalgaon amenable to cultivation by cultivating fruit gardens. The mountain ranges (hilly and fallow lands) near. Jalgaon City have been developed through water conservation and modern irrigation methods. The Commission visited both these undertakings. In this way the uncultivated, fallow, hilly and undulating lands can be brought under cultivation by using modern irrigation methods.

The water made available from watershed development programme (wells, bore wells, percolation tanks, farm ponds, etc.), is relatively of good quality. Such water is, therefore, better suited for use with modern irrigation method. As a result, the unit can work more efficiently. Therefore, interlinking of the watershed development programme (including fallow area and horticultural development schemes) and modern irrigation method is the need of time. Such planning will prove to be mutually complementary with accrual of following benefits:

1) In upper reaches of watershed, water scarcity which is rampant there will also be partially reduced as a result of water conservation measures and water thus made available can be utilised by maximum number of beneficiaries.

2) By adopting drip units on wells in watersheds, 2 to 2.5 times increase in area can be achieved with the available water. An independent evaluation mechanism for cropwise / climatewise inspection, measurement and analysis of social and technical acceptance of this new technique will have to be there. The outline of further programme be framed on the basis of annual inspection of an exclusive set-up specially established therefor instead of relying merely on commercial / sale system.

6.6 Conjunctive Use of Water

6.6.1 From the study carried out so far by the Directorate of Irrigation Research and Development in Maharashtra, it is seen that generally 2 percent area (Statement 7.4.2) of total irrigable command area on canals of various projects has become saline and waterlogged. Also, there are examples of experiencing scarcity of drinking water even in irrigated areas clue to relentless draft of groundwater in commands of various projects. The main reason to which this state of affairs is attributed the understanding that the projects to facilitate use of surface water have to be constructed from public funds and developing facility for using groundwater is fully entrusted to private initiative. As a result, there remained no coordination between these two uses being entailed in irrigation area. Underuse of all total available water resources and increasing groundwater storage resulted in area progressively becoming waterlogged and saline. Achieving proper conjunctive use of surface and groundwater has even emerged as the obvious remedial measure and an inevitable one also.

Earlier Recommendations

6.6.2 The pertinent recommendations offered by the First Irrigation Commission are as follows:

1) There is a marked improvement in the availability of groundwater due to its continuous recharge from the irrigated area where irrigation facility is available. Hence, integrated use of surface and groundwater should be made.
2) For increasing the irrigated area in the canal command, groundwater resource should be used by lift-cum-flow irrigation methods. This includes:
   a) For perennial crops canal water and groundwater be applied alternatively and well water be given for skipped rotation.
   b) It may be made mandatory for each irrigator in canal command to construct a well. After construction of network of wells in an area, alternate rotation be

arranged. Only for initial short period, the irrigators may be denied canal water.

c) To facilitate development of lift-cum-flow irrigation scheme, the canals be kept running continuously during rainy season.

d) As a first step in this direction, Government has to establish right for controlling wells in the command areas of old and new canals. They should be registered and assessment of royalty

3) thereon should be initiated. 3) Scientific study needs to be undertaken to determine in what manner and how much rise in water table takes place due to canal percolation.

All these recommendations have been accepted in principle by the Government. However, in respect of most of these, no action seems to have been initiated till date.

National Irrigation Commission (1972) also advocated the conjunctive use of water. It made several recommendations regarding conjunctive use considering mainly the groundwater occurrence in alluvial aquifers all over the country where conjunctive use is being practised. It offered various recommendations pertinent to conjunctive water use on that line the main among which are as follows:

1) Top most priority be given to conjunctive use of surface and groundwater in the prevailing irrigation system.

2) Before implementing the programme of conjunctive use of water on a large scale, regionwise accurate assessment of available surface and groundwater resources be made through detailed studies. Their interrelationship and use also need to be studied for achieving their integrated development.

3) There is a risk of excessive withdrawal of groundwater while advising conjunctive water-use. Hence, there is a need to exercise control on taking up bore wells through an enactment in those areas where there is a possibility of over-exploitation.

4) Assessment of water charges in the six alternatives for conjunctive use be either made collectively (considering groundwater and surface water use) or separately (as per actual use).

The National Water Policy accepted in 1987 has stipulated guidelines for design of project keeping in mind the objective of conjunctive use of groundwater at the time of very planning irrigation project. The same has not been practised in projects envisaged previously. As per existing guidelines of the Central Water Commission, the explanation as to the existing wells and those likely to be taken up later in command area and the likely irrigation thereon are required to be offered in the layout of the project.

Present Status

6.6.3 Conjunctive use does not mean to intermix water from both the sources. Rather, it is to judiciously use water from both the sources ^W either together or separately - with a view to achieve the common objective of increased in production. Broadly speaking, three alternatives are available for achieving this:

1) Use of surface and groundwater for irrigation in the same area at different times (seasons).
2) Irrigation through groundwater and surface water on different areas.
3) Use of the foregoing ,two alternatives alternatively for the same irrigation area i.e. use of surface water in one rotation and that of groundwater in the subsequent.

The First Irrigation Commission had also undertook an in-depth consideration of this issue and analysed four alternative procedures.

In one procedure, no canal water is to be allowed into areas under perennial crops like sugarcane during post-monsoon period of October to March when sufficient groundwater recharge has been accomplished and these crops have to be protected by only using water lifted from wells. But during the same period water needs to be supplied to *rabi*, seasonal crops also which will induce misuse of water when needed. Keeping this in mind, it was decided not to accept this system.

In the second procedure, it is proposed to close the canal during the period from 15 February to 15 May and farmer has to irrigate perennial crops like sugarcane by lifting water from well. But this proposal was also found unacceptable because wells will go dry if canal is closed for three months and crops like sugarcane will suffer from severe stress. Also, it will not be possible to take hot weather crops.

In the third procedure, the perennial crops are denied canal water during period from July to March. This alternative is also to be found unacceptable as the shortcomings to which the first procedure is subjected are also applicable to this one also.

Canal water is to be supplied to perennial crops in alternate rotations and well water has to be used for remaining rotations in the fourth procedure. This means canal will run continuously but alternate distributaries are to be kept closed in each rotation and water is to he supplied from wells to the crops on these distributaries. The First Commission had recommended this alternative, but it could not be implemented as all farmers may not have access to well water.

Thus, the only alternative left is to use canal and groundwater in separate areas. This alternative is implied in the existing Irrigation Rules in Maharashtra. By the Act, it is binding on irrigators to keep the areas irrigated on canal and wells separate. Carrying canal water and well water through the same field channel is not allowed by the Irrigation Department. There is a rule, which requires a minimum of 3 metre distance between these two channels.

After commissioning of an irrigation project, farmers dig wells and add to their income by harvesting cash crops. As is observed the well population in command area of all projects (area under flow irrigation, canal and area irrigated through lifts on reservoirs) is increased (Annex 6.6.1) considerably once the project is commissioned.

Irrigation on Wells in Command Area

6.6.4 The advantages of using well water are obvious. Firstly, loss of groundwater due to evaporation is less, and secondly, farmers have the facility of begetting water as and when required by the crop. They do not have to wait for the canal rotation. The geological formation in Maharashtra is not favourable for tube well irrigation. In hard rock, the easiest way is to dig large diameter wells and to go in for lift irrigation by installing 5 HP engines. Also, the geological formation varies so much from field to field that while a well in field may yield abundant water, a well dug in the adjacent one may not strike at all. Development of wells in command areas is taking place through private investment. It is, however, observed this development has not taken place in a planned manner. To prevent this, it is desirable to have integrated planning of water resources in command areas following the principle of conjunctive use. Presently, surveys are conducted only for waterlogged and salinity-prone lands and not from the point of view of conjunctive use.

Therefore, for survey and planning of groundwater in command areas, Hydrogeologists should also be involved alongwith soil scientists. While planning conjunctive use in command areas, the well development in the command area should be planned by considering estimated ground water recharge during irrigation season.

At present 45 percent of the area that is irrigated on canals is irrigated by wells in the command area (Annex 6.6.1) and thus, conjunctive use is, in fact, being practised. Canal water and well water are used at the same time but for different areas of the field. Even if this is the way the conjunctive use is taking place, it is not in a completely planned manner. While planning command area development, it may not be possible to strictly demarcate areas to be irrigated on canal and those to be irrigated on wells. Therefore, field channels are to be laid out on the entire surface in command area without excluding any area No separate area devoid of field channels is left for practising well irrigation Farmers subdivide their farm areas according to uses as per necessity relying on their practical experience. The intermixing of well irrigation and canal irrigation in the command of a distributary leads to illegal practice of theft of canal water for benefit of crops irrigated on wells which is difficult to control. This is a sizeable shortcoming in the method of conjunctive use. It can be overcome by giving measured water Besides, no land owner can be compelled to dig well in his land. It depends upon his will and economic condition. According to National Water Policy, it is necessary to consider planning of surface and groundwater as sources of an integrated water resource. Their development should also be done in an integrated manner. But in practice, the concept of conjunctive use has not been put to practice in canal command areas till now. There is a need for trained hydrogeologist for making systematic estimates of aquifers and groundwater potential necessitated for proper management of groundwater in canal command areas. The concept of conjunctive use should be implemented more effectively based on hydrological estimation of surface and groundwater in the catchment under command area and identifying areas, which can be recharged by canal water. Only then the conjunctive use be included as an integral part of groundwater development programme of a larger command area development programme.

Contribution of Cooperative Water Users' Associations in Conjunctive Use

6.6.5 The management rules and system of cooperative water users' associations being established on canals are amenable to conjunctive use. Under this system, seasonwise water quota for the beneficiaries is fixed for *kharif, rabi* and hot weather and that much quota is given by measurement at minor head. A water users' association has right to decide crops to be taken on that much quantum of water and delineate areas farmerwise. Farmers have full freedom to mix well water with canal water. As a result, it has been experienced that after such water users' associations become operational, there is an increase in the number of wells in their commands. For example, there were 180 wells in 1151 hectare command of Banganga, Mahatma Jyotiba Phule and Jay Yeogeshwar societies on the Waghad Project before the latter became operational. This number rose to 300 in five years. To ensure practising conjunctive use this system seems to be appropriate. It is, therefore, necessary to adopt this system here-in-after also It is desirable to make available loan facility at reasonable rate of interest to farmers for taking up such wells as a part of command area development. As a result, the danger of soil becoming waterlogged can be obviated by lifting water from wells and the expenditure on drainage therefor will also be saved. It is also possible to use drip and sprinkler irrigation systems on these wells. In this manner, water saving techniques will also automatically become operational along with conjunctive use. Increase in the area under irrigation will also definitely help increase production. Presently, farmers can secure loan at 12.5% interest rate for taking up wells, through NABARD. But this facility is being given equally to the farmers in the command and those outside. It is desirable to have nominal interest rate for well irrigators in command area as a special incentive.

In order to ensure that by taking undue advantage of this facility, the number of wells does not exceed the natural limit of groundwater recharge, the number of wells permissible under each minor will have to be got worked out through Groundwater Surveys and Development Agency and permission for new wells in command area will be restricted to this number. Requisite powers need to be delegated to the Irrigation Department for regulating groundwater development in command areas. The recommendation of the First Irrigation Commission to this effect is reiterated.

Procedure for Conjunctive Use

6.6.6 In our opinion, the most appropriate approach for conjunctive use, when considered broadly, is to supply water by volumetric measurement and make assessment on that basis giving full freedom to farmers for combined use of well and canal water and that is why it is recommended. The Act and rules be amended therefor. Till such time that the above action is not actually initiated through water users' associations, the water, charges should be assessed for all the wells in command as per rules, because water got recharged by wells depends on canal percolation. Similarly the existing limit of 35 m should be absolved with as it is devoid of any scientific base.

Assessment of Groundwater in Command Areas and Quality thereof

6.6.7 As stated in the foregoing paragraph, the programme of taking up wells in command areas will here-in-after be undertaken on a large scale. Assessment of groundwater resource in project areas essentially be carried therefor. The occurrence of groundwater, being a somewhat complex process and prone to be combinedly influenced by natural as well as man made factors, the assessment of quantity and quality of groundwater resource be 'taken up throughout the State. The concept of conjunctive use can be put into practice by mixing it with surface water of a given quality in the same area.

There is a need to adopt suitable strategy for integrated management duly considering water available temporally from both the sources in a project. While computing the water balance of a project, there is a need to estimate the additional recharge taking place due to water in the project in conformity with the depth of water table and the maximum and minimum bounds of groundwater resource resulting therefrom and long-term variation in geohydrological survey. Strategy for conjunctive use of water should be framed as per the guidelines issued by the Central Water Commission in 1995 based on consideration of geohydrological, climatological, agricultural and economic aspects and site-specific conditions. Besides, there is a need to further increase the scope of measurement and monitoring of groundwater quality in project command areas.

There is a need to involve well-qualified geohydrologist in irrigation management in order to implement conjunctive use of water and to ensure its annual and seasonal regulation. At present, such type of standing base is not there in the executive organs of irrigation management. It is, therefore, necessary to immediately create at least one post of geologist in each irrigation sub-division and with his help to transform the irrigation management into the pattern of conjunctive use in commands of respective subdivisions.

Eight-monthly / Perennial Policy

6.6.8 (A) It has been emphasised for the last several years that in scarce water resource state like Maharashtra which invariably experiences the stress of drought in some part or the other because of the vagaries of monsoon, water should not be provided to water-intensive crops like sugarcane from irrigation projects constructed in the State through public investment. At the beginning of this century during the British regime when design work of Neera Right Bank Canal was in progress, even at that time it was initially planned to run as an eight-monthly canal. Subsequently, however, the Neera Right Bank Canal was planned for perennial use instead of eight-monthly after analysing the performance of the then existing projects and appreciating the fact that in the event of good water availability there is a sharp decline in the demand for seasonal crops and demand for water does not come forth.

(B) Two important management methods were evolved from the steps taken to bring in some stability to irrigation system considering extreme variability in annual rainfall and the resulting inflow in a reservoir on one hand and uncertainty in respect of the demand received for the crops depending water availability status on the other: One of these is the Block System wherein cultivates are assured water supply for perennial and seasonal crops on ,a long-term basis (6 years or even more) and in return the cultivators are expected to agree, to strictly follow the cropping pattern and to pay the water charges regularly throughout the period of agreement at the stipulated rates. In the second method, the canal reach is divided into perennial and non-perennial. In the canal head reach, the length of canal upto that portion of the command which can be irrigated every year within the framework of the Block system with normally assured available water is planned as perennial and the reach below that as a non-perennial one. The blocks are sanctioned in the perennial canal reach and sanction to seasonal crops is accorded in the non-perennial canal reach according to availability of Water. This method imparted stability to irrigation management and it enabled full utilisation of whatever water that used to be available every year.

(C) When study of irrigation evolved through this method was carried out by the First Irrigation Commission, it is observed that due to this method some limited areas flourished and turned into 'islands of prosperity.' An important recommendation had been made to rid of this that the irrigation facility should be spread over to the entire length of the river basin instead of limiting it to the length of the canal. The measures such as redistribution of irrigation sanctions, curtailment in admissible perennial area, canal lining, lift-cum-flow method, for going in for conjunctive use of groundwater and canal water etc. were suggested therefor. None the less, it was also suggested that while implementing all this, it be ensured that the supply of cane to the existing sugar factories remains unaffected.

Government has accepted most of the recommendations made by the First Irrigation Commission for decentralisation of irrigation facilities. 1:4 sugarcane block has been implemented in place of 1:3 sugarcane block. Permits have been issued for lift irrigation on canals and reservoirs within certain limit. The minor irrigation programme has been accelerated. However, recommendations in regard to lift-cum-flow irrigation could not be implemented. Even then, demands for effective distribution of water on an extensive area and putting restrictions on cash crops such as sugarcane continued to be placed.

(D) It was recommended by the committee for Drought Affected Areas appointed in 1972[1] that irrigation from reservoirs in the drought

1. Sukhthankar Committee Report: 1973, Paragraph 8.17.2.

affected areas should be restricted to *kharif* and *rabi* seasons only. As a result, the reservoirs will be completely depleted by the end of February effecting thereby saving in water loss due to evaporation and water so saved can be used Tor agriculture. Subsequently in 1978, the Government appointed a committee, under the chairmanship of late Prof. Dandekar for an in-depth study of the issue of eight-monthly water distribution. This committee submitted an interim report in 1979 wherein it was stated that a review be taken of water available at 50% dependability in all the river basins and sub-basins thereof in the State and its classification be made as follows:

1) Basins in which more than 1 Mcft water is available for 12.5 acre culturable area (that is, those with more than 5600 m^3 per ha water availability).

2) Basins in which 1 Mcft water is available for area more than 12.5 acres but less than 25 acres (that is, basins where water available from 5600 to 2800 m^3 per ha).

3) Basins in which 2 Mcft water is available for more than 25 acres (basins having water available less than 2800 m^3 per ha).

In the foregoing classification, basins at Sr. No. (2) and (3) be treated as basins having scarcity of water for which the committee made the following recommendations for accomplishing water distribution.

1) 1/3 of available water be given in *kharif* season, and

2) 2/3 water be given in *rabi* season. If water is not used in *rabi* season or there is no demand for water, then that much water after deducting evaporation losses be sanctioned to hot weather crops. In no case, water be supplied to perennial crops from the irrigation projects constructed through public funds. The perennial crops should be irrigated through groundwater only.

3) Existing block system be absolved and available water be distributed to all beneficiaries in proportion to their land holdings.

4) Canals be extended in such a way that the area of 25 acres will be brought under its command per Mcft of water use to be entailed through the project (that is 2800 m3 water per ha). Wherever on account of natural limitation that much area is not realisable through flow irrigation, the same may be got compensated by going in for lift irrigation.

5) Water be supplied on volumetric basis.

The committee was to undertake an independent study and submit a report as to the manner in which to implement these recommendations without disturbing the sugar industry which has been established due to development of sugarcane irrigation on old canals. However, this could not be materialised in course of time. Meanwhile, the Government even started construction of Kukadi and Upper Pravara Projects after incorporating necessary changes in planning thereof. It has also been decided to modify the plans for Mula and Ujjani (Bhima) Projects in accordance with eight-monthly system. Subsequently, a policy order was issued in February 1987 to the effect that eight monthly water supply will be provided in all irrigation projects to be taken up in future in water-short basins and sub-basins (Government Resolution No Irrigation Department BKS 1086/379/I.M. dated 12.2.1987).

(E) Eight-monthly policy has as such been supported strongly by all thinkers and the Government has also accepted this as a policy. From the data presented in Statement 7.3.5 about the seasonwise actual irrigation accomplished during 1994-95 as against irrigation potential created in respect of various regions in the State, it is seen that, in all the regions except Nagpur, the irrigated areas in *kharif* and *rabi* seasons are far below the potential. In this regard, the percentage in respect of Nagpur Region is found to be somewhat satisfactory due to paddy crop. Even in the major drought prone area of Aurangabad, Pune and Nashik, the water use entailed in *kharif* and *rabi* seasons is less than expected. On the contrary, hot weather irrigation and irrigation of perennial crops is more than the projected potential. Specially the area under Hot Weather seasonal crop is almost double of the projected potential. In all the regions in this State, one crop in *kharif* or *rabi* can be grown on rainfall in an ordinary year. Therefore, necessity of irrigation arises only in case of inadequate rains once the crops are sown. Increase in income due to irrigation is not sizeable to motivate the farmers to accrue benefit of irrigation. In the performance budget of the Irrigation Department, production figures in respect of some major irrigation projects are presented based on crop cutting .experiments. Data pertaining to the three years viz. 1994-95, 95-96 and 96-97 is indicated in Statement 7.3.7. From this, a maximum increase of 50% is observed in foodgrain production in *kharif* and *rabi* seasons. It is far less in respect of *kharif* jowar. Therefore the real demand of farmers is for such crops which can not be cultivated without irrigation facility. This includes crops such as hot weather groundnut, vegetables, sugarcane and banana. After comparative study of the projected cropping pattern and the actually existing one, it is seen that irrigated area of *kharif* and *rabi* foodgrain crops and two-seasonal crops is very small as compared to the projected area and a marked increase is seen in areas of cash crops such as hot weather groundnut, sugarcane, etc.

A study group of Chief Engineers appointed by the Government for undertaking a realistic review of the irrigation potential created by irrigation projects submitted one interim report in March 1993. The report present, a studied analysis of water utilisation in respect of following projects which have been in operation for 15-20 years: Nazare Medium Irrigation Project in the scarcity area of Purandar *Taluka* in Pune District and Manar Major Project in assured rainfall area of Kandhar and Biloli Talukas in Nanded District. The broad findings are as follows:

1) In Nazare Project, 655 ha area was irrigated in *kharif* season as against 1278 hectares as projected. Actual area under two-seasonal crops was nil as against projected 492 ha.

Though there is no hot weather area envisaged, 243 ha area was actually irrigated. Besides, 112 ha area in hot weather is irrigated on wells in the command. As such, 10 percent of the total irrigation envisaged in the project is achieved in hot weather.

2) In Manar Project, envisaged area under *kharif* paddy was 2332 ha. Actually irrigation is catered to in 700 ha. The projected area of other *kharif* seasonal crops was 5828 ha but actually it was only 1005 ha. The estimated area of Two Seasonal crops was 5828 ha. According to the committee, provision for this be reduced to 467 ha only because there is no demand at all In contrast, the actual area under sugarcane was 1750 ha as against 1050 ha as envisaged.

3) Only limited irrigation will be catered to during *kharif* season in areas having assured rainfall, (i.e., more than 700 mm average rainfall) as no used to be delivered during *kharif* for the cropping pattern in deep black cotton soil areas. In such areas water is used for hot weather crops. Water is used up to an extent of about 20% for hot weather crops in Purna, Jayakwadi and Pus Projects.

From the foregoing representative examples, one can have an idea about the response received from the beneficiaries to irrigation management. This psychology of the cultivators has mainly developed from the net financial profit gained from irrigation. Therefore, it will here-in-after be necessary to plan the use of water that is saved in *kharif* and *rabi* seasons (after deducting water losses) in hot weather based on the demand received for taking hot weather crops in summer from at least 51 percent water users' associations in a project and water rates be revised accordingly.

6.7 Measurement of Water Use

6.7.1 It is necessary to have an orderly measurements of all aspects about the storage in a reservoir, e.g., available live storage at the end of given monsoon, post monsoon yield reaching the reservoir, evaporation losses till the end of the irrigation year, use of water for irrigation and non-irrigation purposes, percolation losses through the reservoir and loss of capacity through silt deposition. It is not possible to plan the optimum use of water without such measurements. The present accounting in this respect is very rough and needs immediate improvement.

Water is utilised for the following different purposes after it is stored in the reservoirs:

1) For irrigation/non-irrigation purposes through canals off- taking from a reservoir:
2) For irrigation/non-irrigation purposes by lifting through a reservoir.
3) For individuals or cooperative lift irrigation schemes on canals.
4) For irrigation from river/*nalla* getting water from wastage or percolation in the command area.
5) For lift irrigation from wells in the command area.
6) For lift irrigation from wells situated around the reservoir periphery and on the river side of canals (influence area) getting water due to percolation.

All this use must be measured carefully. It is necessary to measure the quantum of water used for different purpose, starting right from the main source and reaching the various points at which it is used and also the quantum lost in transit. Different measuring instruments need to be installed everywhere for this purpose. Discharge on main canal should be measured at every 15 km. At all points where cross regulator-cum-escapes are provided, discharge should be measured with the help of standing save flumes (SWF) or current meters. In addition, discharge measuring instruments in working order should be installed at the head of every branch canal, main distributary and minor.

6.7.2 At present, the measurement of water in major, medium and minor reservoirs is carried out by predetermined capacity contour survey maps. The water level is also measured here by the scale available there. The post-monsoon yield is also measured in a similar manner. The capacity of reservoir changes over the years due to silt deposition. This must be considered in the account of water. The change in the capacity of large reservoirs is now possible to be checked by water spread maps obtained through satellites. Evaporation goes on continuously over the water surface, and so also the percolation from reservoirs. To begin with, both of these need to be measured. Evaporation can be measured at least to a certain extent but it is not possible to measure the percolation accurately. This factor in the over all account, it seems, will remain a weak link.

6.7.3 It is difficult to measure the evaporation taking place at the surface of water, in a reservoir. The changes occurring in the atmosphere and the variability make it even more difficult. Even then a fair estimate can be made with the help of an evaporimeter. The rates of evaporation in a evaporimeter and over the dam are related to each other. The ratio between them can be used for computation. The depth of water in a reservoir (shallow or deep) also affects the evaporation. Experimental data regarding the depth and volume of water and the rate of evaporation is not available for Indian conditions. The term 'shallow' also needs to be defined. Studies carried out in respect of reservoirs in different climates and for all the months in a year need to be at hand. An extensive programme of observational survey for the next ten years needs to be immediately undertaken under the control of the Chief Engineer (Hydrology). Such surveys should be carried out even on canals, fields and rivers alongwith that in case of reservoirs.

Importance of Measurements

6.7.4 More the improvement in the method of water use, more is the importance of measurement. If complementary use of well water is intended, an estimate of the quantum water that is available is firstly needed. This means that the groundwater storage and its augmentation due to rainwater and canal water will also have to be measured. The quantity of water which, while flowing through canals, distributaries and filed channels, reaches and augments the groundwater by percolation, how much of it is actually used up in the process of evapotranspiration, how much percolates into *nallas* (and then into rivers) ^W consideration of all these aspects is in order.

All these measurements cannot accomplished every time. Some sort of thumb rules get formulated for every project by experience and planning is accomplished on the basis of these thumb rules only. But it is to be periodically verified whether these thumb rules are correct; whether the planning done on their basis is realistic; and these thumb rules are to be improved whereever necessary. This will have an additional advantage. Mutual relationship between important parameters will be made more and more clear, e.g., groundwater level and rainfall in the command area, groundwater level and discharge in the distribution system, irrigable area and the discharge of the *nallas* in the command area etc. These relationships will mainly be project specific. However, as more and more data will' accumulate, the similarity between projects of different categories like particular geological categories, a particular rainfall categories, etc., will be clearly brought out.

Actual Measurements

6.7.5 If the planning of water use is to be more and more accurate and dependable, the different types of measurements will have to be undertaken and will have to be executed faultlessly. For example:

(a) Post-monsoon yield

This is the yield reaching a reservoir after the monsoon is over which may be due to different reasons:-

1) Water let out from an upstream dam or an escape.

2) Extra water in upstream command area finding its way back into the river, etc.

To accomplish measurement of (2) in the foregoing is difficult but not impossible.

(b) Water in a distributary

Information about this can be obtained by careful measurements of discharge in a distributary, total of discharge in field channels, the amount of percolation in a distributary, the relationship between percolation and rise in groundwater level, etc.

(c) Lifting from reservoir

All water lifted from a reservoir, excluding the evapotranspiration losses, must 'be reaching back the reservoir the proportion of which can be determined by careful measurements. It will definitely be beneficial to the project planning.

Previously only traditional devices such as V. notches and flumes were available for measurement. Nowadays, numerous modern techniques have been developed. Even softwares giving details of measurement are also available in the market. The measurement techniques and the management to be achieved therefrom must now be modernised with the use of such devices. The Irrigation Research & Development Directorate can be entrusted with this work.

Sub-basinwise planning is an important recommendation of the Commission. The above cited measurements will prove useful from that count also.

A proper plan of action regarding the seepage from a reservoir has not so far been evolved. This is a complex topic for research. MERI and Groundwater Surveys & Development Agency should jointly carry out some special work in this respect. Similar study also needs to be undertaken for seepage through canals. The measurement of water use can be thoroughly accomplished in the real sense only when exhaustive data in this regard is gathered.

A pan evaporimeter must be available on every project to carry out measurement of evaporation and the data therefrom should be used in the annual water account of the reservoir. The reservoir storage water account must be published by compiling in the format indicated in what follows in the annual report at the end of an irrigation year:

Statement of account for water use

Water : Mm^3

Available live storage		Use achieved from live storage	
1) Live storage available as on 15 th October	....	1) Evaporation loss	....
2) Augmented storage due to post-monsoon yield	....	2) Lifting from reservoir	....
		a) For irrigation purpose	
		b) for non irrigation purpose	
		3) Water released from main canal	....
		a) for irrigation purpose	....
		b) For non-irrigation purpose	....
Total available live storage		Total use	....

Measurements of water let out from the main canal

Water : Mm^3

Main canal		Water use achieved	
1) Quantity measured at the head	....	1) Loss due to flow through canal	....
		2) Loss through canals upto outlet (due to evaporation)	....
		3) Quantity of water used by lift irrigation	....
		4) Water given to farming through outlet	....
		5) Water lifted from the canal & wells in influence area	....
Total	....	Total	....

6.8 Measurements of Irrigated Area

6.8.1 The Irrigation Inquiry Committee established under the chairmanship of Sir M. Visvesvaraya during the pre-independence days to review irrigation in the then Bombay Presidency has recommended that the beneficiaries should be encouraged to form suitable bodies and water be supplied at the head of a field channel as far as possible in a measured quantity only.

6.8.2 Suggestions offered in the report of the

Maharashtra State Irrigation Commission constituted in 1960 that the irrigated area will increase if the entire area is supplied water in measured quantity. However it is impossible to supply every irrigator a measured quantum of water. Therefore, groups of cooperative nature of the cultivators should be supplied a measured quantum of water at the outlet gate.

6.8.3 The water charges are levied in two different ways:

1) Area measurement method: Bill for irrigation water is prepared on the basis of the total area irrigated by a cultivator, the crop grown in the area and the season and assessment is made.
2) Water by measurement: In the method 'water by measurement' the quantum of water tendered to a beneficiary for irrigation or non-irrigation use is measured volumetrically. Assessment statements are prepared and assessment is made.

6.8.4 The irrigated area is measured by three different departments, viz., the Revenue, Agriculture and Irrigation and by different methods. The method and objectives of each department are different.

Revenue Department: The Revenue Department gathers information through *talathis* about the total agricultural area, by having conducted a broad survey of the field and by instituting a direct inquiry with the farm owners. Education cess is levied upon the commercial crops, e.g., sugarcane, banana, etc., and then it is collected along with the agricultural cess.

Agriculture Department: The Agriculture Department collects information for submitting villagewise and cropwise statistical data to the Government. It is based upon the information collected by the Revenue Department. It is published annually at the Government level by the Agricultural Directorate.

In addition, the Agriculture Department compiles information for 20% villages from every *taluka* through the *talathis* as to seasonwise irrigated/non- irrigated crops, and predictions about crops and area under crops for the year are made. Such information about the entire State is consolidated in the office of the Agricultural Commissioner. The use of information is made for accomplishing planning in respect of seeds, fertilizers, etc., for the next year.

Irrigation Department: The Irrigation Department surveys the area irrigated every season villagewise, cropwise and beneficiarywise. The assessment statements are prepared on the basis of this survey and assessment is finalized.

6.8.5 Out of the measurements got carried out by three different departments, it is expected that only the Irrigation Department will arrange for the actual physical measurement of the canal irrigated area.

Prevailing Method of Measurement of Irrigated Area

6.8.6 Employees in the Irrigation Department designated as 'Surveyors' measure the irrigated area under Government canals. These surveyors are expected to actually measure the area under a crop in that season before it actually ends and by physically measuring the area at the mid season to enter the same in their record book. It is checked by Sectional Officer, Sub-Divisional Engineer/Officer, Executive Engineer. If after measurement the actual irrigated area is found to exceed the sanctioned one Panchanamas are done and an entry to that effect is made in, the record book. An area of about 1000 ha. is entrusted with one surveyor. Considering his salary, etc., it seems that the minimum expense of measurement per hectare is Rs. 39/-.

Shortcomings in the prevailing Area Measurement System

6.8.7 The irrigation charges are seasonwise and cropwise. Different crops call for different rates. Therefore, the possibility of actually taking/giving water for a crop of higher rate showing it as one with lower rates cannot be ruled out.

The work of measurement goes on practically the whole year round in the prevailing system. This results in more loss of time and manpower.

Separate field channels are required for canal water and well water.

Under the area measurement method, it is expected to levy charges once the area and crop is sanctioned even if the beneficiary does not actually take any water.

The employees/officers in the Irrigation Department connected with the measurement of irrigated areas are usually local residents whereby it is difficult for the higher, authorities to exercise control over them as far as the working culture /disciplinary aspects are concerned.

6.8.8 The Irrigation Department is required to complete the measurements of irrigated area, prepare assessment statements at every village and then send a bill to every beneficiary informing him the amount payable by him.

The area under canal irrigation in the State is about 32.28 lakh hectare at present out of which 0.78 lakh hectare area is handed over to 206 cooperative water users' societies. These societies are supplied water by measurement. This means that the Department has to carry out measurements, prepare statement of charges and bills for about 31.50 lakh hectare 'area. Assuming the average holding as 1.66 hectare per beneficiary, the Department has to prepare such statements and bills for about 18.98 lakh beneficiaries. This is a highly involved work to handle. The irrigated area is large and scattered. The Commission, during its field visits, came to know that shortcomings have crept in while maintaining precision and regularity in the measurements, of projectwise, villagewise and cropwise and scattered irrigated area in view of the areal extent. Inadequate and untrained staff is also a major reason for it. Therefore, the measurement of irrigated area and the assessment can not said to conform with the real state of affairs.

6.8.9 The area of operation of one water users' cooperative society of beneficiaries is generally 150 to 500 hectares at present. Assuming an average of 300 hectares for an individual society, the Government will have to prepare water bills for 0.11 lakh cooperative water users' societies. Thus the burden on the Government machinery will be reduced to a considerable extent and therefore the measurement, it is hoped, will be precise and regular, If water users' cooperative societies are established and water is supplied to them by measurements, the work of preparing water bills will be reduced from 18.98 lakh bills to only 0.11 lakh bills, i.e., work will be reduced by 99%. As the number of bills is reduced, the work of preparation, recovery, deposition of the recovered amount in treasury maintaining accounts of the bills and recoveries will also he reduced and some staff - surveyors, clerks and canal inspectors ^W will be found surplus. Such staff can be absorbed on deputation to the cooperative water users' societies by the mutual consent of the Government and such societies. The recommendation of the Commission in this regard is that water for irrigation should be supplied only to the cooperative water users' societies of the beneficiaries and that too only by measurement. For this, as long as such a cooperative society is not formed, water for irrigation is not demanded and it does not enter into an agreement with the Government, no water be released to that particular field channel/water course. This system be made applicable in phases by the year 2010. Till that time no necessity appears to incorporate any changes in the prevailing measurement system outside the area covered by water users' societies.

6.8.10 Hereafter, the Irrigation Department should not classify the area handed over to water users' societies which is irrigated as seasonwise, cropwise, covered under flow/lift/drip/sprinkler systems and measured accordingly Such details be sought from the society itself and then the information be complied. It is necessary to establish a system for this By this system annual account of irrigated actually area and the water use can be maintained.

6.8.11 Handing over the irrigation area to the cooperative water users' societies of the beneficiaries is going to be a need of the time Such societies should take the water from Government canal by measurement and distribute it to their members in a time bound manner.

The Commission recommends that a provision to that effect be made in the agreement for water supply to be made between such a society and the Government.

6.8.12 In case of some agricultural corporations and water users' cooperative societies of beneficiaries, water is tendered by measurement according to the provisions incorporated in agreements effected while approving. While releasing measured quantity of water for irrigation, it is supplied by the Government to the water users' cooperative societies with the help of water measuring devices at the head of the concerned distributary and by the society to the beneficiaries by measurement at the initial field boundary. The members of the Commission visited the Saswad Mali Sugar Factory Ltd, Malinagar on 17.11.97 where the system .of irrigation having measured water distribution is practised. This, factory practices irrigation since 1932 by taking measured quantum of water from the Government and practises irrigation management by distributing it to the farmers in the same manner. The important aspect is that every single farmer gets water by measurement only. There should be no difficulty in implementing this system elsewhere also. This was the only water users' cooperative society of the beneficiaries in the region using water by measurement. The system does not seem to have been adopted elsewhere in the command area during the last 60-65 years. The main characteristics of the society as observed were: 1) Economical use of water 2) Prompt payment of water bills 3) The societies' own management and staff 4) Distribution of water to every beneficiary by measurement only and 5) The factory's own sugarcane field where irrigation is practised by seeking water by measurements and in a participatory approach.

6.8.13 It may be necessary to use the remote seasoning technique for checking the accuracy of measurement of the irrigated area. Verification of the crops in command area using satellites is a modern method with scientific approach. It was brought to the attention of the Commission that this method was tried on experimental basis under Maharashtra Krishna Valley Development Corporation. The work was accomplished by MERI with the help of Maharashtra Remote Seasoning Application Centre, Nagpur. It was noticed at this time that the actual irrigated area was 2.5 times in excess of the area registered with the Corporation for recovery of water charges. It will be necessary to carry out actual field surveys for precise interpretation of the data obtained through these imageries. The system of measurement's can be made more accurate with the help of villagewise maps of command area to the desired in proper scale and interpreting it in conjunction with ground truth.

6.8.14 It takes approximately 6 months time to complete the survey of 1 lakh hectare -area for one season by remote sensing techniques which approximately costs Rs. 0.40 per hectare.[1] Thus by using this system it will cost 0.40 x 3, i.e., Rs.

1. Maharashtra Remote Sensing Application Centre, Nagpur.

1.20 per hectare per year. It costs Rs. 39 per hectare per year if the job is accomplished manually. As this method is precise and at the same time far cheaper, its scope should be widened and MERI should be provided with all amenities necessitated by, the undertaking.

The remote sensing technique has following limitations:

1) It is difficult to get clear pictures in cloudy weather.
2) It is not possible to distinguish the area as Government canal-irrigated from private Well-irrigated area.
3) The Irrigation Department can only have a limited use of the technique in preparing assessment statements, as the areas in different blocks cannot be measured accurately and particulars such as name of the cultivator, block number, name of crop, lift/canal-irrigated area etc. cannot be obtained.
4) The Revenue Department is compiling sat-barn statements using computers. This technique can be used effectively when the system of compiling information like villagewise maps and ownership with the help of computers gets developed and the capability of accurate crop assessment for small farms is acquired.
5) The data pertinent to the extensive irrigation area and cropwise total area in the. State can be gathered and complied in near future by employing this technique.

Publication of Annual Irrigation Measurement Report

6.8.15 The Irrigation Department does not publish bring out an annual irrigation measurement report. However, it is necessary to publish one at the Government level regularly every year after firstly compiling the projectwise and subbasinwise annual report on measurement of irrigation area The Commission recommends the field officers should send the annual information about canal irrigation to the Revenue Department which should publish the same after compiling the information for the entire State, duly carrying out verification thereof. It is beneficial to entrust the responsibility of the account of land use with the Revenue Department. It is felt this information should be published again in a combined form every five years. It is necessary to strengthen the present set-up of the Revenue Department for this It is not possible for an individual talathi to accomplish the task. It is necessary to set up a better system of maintaining over all account of land use.

6.9 Evaluation of DISNET

6.9.1 Out of total water use in Maharashtra, about 85 percent is entailed for irrigation. Most of this (more than 90%) is achieved through irrigation (canal) schemes. Water is distributed up to farm head through a canal network.' Also on farms, the irrigation to crops is mostly catered through flow irrigation method even now. This distribution system entails wastage of water on a large scale resulting in a sizeable deficit. This deficit of the entire distribution system is caused by several factors. The over efficiency of the DISNET is ultimately governed by various factors such as actual discharge received, through network, wastage of water, efficiency of water control gates / aqueducts / outlets, farmers' participation, maintenance etc. In view of the fact that more than 80% water is used by the society through this system and with progressively increasing shortage of water, there is a need for strict evaluation of this system.

Defects in DISNET and Improvements Needed

6.9.2 In principle, canals are constructed to accommodate design discharge. However, it is observed in practice that in case of many projects in Maharashtra, the actual discharge that can pass through the canals is far less than for which it is designed: A study on canals in 12 major projects conducted by Maharashtra Engineering Research Institute has shown that only 47 to 80% the design discharge can actually pass through these canals. Several technical reasons are instrumental for this It is observed that the gates through which water is being let out in canals from the reservoirs are not designed for releasing full discharge. Another study pertaining to 12 minor irrigation tanks carried out at Government level revealed that designed discharge can pass through the gates of 6 projects only and 10 to 20% less than designed discharge passes through the gates of the remaining projects. It is necessary to release designed discharge in canals through outlet gates for realising the intended irrigation. Special technical attention needs to be paid henceforth to manufacturing of gates and creation of a properly laid out discharge system.

At several places, the excavation of canals and distribution system having not been carried out according to the hydraulic section is another major reason. Canal section gets reduced due to non removal of silt and trees / bushes in canal thereby reducing its carrying capacity. Diagnostic analysis of one completed minor irrigation tank was carried out through WALMI in 1985. Review of distribution system in that study also showed that the actual canal bed gradient is not at par with that designed; there are excessive leakages at the canal bridge structures, the loss of head at canal structures, the loss of head at canal structures is more than that considered during design. The cross section of canal is not as per design; the actual coefficient of rugosity is higher than the value assumed in design. The free board of canal embankment is also reduced.

It is observed that designed discharge does not pass through canals due to such shortcomings. This eventually affects irrigation area While preparing preliminary irrigation programme (PIP), it is assumed that the canals carry designed discharge, which however is not so in reality. Water cannot reach the tail end areas of canal and, even if it does, it does so in an inadequate, measure. Consequently, even if the project irrigation potential appears to have been created due to construction of extensive distribution network, in reality the benefit of irrigation is not available to the entire projected command. In order to ensure equitable supply of water for irrigation to the entire area, it is very essential that water distribution system be technically sound. Henceforward, special attention will have to be provided to this need. It will be of little use if merely different structures such as aqueducts, escapes, canal bridges are of strong and good quality construction, but a flawless conveyance system of all these structures and the canal reach passing through the soil-rock complex should be efficiently functional as intended. Therefore, instead of only looking at the stability of construction of structures and reach of canal, it will be necessary to pay much more attention in hereafter to the quality of water conveyance.

The fact that assumptions as regards conveyance are not unrealistic will have to be appreciated while planning canals. In this context, it is desirable that a review be taken of the existing technical guidelines and manuals and the necessary improvement in the prescribed procedures be made forthwith. One more intrinsic shortcoming in the flow distribution network is flow in canal cannot be suddenly stopped everywhere completely nor can the entire canal be set in flow suddenly. It takes considerable time for the canal to get filled up and to be emptied. The present canal management system is one of the upstream control. Water once released from the head regulator goes a waste if it is not required for the crops in absence of cross regulators at various places along its length and facility to hold water therein. Similarly considerable amount of canal water is lost due to seepage. This seepage can be reduced by providing lining. However, considerable expenditure will have to be incurred for constructing lining. It has been experienced that lining does not sustain in black cotton soil areas. Therefore, planning conjunctive use of groundwater proves more fruitful than providing fining.

Measurement of Irrigation Efficiency

6.9.3 Measurement of irrigation efficiency for different components of a project can be made independently and the project efficiency can also be measured separately. For example, in conveyance efficiency, ratio of water made available to the distribution system and water diverted from source (from canal head to distributary head) is measured. In distribution efficiency, ratio of water made available at the farm head and water delivered at distributary head (from distributary head to farm head) is measured. In field application efficiency, ratio of water available at the root zone and water delivered at the farm head is measured, By considering three efficiencies together the overall project efficiency turns out to be the ratio of water available at the crop root zone and water diverted from the source.

Irrigation Efficiency - Global Review

6.9.4 The International Commission on Irrigation and Drainage (ICID) has collected information about irrigation efficiency of 54 projects in 29 countries including India' as a sample study and the analysis of this data has been published in the form of a book (ILRI - Netherlands Publication No. 51 /1992). The summery of that study shows that average conveyance efficiency of the project is 70%, the distribution efficiency is 75 to 80%, field application efficiency is 38 to 58% and overall project efficiency is 23 to 42%. Conveyance efficiency depends on characteristics of conveyance system, e.g., whether it consists of lined canal or unlined one or use of pipes and also depends on the type of distribution and corresponding conveyance method, e.g., continuous flow, non-continuous flow or partly non-continuous flow. Even then, not much deviation is observed in the average conveyance efficiency in these various types. Distribution efficiency depends only upon individual land holding, command area of the distributary and type of off-take. Inspite of this, not much deviation is observed in average distribution efficiency. It is the field application efficiency whereby a sizeable deviation is caused. Average efficiency from water source to field is 50 to 65%, but the field application efficiency is much less - on an average at 38 to 58%. This means among all the components, the maximum water loss occurs on the farm itself. Field water use efficiency depends on type of rainfall and its quantum, type of crop and irrigation method. Therefore, the overall project efficiency is also found to be dependent on the type of rainfall, type of crop and irrigation method by and large. The project efficiency is less where annual rainfall is more and project efficiency is more where annual rainfall is less (less than 200 mm). Such an inverse relation appears exist in this respect.

Irrigation Efficiency - Maharashtra Review

6.9.5 Irrigation efficiency has not yet been measured on all the projects in Maharashtra. Nevertheless, it is necessary in view of the increasing importance of water to make customary such a measuring system. WALMI has carried out studies in respect of a few projects. Based thereon and the technical information available pertaining to a few other projects, the status of conveyance and distribution efficiency appears to present the following scenario.

Project	Conveyance and distribution efficiency (%)	Remarks
Mula	21	Based on detailed study carried out by WALMI.
Godavari Canals	30	Losses in main canal amount to 45%.
Pravara Canals	32	Losses in main canal amount to 45%.
Palkhed Canals	25	Losses in main canal amount to 50%.
Jayakwadi	30	Actual data not available. (Based on discussions with field officers.)
Pus (medium)	33	Based on detailed study carried out by WALMI.
Kalote Mokashi (medium)	32	Based on study carried out by DIRD, Pune.
Nirgudi (minor),	41	Based on study conducted under the guidance of WALMI.

Besides this, the field application efficiency is there. It is assumed to be 50 percent, the overall irrigation efficiency of irrigation projects in Maharashtra in the context of envisaged water planning falls between 15 to 20 percent only Based on this field experience, it is essential to frame new rules for design and water distribution and to adopt new procedures with a view to make water distribution system of the forthcoming projects more realistic. Besides, it is necessary to have the fresh evaluation of the distribution system and project efficiency every 10 years after the project is commissioned. Through such evaluation, projectwise deficiencies can be appreciated and priorities for improvement can be decided accordingly. This will facilitate taking project-specific appropriate and timely measures for preventing water losses and improvement of conveyance efficiency. The loss of water occurring due to percolation during conveyance is not in fact a total loss as it is reused by lifting. But in the absence of facility for accurate quantification of reuse, no clear estimate can be made about the actual water use entailed -out of the total-water distributed. The system to be adopted for evaluation should also include here-in-after correct account of the reuse of water entailed from groundwater. If deficient utilisation is observed, the evaluation team will have to suggest going in for an increased number of wells for reuse of water that percolates.

Measures for Improving Efficiency

6.9.6 (1) Due to use of groundwater in command areas irrigation intensity increases substantially as compared to the intensity prevailing in case of irrigation on canal water. Considering wider objective of equitable water distribution, it is desirable to extend the command area using additional water available from groundwater instead of allowing the intensity to increase on a limited area. The total additional area that can be supplied canal water from the distribution system is one of the important indicators of efficiency. It will be desirable to expand the canal command by limiting the irrigation intensity from the point of view of social equity.

(2) Once the concept of conjunctive use is accepted, the extent of actual conjunctive use as indicated by the, evaluation of distribution system should be considered as an important parameter of measurement of efficiency. Presently, this parameter is not being used anywhere. It will, however, be desirable in the water-short basins to evolve a new indicator for efficiency in the coming decade by conducting several field measurement experiments. in water scarcity basins.

(3) The main objective of irrigation management here-in-after should be to maximise - the on farm water use efficiency focusing rather on

the production as the chief criterion. The importance of water saving by new techniques such as drip and sprinkler along with traditional irrigation methods in irrigation management will be much more furthermore. There will not be an overall increase in-project efficiency, in a true sense unless the distribution system for canal and piped irrigation is ultimately linked to drip / sprinkler irrigation. The Planning Commission in its 9th Five Year Plan Document has laid stress on increasing irrigation efficiency by minimising water losses in conveyance and distribution.

(4) In the total water account, even if water lost due to percolation and leakage is planned to be utilised in the form of groundwater, water lost due to evaporation from reservoir, evaporation loss in Conveyance system and evaporation loss on agricultural farms will still remain major components entailing water loss. Therefore, measures for evaporation control will gain hereafter increasing importance yin the context of efficiency. Just as the efficiency of irrigation distribution system is measured, the water use efficiency of reservoirs also needs to be measured. It is necessary to evaluate efficiency of reservoir taking into account the continually diminishing storage due to siltation and annual water loss due to evaporation. At present, there is no satisfactory arrangement for measurement of evaporation losses. Therefore, no explicit data is, available as to precisely how much water is lost through evaporation from reservoirs in Maharashtra Considering the overall water scarcity, specially urgent attention will have to be paid here-in-after for prevention of evaporation.

(5) After the irrigation. Water is applied to the field, a major portion of it is lost due to evaporation from the land. Efforts must be intensified for adopting measures for retaining soil moisture for longer time by measures, such as mulching, spreading plastic sheets, etc. For measurement of efficiency, periodic accounting needs to be made for amount of water actually used up for growth of the plants, amount of water infiltrated into the soil and that, lost through evaporation out of water received at the farm head.

Evaluation Cell

6.9.7 There is a need of water distribution evaluation cell for this purpose at the State level. This cell be made responsible for measurement of actual water loss and arranging its analysts and offering suggestions to the project officers for improvement accordingly. It is given to understand that 10 percent increase in project efficiency l is accomplished elsewhere by achieving improvement in water use after such cells are set up. Styli an evaluation cell has to be different from the administrative set-up. It should draw upon the assistance from interdisciplinary experts. It should include agricultural experts, groundwater experts, meteorologists, etc. It may be possible to set up forthwith Such a cell on a standing basis in peared necessary to entrust this work to WALMI on a' permanent basis by extending its stipulated working frame.

6.11 Review of Storage Capacities

6.11.1 The silting of reservoirs is an unavoidable natural phenomenon. It is obvious that the soil will get loosened when the fields are ploughed as a part of intercultural operations. The loose soil is brought along with the surface run-off after intensive monsoon rains. This silt flows to in the reservoir through rivets- nallas. The annual rate of flow of such silt brought along the river water depends upon several factors. Main factors among which are erodibility of land, the amount of rainfall and the catchment area of the project. The area under vegetation in the catchment, land slope, rainfall intensity, etc., are also the factors to be reckoned with which affect the inflowing silt.

6.11.2 Some allowance in the form of unusable storage is reserved for accumulating the silt being deposited in the tank, to a certain level while planning projects. Life of a project therefor is assumed as per the following:

1) Major projects 100 years
2) Medium projects 75 years
3) Minor projects 60 years.

Not only the silt simply gets deposited in the dead storage but also it diminishes the live storage of the reservoir. In practice, the both - dead and live storage capacities - go in diminishing due to silt deposition (Government Circular dated. 5th May 1992). The proportion of the silt being deposited in dead and live storages is observed to be generally 50:50.

6.11.3 The process of silt deposition in a reservoir is of long duration. The estimates as to the amount of silt that may be deposited tend to be entirely of a random nature. The knowledge of the process is still limited and want of adequate field data compels to estimate the extent of siltation at best though broadly.

The *galper* land in submergence area is used for cultivation when reservoir water level depletes. The original owner of the land has a right to cultivate it and reap the harvest. However, the soil in *galper* area is loosened due to ploughing. The loose soil is conveyed in monsoon with the inflow and settles in reservoir. This silt tends to get deposited in the reservoir at a fast rate. This ultimately reduces the utility of the reservoir.

In the post-independence era, the rate of silt deposition assumed while planning was based upon European studies. It has been found from the surveys and field studies carried out so far that the actual rate of silt deposition is quite in excess of that assumed due to dry and hot in India and the large extent of ploughed fields. MERI, Nashik has carried out a study of the silting of reservoirs in /Maharashtra. A report of the same has been published in 1995. In last 30-40 years, there has been accomplished considerable amount of study elsewhere in the country. It has been compiled and analyzed. It reveals that the rate of siltation is 1/2 to 1 percent of the useful storage capacity of major reservoirs and 1 to 2 percent in case of minor reservoirs.

In 1994-95 a study of the silting of Manjra - a major project - was carried out with the cooperation of MERI, Nashik. Two independent surveys - one by remote sensing technique and the other by echo sounding technique - were carried out The major conclusion reached is that the annual rate of silt deposition in the dead and live storage is 2.35% and 0.58%, respectively. The rate of silt deposition is high in the first 10 years after which it stabilizes first becoming asymptotic. It seems, from the studies carried out to date if there are no gates to the spillway, it takes about 100 to 320 years to get the reservoir completely filled up with silt. The Figure 6.11.1 shows the stabilized siltation scenario in a reservoir after a long period.

6.11.4 An effective way of keeping the live storage unaffected is to install gates on the spillway and maintain as much storage as possible against them. Design of most of the major projects have now made consistent with, this principle. Therefore, most of the live storage capacity of these dams will remain unaffected with silt over a long period.

6.11.5 The Commission visited in December 1996 Sukhana (Aurangabad), Rohilagad, Kanadgaon (Jalna), Madalmohi- Jawaharwadi-Govindwadi (Beed) Irrigation Projects. It was notices: that aquatic weeds were growing on the silt, deposits and such islands of weeds were being formed whereby the' designed capacity of the reservoirs was being reduced to that much extent. But the exact loss of capacity could not be known for want of measurements, and the annual water use accounts were, therefore, being made based on the old known capacities only. The Commission visited the command and rehabilitated area of Hatnoor Project in July 1997. The dam site for this project is situated below the confluence of rivers Puma and Tapi. Sodium occurs more prominently in the soils of Tapi Basin. Therefore, when water comes into contact with such a soil, conditions favorable for separation, of soil particles from one another are created. Thus a considerable amount of silt flows into this river and gets deposited in the Hatnoor Reservoir. The bottom level of this reservoir is also slowly rising. Consequently the capacity of this reservoirs is diminishing, but this too has not been measured properly.

The Commission visited the Nandur-Madhameshwar *Bandhara* constructed in 1910 in the Upper Godavari Basin near Nashik. Nearly 80 to 90 percent of its capacity has been filled up by silting. Moreover, islands of the aquatic weed, viz., *besharam* have been formed thereby deteriorating water quality thereof.

6.11.6 The Central Water commission published acompilation of abstracts on the subject of silting of reservoirs in January 1991 presented data in respect of 46 reservoirs in the country. It is recorded therein that out of these, silt survey of 22 reservoirs has been carried out only once and that in respect of 10-reservoirs twice. It will not be realistic to determine the rate of silting and degree of loss of capacity based upon such a meagre data . In the present circumstances it is necessary to immediately take up the work of carrying out hydrographic survey of storage capacity of the reservoirs impounded by old dams as a systematic scheme. The term ‘old dams’ should be taken to mean those dams where storage built up has been commenced at least for the last 25 years. Thus it is necessary to first complete the survey of reservoirs created prior to 1970. There are more than 200 such reservoirs in Maharashtra (as per the information of 1995). The results of the aforementioned study of silting of 46 reservoirs published by the Central Water Commission show that the silt deposition is fast in the first 15-20 years and slows down thereafter. That is to say that such a phase comes in the life of a reservoir after about 25 years. Therefore it is necessary to carry out capacity survey for every reservoir after completion of 25 years of its service life. It is possible that 10-15 percent capacity has been lost during that period. Fresh surveys are required every 10 years thereafter as more accurate data about the capacity will be necessary as water use go on increasing for, accomplishing planning thereof. More frequent assessment of the silting of reservoirs may prove convenient hereafter by the adoption of remote sensing technique. The information obtained with this method can be verified on the basis of findings of the survey carried out on ground in a conventional manner. It is necessary to take up in right earnest a programme for compensating this lost storage capacity by creating new storages in the upper and lower reaches.

6.11.7 It is impossible to stop the silting up of reservoir completely. The rate of silting is also dependent on the land being cultivated in catchment area. The measures of soil conservation and water conservation can help to arrest soil erosion to a certain extent and the bunding of a field can help confine most of the silt in the field itself. The maintenance of the bunding is, however, necessarily be carried out carefully and continuously over the entire area. Otherwise the bunds once constructed get washed away in heavy rains and erosion gets momentum again.

The Central Water Commission has disseminated in 1993 some guidelines in this respect. The *nallas* meeting the reservoir directly bring in most of the silt. Therefore, it is suggested therein that taking remedial measures for checking soil erosion around such directly draining *nallas* and checking the pace of silt siltation be assumed to be a part of the project itself. In order to obtain sanction for water resources development project from the Central Water Commission it is made obligatory to make a provision for water and soil conservation works in the catchment areas of such *nallas* and to execute them along with the storage built up (Environment Impact Assessment Notification: 1994 issued by MOEF, GOI). Not only this, but it is also implied that the expenditure required for the same should be provided for in advance in the estimates of projects. One additional complementary measure suggested is to encourage dense forests in the belt around the reservoir above the *galper* land.

A) During the last 5 years, watershed development programme has been implemented on the Kamini *Nalla* near Shirur in Pune District. The Commission paid a visit to this watershed area in November 1998. Gabion as well as stone bunds have been built at numerous places across the Kamini *Nalla.* It had rained just a day or two before hi this watershed and water was oveflowing the bunds. But the water was turbid. It was noticed that soil was being washed away along with the rains in spite of implementing the watershed area development programme The only truth is that the soil erosion process in nature cannot be completely stopped. The testing revealed that proportion of sand in this water to be of the order of 7.5 to 10 ppm.

B) An opinion is generally expressed that soil erosion can be checked by dense tree cover on the land or by forests. There is no doubt that tree cover has its own unique place in the cycle of nature. But it does not seem possible to completely prevent the soil erosion by tree cover. The Commission visited Konkan area and the Satpuda *Jungles* in May-June 1998. At several places, it was observed that even though there was tree cover, the land was subjected to gully formation, the roots of trees were exposed and all the *nallas*, streams were dried up. The contention, that trees check soil erosion and cause precipitation could not seem to be corroborated.

6.11.8 There can be one remedy to reduce its intensity, if not to check the siltation. A bund be built on the upstream side of the reservoir and a grill be spread across it which will catch the silt and debris. However, this remedy may also be rendered useless due to silt deposition at that point itself. Mechanical dredging also can be resorted to For example, silt may be removed and thrown far away by dredging either at the point where the river enters the reservoir and deposits silt; or at the approach channel some distance upstream of the intake. This, however, is costly as it will have to be accomplished every year.

6.11.9 Most of the reservoirs in Maharashtra are State-owned. There is no ban on taking away silt so deposited. Those who wish may take it away and use it But the response is poor because the work of lifting and taking out silt from the reservoir bottom by lifting beyond reservoir height and conveying it becomes costly due to stickiness of the silt and longer lead. It becomes even more costly in the case of large and deep reservoirs. In comparison, in case of small lakes, the farmers on the banks can take off the silt in summer at their own cost and carry it to their own fields. The silt is quite useful for the brick making industry. The brick manufactures should be encouraged to make the bricks from this silty soil available in the submergence of reservoirs, whereby the process of removing silt can be kept going. Otherwise soil from good fertile lands is being used up for making bricks thereby causing reduction-in the extent of fertile lands.

6.11.10 Around the end of February-March, 70 to 80 percent of small reservoirs deplete to so much extent as to be devoid of any water and the bottom gets exposed and dried up. The process of getting it exposed is quite slow in case of large reservoirs. In the years of good monsoon such possibility is even less frequent. Roughly 2/3 part of bottom of reservoirs in Maharashtra is available for cultivation of hot weather crops (*galper* land). Thus

2/3 part of the submerged land is available every year for mono-seasonal perennial crop. The permanently submerged land used to be hardly 1/3.

6.11.11 More the storage against the spillway gates, the lesser is the amount of silt deposition. If the yield reaching just after the first heavy rains can be discharged, the silt will be conveyed to downstream side and will not settle down. Nevertheless, this is beset with limitations. Especially in deficit basins where there is no guarantee of heavy rains furthermore, it will prove to be perhaps risky to do so. However, some control can be exercised over the raze of silt deposition by devising a suitable method for the operation of gates while framing the reservoir operation schedule after studying the complete record of the inflow coming to the reservoir. In years of heavy rainfall and large floods, some silt is thrown out due to accelerating erosion process resulting from the flux of water when gates are opened and the capacity of reservoir against the gates gets replenished. The analysis of silt deposition process shows that after the reservoir starts functioning, the silt deposition takes place at a foster rate initially. But after the silt layer rises, the impact of large influx of flood washes off the depositing silt and thereafter the silt deposition slows down. There are 68 gates dams completed at present in Maharashtra. Out of these, the storage data is made available in case of 48 dams. It revealed that for 3 dams the storage against gates is about 25 percent of the gross storage. Similarly for 8 darns, it exceeds 75 percent while in case of 37 dams, it is between 25 to 75 percent.

Sr. No.	Percentage of storage against gates to the gross storage	No. of dams
1	0-25	03
2	25-50	24
3	50-75	13
4	More that 75	08

6.11.12 Providing a gated sluice at a sufficient depth and of an adequate size in the dam wall enabling flushing of sand and silt of the reservoir alongwith water into the river down below can be one of the measures. This method has been adopted at a number of places in countries of (the then) USSR and China. It is also used in some dams in the Himalayas. The experience of washing the silt off the reservoir is available to some extent.

The effect of washing off silt through sluices is useful over only a limited area in the vicinity thereof. It is observed it is possible to clear the entire reservoir using sluices. The amount of silt washed off depends on the stickiness of the soil. Mathematical models pertaining to this are now at hand. It is going to be useful to have such sluices forthcoming future dams. These sluices can also be used for taking off water from the dead storage in times of deficit years.

Chapter 6
Distribution and Management of Water
List of Annexes & Figures

Annex: 6.1.1.
Sub-basinwise No. of Major and Medium reservoirs
(Completed and under impoundment)
discharging in One River Course

Sr.No.	River	No. and Name of Sub Basin	Major Projects	Medium Projects
(1)	(2)	(3)	(4)	(5)
1	Godavari	1) Upper Godavari (upto Paithan Dam)		
		A) Godavari (Excluding Mula & Pravara)	8	3
		B) Godavari (Mula-Pravara)	2	3
		Total upto Paithan Dam	10	6
		2) Lower Godavari (D/s of Paithan Dam)	2	12
		3) Purna (including Dudhana)	2	12
		Total upto Vishnupuri (1+2+3)	14	30
2	Manjra	4) Manjra	2	20
3	Painganga	6) Painganga	5	15
4	Wardha	7) Wardha	5	22
5	Wainganga	8) Middle Wainganga	10	41
		9) Lower Wainganga	3	28
6	Pranhita	Pranhita (6+7+8+9)	23	106
7	Tapi	10) Puma (Tapi)	4	10
		11) Girna	4	10
		12) Panzra	0	5
		13) Middle Tapi	1	4
		Total Tapi (10+11+12+13)	9	29
8	Krishna	15) Upper Krishna (West)	12	0
		16) Upper Krishna (East)	0	3
		Total Krishna (15+16)	12	3
9	Bhima	17) Upper Bhima (upto Ujjani)	6	0
		18) Remaining Bhima (D/s of Ujjani)	4	0
		19) Sina	0	19
		Total Bhima (17+18+19)	10	19

Reference Paragraph: 6.1.13

Annex: 6.6.1 Development of Well Irrigation in Command and Areas

Area- ha.

Sr.No.	Region	No of Wells in the command prior to construction of Project				No. of Wells in the Command at present				Irrigation Potential of Wells in the Command				Total benefitted Area in the Command			
		Major	Medium	Minor	Total	Major	Medium	Minor	Total	Major	Medium	Minor	Total	Major	Medium	Minor	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
1	Konkan	0	58	423	481	498	188	549	1335	0	0	10	10	7240	920	3840	12000
2	Pune	14169	2195	2449	18813	62213	5906	11249	79368	141270	8510	14890	164670	402540	27340	27720	457600
3	Aurangabad	5599	2833	8725	17157	21169	5551	14495	41215	28722	18501	47323	94546	97260	9270	7480	114010
4	Amravati	1246	1306	5061	7613	2359	5129	6375	13863	1800	4265	4400	10465	8930	17270	18670	44870
5	Nagpur	2119	2287	1770	6176	6686	5051	3469	15206	7227	4931	2227	14385	158920	49140	36960	245020
6	North Maharashtra	31030	5825	3673	40528	90210	13996	8093	112299	148563	35488	22303	206354	195890	27220	24770	247880
	Total	**54163**	**14504**	**22101**	**90768**	**183135**	**35821**	**44330**	**263286**	**327582**	**71695**	**91153**	**490430**	**870780**	**131160**	**119440**	**1121380**

Source: Status Report (1994-95) of Irrigation in Maharashtra State. Irrigation Department. Govt. of Maharashtra

Inference:

1) After commission of the Irrigation Project, due to increase in groundwater recharge, in the command Areas number of wells have been found increased.

2) 45 % of total area under canal command is actually irrigated on Wells, establishing the tendency of conjunctive use of water.

Reference Paragraph: 6.6.3.

CHAPTER 8 IRRIGATION ACT AND RULES

In what manner the equitable distribution of available water resources in deficit and highly deficit basins can be achieved for irrigation? What provisions related to water use are there in the Constitution of India? What changes as regards to powers and responsibilities pertinent to water use of *grampanchayats, taluka panchayats* and state governments are instituted on the back drop of three-tier set-up - in the form of Union Government, state governments and panchayat *raj* - lent to the state's administration in the light of 2 constitutional amendments to which the Constitution is subjected in recent times? Which are the existing acts pertinent to water-related users? What is the nature of irrigation acts which existed here-in-before and exist now? What should be the legislative frame work which supports the modus operandi of objective - oriented irrigation management? Which changes are required to be incorporated in the Irrigation Act to enforce a methodology involving participatory approach in the irrigation management all over Maharashtra? Also, how should be the legislative foundation for accomplishing integrated planning, regulation and management of available water resources in a basin? Expounding of principles appertaining to all these issues is the subject matter of this Chapter.

8.1 Equity in Water Distribution

8.1.1 According to the Section 38 and 39 of the Constitution of India, a state has to strive hard to minimise the inequity that exists amongst individuals, areas and groups of people. Efforts will also have to be made to nurture social welfare and to remove inequity in facilities and opportunities made available to people. In addition, the principles of state policy to be followed should be such that ownership and control of material resources of the community are so distributed as to sub-serve the common good and should not result in concentration of wealth as a result of rendering means of production detrimental.

8.1.2 According to the guidelines proposed by the International Law Association (1992), equitable distribution does not mean equal share for all but an allocation which does justice to all. It is, therefore, necessary to decide the water allocations for different areas on the basis of various parameters like area-specific needs, climate and population etc. First priority is to be given to fulfill the needs for drinking water and health; the community requirements of the area will follow suit.

8.1.3 As water availability in Maharashtra is very much limited, the Barve Commission (1962) had suggested dispersal of irrigation facilities in each basin and equitable distribution of water in command areas of irrigation projects. In pursuance to the recommendation of the Barve Commission, the State Government has made several efforts to remove inequity in water distribution by allocating water to as much area and as many beneficiaries as possible, it appears. According to the suggestion of the commission, permission was given for lift irrigation to the extent of 6% and 10% of permissible area from lakes and canals, respectively. Norms for accepting projects for execution drought prone area were liberalised. In water deficit basins, it was decided to sanction only those projects with eight-monthly cropping pattern instead of perennial one. On the old irrigation systems, where Block System was conventionally practised, the area of sugarcane was reduced from 1/3 to 1/4. Restrictions were imposed on sugarcane varieties like *adsali* which require water for a longer period.

8.1.4 In many areas of Maharashtra, availability of surface water is limited and it so happens that these areas are underlain with rock (Deccan Trap/basalt) which has very low water holding capacity. The availability of groundwater is therefore also limited in these areas. By nature, rainfall from basin to basin and sub-basin to sub-basin is not uniform and is extremely variable. The proportion of rain which infiltrates and gets stored into the ground is also not even because of the variation in the capacity of aquifers. With this natural variation in the availability of water, it is not possible to consider the society as a whole and make equitable distribution of water. There is also inequity among the land holders due to changes to which land holdings are subjected because of historical propriety of ownership, sale and purchase and land fragmentation. Thus as there is inequity both in water and land which form the main foundation of irrigation and basically are inequitably distributed, it does not appear possible to formulate a entirely equitable irrigation system. Water available in different forms for irrigation is also not equally distributed. There is wide aerial variation in the availability of water from rainfall, the naturally occurring groundwater and stored water in reservoirs by construction of dams across rivers. Relatively more groundwater is be made available to some culturable lands through the facility of percolation tanks and watershed development.

8.1.5 In sub-basins/basins where the availability of natural water is more than 1000 m^3 per capita or 10000 m^3 per hectare of land, problems of water distribution and consequently problems of equity does not appear to have arisen so far by virtue of abundance of water. But, in areas where water availability is less than this, particularly where the water availability is less than 500 m^3 per capita or less than 5000 m^3 per hectare, social and economic propriety is necessary in water allocation as water deficit is felt very much in these very areas.

8.1.6 The dependability of available water varies with the source from where water is made available. There is a wide variation in the dependability of water made available from different sources like lifts from reservoirs, by flow from canals, lifts on wells in command areas of canals, lifts on wells in areas covered by watershed development, lifts on *nalla* bunds, lifts on wells downstream of percolation tanks and lifts on wells which have no facility of recharge. Though the quantum of availability in some cases appears to be the same, from the point of view of dependability of service from water, these different units enjoying the service of water from different sources are in fact not at the same level. As large projects have large catchments and as the variation in run off from these area is small compared to that of small catchments the beneficiaries of large and small projects are therefore not on equal footing as far as dependability of water supply is concerned.

8.1.7 Thus in a situation, where there is a difference in the quantitative and qualitative availability, it is very difficult to bring all on the same footing in status of water. Transfer of one cubic metre of water from an area of water abundance to water short area may be unrealistically costly. Comparatively transport of other utilities required in day-to-day life is neither difficult nor expensive. There is surplus water in the Wainganga Basin. But conveying the same to overcome the deficit in the Bhima Basin is not commercially feasible from the point of view of capital investment and maintenance. Therefore, while considering the allocation of water, it can be accomplished properly only with reference to a limited geographical extent. As the natural flow of water in a basin/sub-basin is from upstream to downstream; it is more practicable to consider a basin or a sub-basin as an integral geographical unit for availability and planning of water.

8.1.8 The cost involved in water distribution by gravity flow is mainly a capital investment and the recurring expenditure is low. On the other hand, if water is to be delivered by lift, the system involves huge capital cost and very large recurring expenditure depending upon the height of lift involved. Generally distribution of water is not economically feasible where water is to be conveyed by a gravity canal beyond 100 km or by a combination of more than 60 m of lift and 4 km of flow. Therefore while considering the allocation of water, it is necessary to consider the extent of area within which the distribution is economically feasible. Only then it will be appropriate to properly distribute the available water in the projected command area amongst different users /units. Extending the limits of command areas beyond where the benefit-cost ratio falls below one, it adversely affects the overall economical well being of the society and is, therefore, not desirable. Accordingly once the practical and economical bounds of area for water allocation are thus decided, main focus in equitable distribution of water will be to reduce, as far as possible, inequality in the internal distribution of water and this procedure of equitable distribution of water as such be followed.

8.1.9 The needs of urban water and industrial water are concentrated in very small areas; whereas the needs of rural drinking water and the needs of irrigation water required for agricultural land are spread over extensive areas. Establishing a water management system which will ensure a proper balance amongst the different uses of water cannot be reached through simple mathematical formula. It, therefore, follows that while allocating water for different uses, it is necessary to take a balanced view of the mutual dependence of integral groups and their rise together. With new technology, it is possible to strive to achieve to some extent a good balance between the overall concentrated requirement and the diversified demand thereof by taking cognisance of the increased possibilities of reuse of municipal and industrial water. Therefore, in the sub-basinwise planning of water, provision as to reuse will have to be incorporated. It appears that in the aerial allocation of water in each sub-basin, ordinarily a *taluka* may be a geographically convenient unit. The Dandekar Committee, which studied the backlog in development of different regions of the State, had also recommended '*taluka*' as a unit in respect of irrigation. In this context, the district as a unit is inconvenient. District is spread across different basins and sub-basins, whereas it is seen that *taluka* is usually limited to a single sub-basin. Therefore basically primary objective of planning of water allocation should be to bring the different *talukas* in a sub-basin to the same level as far as possible by applying norms of practicability and economic feasibility. The second important stage is equitable distribution of water amongst the different groups of beneficiaries formed according to available water resources in a *taluka*. Within the economical and other practicable constraints, efforts are required to be made to minimise the difference in availability of water among different groups of beneficiaries. Thereafter thought should be given to a set-up where the various units in different groups of beneficiaries beget equitable share individually. Thus, water distribution appears to be desirable when not effected directly from the total quantum of available water to an individual user, but firstly it will have to be equitably distributed amongst the different aerial units, then amongst different groups, and then amongst individuals, keeping in view the practicable and economic propriety.

8.1.10 After allocating water to aerial units and groups of beneficiaries in the area, because of the limited availability of water and constraints of economics, it appears inevitable that sizable cultural area may remain deprived of irrigation in many sub-basins and *talukas.* The only good alternative is to setup other systems for economic development of the areas left out from water allocation from practical point of view. These limitations have to be particularly kept in view while undertaking consideration of the sub-basins of Sins, Bori and Manjra.

8.1.11 Communities of beneficiaries of common interest in areas of watershed development, areas of recharge below percolation tanks or areas on canal lift or command areas of main distributaries are automatically formed. The principal objective of water and irrigation set-ups should be to strengthen these communities with social and legislative support and to infuse transparency and lend justifiability in their joint allocation and inter-se allocation of water within their sub-groups. In that, the social understanding within a group is also going to be an important factor. Apart from the various individual needs, each group has its own social collective needs. Water required for such community needs, (e.g., water required at a railway station) and primary needs like drinking water, etc., has to be reserved from the water allocation and then the remaining water can be considered for use by individuals.

8.1.12 While allocating water within a group of beneficiaries for irrigation, three alternatives are available, viz., whether to accomplish allocation by recognising an individual as a unit, or a family as a unit or land as a unit. Though the overall status of availability of water in each sub-basin can be expressly stated as a unit, land and irrigation water are closely linked. Land cannot be separated from water for consideration in allocation of irrigation water. Moreover, in a given area the individuals and the families are subject to change numerically. That is why there cannot be a permanent allocation of water with reference to them. On the other hand, the unit of land is a permanent one and therefore in planning and management of water, allocation with reference to this unit proves practicable.

8.1.13 During the British rule, when irrigation projects like Nira, Pravara, Godavari, Asolamendha etc were constructed for protection from drought, the planning of these projects was with the concept of allocating the available water in proportion to land. Even in the *warabandi* system prevailing in North India, the basic unit for water allocation is a holding and not the family. Similarly in the *Phad* System prevailing in the Panzra and Girna Basins which is acknowledged to be an irrigation system in which an equitable distribution of the highest order is ensured, irrigation rotations are based on land holding. And for centuries this system has earned the trust of these people as a system of equitable water distribution to all concerned. It was the suggestion of *Bharatratna* Visvesvaraya that these principles should be applied to the commands of large projects by sub-dividing commands into different blocks. The Dandekar Committee (1978) which recommended eight-monthly cropping pattern on canals, also accepted the water to land ratio for classifying the basins with reference to water availability and for accomplishing detailed planning of projects. The committee suggested the canal layout on the principles of delivering water in proportion to land.

8.1.14 While presenting the concept of water for irrigation, the National Agricultural Commission has suggested that irrigation benefits should be made available to as many farmers' as possible wherever economically and technically feasible. National Water Policy states that intensity of irrigation should be such that it will benefit as many farm families as possible. It is keeping with the objective of bringing the farmers above poverty line which was before the National Agricultural Commission and the National Water Policy. If land holder is considered as a basic unit and the water allocation amongst land holders is accomplished in some definite proportion to land holding, The water distribution will also be more practicable as it is got linked with land. It is desirable if water allocation in water deficit basin is so accomplished that each land holder gets benefit of growing crop in two seasons-one rainfed crop according to the natural condition and later, one more crop through irrigation system. The land holder will have freedom of cropping but while deciding the water allocation, the unit will be 'land holder'.

8.1.15 No clear substantiation is available as to how much minimum land and water are required for bringing general economic prosperity to a land holding family. Over time and in the context of development this will also go on changing as the productivity of land goes on changing according to the selection of crop, agricultural techniques and other available facilities. It is not possible to arrive at a definite conclusion as to how much area of land and water can bring a farm family to the State average income or make it cross the poverty line. However, looking to the experience gained of irrigation system in Maharashtra so far and keeping in view the water requirements of crops as recommended by agricultural universities, it appears that if 3000 m^3 of water is given to one hectare of land for irrigation, it is possible therefrom to two cultivate crops in seasons profitably.

The Commission has divided the 25 basins in the State into 5 categories (Statement 3.2.2) according to the natural (average) availability of water:-

1. Highly deficit
2. Deficit
3. Normal
4. Surplus
5. Abundant.

The Commission suggests that for equitable water distribution in highly deficit or deficit sub-basins, a minimum of 3000 m^3 of water per hectare should be supplied. The Commission has accepted the concept that growing crops in two seasons amounts to irrigation, i.e., one rainfed crop and one crop based on man-managed water. This concept is for a year of normal rainfall and medium class soils. Where the soil is of above average type, in a year of good rainfall the situation would be more favorable and where the conditions are more adverse (drought and light soils) it may not be possible to supply even 3000 m^3 of water per hectare.

The Commission has taken into consideration two points in this connection. The irrigation needs of two seasonal crops like cotton, pigeon pea and *rabbi* crops like *rabbi* sunflower, sorghum, safflower, gram and cow pea should be met with. Even if such crops are subject to some moisture stress, there is no large scale reduction in their yield.

It will be seen from the forthcoming table that irrigation needs of these crops vary from 250 mm to 400 mm.

Sr. No.	Crops	Sowing time	Water requirement (mm)*	Effective rainfall (mm)	Soil moisture retained (mm)	Irrigation requirement (mm)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	Cotton	15 June	600-700	350-450	50	200
2	Pigeon pea	July	600-650	300-400	50	200-250
3	Rabi sunflower	15 October	400-450	50	50	300-350
4	Rabi sorghum	15 September to 1 October	400-500	50	100	250-350
5	Gram	September/ November	250-500	50	50	150-400

*Source: Reference Statement 4.2.2.

While working out this irrigation requirement, only 50 mm soil moisture is taken into consideration; but if the soil is medium to deep, the moisture retained in such a soil is relatively more and this moisture would be definitely useful to rabbi crops. In addition, the farmer used to develop of his own some land for receiving irrigation and thereby accrues to some extent the benefit of water that manifests as return flow from irrigation and also naturally occurring groundwater. Thus if total available groundwater, the moisture retained in soil and water supplied for irrigation (at 3000 m^3 per hectare) are all considered together, the water is adequate for foregoing crops.

The second consideration is that the income generated from this water (3000 m^3 per hectare) will keep the family above the poverty line. The net income generated from one kharif crop and one irrigated crop on one hectare of land can be such as to bring the family above the poverty line (Rs. 20000/- per family[1]) The family supported by this land (assuming that in a family of 5, normally 2-3 persons will be available for work) gets employment for 8 months in a year and therefore even migration of that family will be prevented.

In the context of water allocation in sub-basins, the Commission is of the view that the available water should be supplied to as many families as possible equitably to enable to ha? e an economically viable farming from the water so supplied to sustain the family.

One rainfed crop and one irrigated crop, or one two-seasonal long duration crop (for example cotton, pigeon pea) can be raised with this arrangement. Even in drought prone areas, out of the average 600 mm of rainfall, at least 500-1500 m^3 of water can be stored in ground and can be made available in the form of groundwater or soil moisture or in farm ponds by way of storage. Thus a total of 3500-4500 m^3 of water becomes available to the landholder for crop production.

A study of irrigation systems elsewhere in the world where prosperity is attained by entailing economic use of water only shows that a total of 4500 m^3 of water use per hectare is sufficient. Where water available is more than this it can be equally distributed but a holder of one hectare of land should necessarily get at least 3000 m^3 of water at the turn out (property head) through the distribution network. The supply of water short than this proportion can only partially support the livelihood of a farmer; but he cannot become self-sufficient agricultural producer it a true sense.

That is why the quantum of water allocated should not be less than this much. In the State, landholders holding less than one hectare land number 34%. It will be appropriate to supply them at the property head, water at the rate of 3000 m^3 per hectare. It is felt that for those who hold more than one hectare of land, it will be proper to supply at the rate of a minimum of 3000 m^3 for every four hectares of land.

8.2 Related Acts in Vogue

8.2.1 The Barve Commission had at that time not deliberated on the acts relating to water. However, in the report of the National Irrigation Commission of 1972, there is an exclusive chapter in this regard and the commission had made a recommendation that all the acts being used, in irrigation management be examined and one single comprehensive act should be enacted for irrigation. This is because the irrigation management calls for undertaking actions under "various different acts and the powers conferred through these several streams do not lead to administrative convenience. That commission

1. Source: Rural Development & Water Conservation Department, Govt. of Maharashtra Guidelines 'Census of Families below Poverty Line-1997'.

had also suggested that the powers of government and control over groundwater should be brought home through the act. It will be useful to examine the prevailing acts relating to water resources and irrigation to review these needs in the new context of newly emerging situation. Some of the current acts are directly related to irrigation and some are of relevance only. The status in these acts relating to water and irrigation is briefly spelt out in what follows. The following paragraph undertakes an elaborate exposition on the provisions which are deemed necessary here-in-after over and above the existing provisions.

8.2.2 In the Constitution of India which is the source of all acts and the powers therein, the following mention has been made against the Entry 17 of List II under the Seventh Schedule relating to state subjects. Water, that is to say, water supplies, irrigation canals, drainage and embankments, water storage and water power subject to the provisions of Entry 56 of List I.'

The systems in the context of water use and irrigation have to be evolved in accordance with the foregoing provisions. The responsibility of the Central Government has been clearly stated in these words according to the Entry 56 of the First Schedule: "Regulation and development of interstate river basins to the extent to which such regulation and development under the control of the Union is declared by Parliament through an enactment to be expedient in the public, interest." Accordingly the subject of irrigation is completely in the ambit of states. The only limitation on the power of state governments is by the mention against the Entry 56 of the List I regarding the subjects in the purview of the Central Government. In addition, Article 262 of the Constitution is pertinent to water.

Article 21 of the Constitution

8.2.3 Article 21 of the Constitution states "No person shall be deprived of his life or personal liberty except according to procedure established by law".

In some court cases relating to pollution, the Supreme Court has extended the limitations of objectives of this Article 21 of Constitution of India.

According to the interpretation offered by the Supreme Court, the assurance given in Article 21 is violated due to pollution and poor quality of water in reservoirs, ponds and rivers. Therefore the administrative responsibility of departments and officers concerned with the water quality management has become of a statutory nature. The concerned departments should carefully study all relevant judgments of the Supreme Court so that their own responsibilities and duties relating to the same should become clear. With the foregoing interpretation of the Supreme Court, the work of pollution control will get increasing importance hereafter.

Article 39 of the Constitution

8.2.4 Article 39 of the Constitution of India states that the ownership and control of the material resources of the country should be so distributed as best to subserve the common good.

Article 252 of the Constitution

8.2.5 Article 252 of the Constitution is not that way directly related to irrigation. None the less, there is a provision that if the legislative assemblies of the two states pass resolutions to that effect, a legislation can be passed in the Parliament on a subject beyond the purview of the Central Government. Water (Pollution and Control) Act, 1974 is an act passed in the Parliament under this Article. Later several states have given approval or acceptance to the same by passing legislation in their legislative assemblies. Later on, the subject of pollution has been included in List III showing the common subjects of Central Government and the state governments by an amendment to the Constitution.

8.2.6 The aforementioned provisions in the Constitution of India are important because no state legislation - old or new - can be in contradiction or discordance with these provisions.

8.2.7 In accordance with the Entry 56 of the List I and Article 262 the Central Government has passed two acts relating to interstate disputes.

1) River Boards Act, 1956
2) Interstate Water Disputes Act, 1956.

Under the act at Sr.No. 1, the Central Government has recently formed a River Board for the Yamuna Basin. The Damodar Valley .Corporation, Betwa River Board and Brahamputra River Board have however been formed by separate acts of the Parliament.

Under the act at Sr.No. 2, the Central Government had appointed tribunals for, giving awards on the interstate disputes of Krishna, Godavari and Narmada Rivers. The awards given by them have importance at par with the acts, and clauses therein are binding on the concerned state governments. The act pertaining to water disputes was amended in 1980 and provides for appointing authorities to enforce clauses in awards of tribunals. The facility was not available earlier.

8.2.8 The National Water Policy 1987 which presents the national policy and guidelines about water resources and use thereof, was sanctioned by a resolution of the National Water Resources Council. The Chief Ministers of all states are members of this council and the Prime Minister is the chairman. Naturally, the National Water Policy will have a profound influence on all actions in India relating to water. Nevertheless, it does not have a formal status of an act. It draws its authority from the National Development Council which has the Chief Ministers of all states as its members.

8.2.9 The Maharashtra Irrigation Act 1976 is the principal act relating to irrigation proper. The discussion of the provisions and discrepancies therein will follow later in this Chapter. The recommendations of the Commission suggesting modifications to be made in the Act and particularly improvements and changes in the rules made thereunder have been presented in various chapters of the Report.

8.2.10 In addition to the Irrigation Act described in the foregoing para, the following acts are directly or indirectly related to water resources and its use:

1. The Land Acquisition Act, 1894
2. The Maharashtra Project Affected Persons Rehabilitation Act, 1986
3. The Maharashtra Land Revenue Code, 1966
4. The Bombay Land Improvement Schemes Act, 1942
5. Maharashtra Ground Water (Regulation for Drinking Water Purpose) Act, 1993
6. The Water Pollution Prevention and Control Act, 1974
7. The Maharashtra *Zilla Parishads* and *Panchayat Samities* Act, 1961
8. The Bombay Village Panchayats Act, 1958
9. The Maharashtra District Planning Committees Act, 1998
10. The Maharashtra Forest (Conservation) Act, 1980
11. Maharashtra Fisheries Act
12. Maharashtra *Khar* Land Development Act, 1979.

An exclusive but brief discussion on each of the twelve acts follows in paragraphs 8.2.12 to 8.2.60 and 8.2.63.

8.2.11 During the three years, i.e., from 1996 to 1998 the following five acts, bringing about important organisational changes in the Irrigation Department, are enacted by the Government and

Corporations were formed thereunder for the development of irrigation in the following five basins:

1. The Maharashtra Krishna Valley Development Corporation Act, 1996
2. The Maharashtra Vidarbha Irrigation Development Corporation Act, 1997
3. The Maharashtra Konkan Irrigation Development Corporation Act, 1997
4. The Maharashtra Tapi Irrigation Development Corporation Act, 1997
5. The Maharashtra Godavari Marathwada Irrigation Development Corporation Act, 1998.

A common discussion of all these five acts appears in paragraphs 13.4.5 to 13.4.30 of Chapter 13.

Land Acquisition Act, 1894

8.2.12 According to Entry 42 appearing in the Third Schedule of the Constitution of India and showing areas of concurrent jurisdiction, the acquisition of property is under the jurisdiction of both the Central Government and the state government. The original act is enacted by the Centre but the State Government has made amendments according to the local needs (applicable only within the State). This Central Act is more than 100 years old and 29 amendments (corrections) have been brought out. 13 of which pertain to the Maharashtra State.

8.2.13 The first action for any project work is acquisition of land required for the project. The process for land acquisition under this act starts when the proposal therefor is framed and sent to the Collector. After the land is surveyed, notification of intention of land acquisition is issued under section 4 (1). Then follows actual measurements of the land to be acquired under section 4 (2) by marking on site. Land is acquired then by holding hearing by the Collector under section 5 (1) by issuing advance notice in the matter if objections are raised by people. After hearing, the Collector gives decision regarding land to be acquired and accordingly issues notification under section 6. This completes the first phase of land acquisition process.

8.2.14 Land can also be obtained by private negotiations with the land owners. But even for such land also, the formal procedure of land acquisition has to be followed and completed. If there are any legitimate claims of third parties in the land to be acquired, their rights are also acquired through such a procedure and the land that comes to the project is without any encumbrance of any kind.

8.2.15 Powers vested in the Government under this act have also been delegated to the Divisional Commissioners. Similarly the powers of the Collectors Under this act have also been delegated to the Land Acquisition Officers of the rank of Deputy Collector.

8.2.16A bill of amendments to this act is under consideration in the Parliament since 1998 which provides for speedy and time bound process for acquisition of land. Since 1984, the present act provides for 30% additional payment over and above the award as a compensation for the inconvenience caused by land acquisition. In draft bill for the new act this amount is proposed to be raised to 100% of the award.

Because of such provisions in the bill under consideration, it is clear that land acquisition is going to be expensive hereafter.

The Maharashtra Project Affected Persons Rehabilitation Act, 1986

8.2.17 This Rehabilitation Act had been passed by the Maharashtra Legislative Assembly in 1986,but it was approved by the President in 1989 and it came into force from 1st January 1990. Earlier, act of 1976 was in force but there were many grievances pertaining to rehabilitation. A committee was appointed in 1982 to redress these and to advise the ministers. According to the recommendation of this committee, the 1976 act was repealed and the new act of 1986 came into being.

8.2.18 The 1986 Act is applicable to all irrigation projects where the affected area is more than 50 hectares or where the land irrigated under the project is more than 200 hectares. According to this act, project affected persons include land holders in the affected area; the tenants in possession of land, landless labourers, traders and professionals who have been practising in the affected area for 5 years or more and also persons in command area whose lands have been acquired for the canal or whose lands are no longer culturable. With this exhaustive definition of affected person, the number of such affected persons has increased. Their rehabilitation therefore now calls for more land to be acquired.

8:2.19 For rehabilitation work a separate organisation under the General Administration Department itself in Mantralaya has been set up since 1965. Since the work has now increased, the Commissioners have been directed to oversee the work of Collectors and Chief Executive Officers of *Zilla Parishads.*

8.2.20 The concept of rehabilitation in the 1986 act also encompasses the concept of economic and social rehabilitation of the affected persons. Cost of rehabilitation is charged to the concerned project. Civic amenities in the new village (*gaothan*) are required to be provided-by the project officers. It is a laid down policy to lend priority to project affected persons in the cadre of Class-III and Class-IV of the project organisation. The idea is to ensure at least one job to each family.

The Collectors have powers to acquire land in command area so that lands can be allotted to the project affected persons.

8.2.21 With the provisions made by the Gujarat Government for the Narmada Project in Gujarat, the rehabilitation policy has become more liberal the Government of Maharashtra has also accepted the same. In the meantime Draft National Policy of Rehabilitation has been announced in 1998. It is suggested therein that separate land for each adult boy and girl in each project affected family be allocated. It has been suggested that purpose of rehabilitation is to ensure that displaced families should be able to enjoy at least the same standard of living which they enjoyed before the project. In that context the New Resettlement and Rehabilitation Policy and the new Rehabilitation Act of 1999 have been approved during the budget session of the Legislative Assembly of Maharashtra in 1999.

The Maharashtra Land Revenue Code, 1966

8.2.22 Even after the formation of the State of Maharashtra there were separate revenue acts in force in the three regions, viz. Western Maharashtra, Vidarbha and Marathwada. They were all replaced by a new act in 1966 which is in vogue today. According to the provisions under this act the irrigation officers have been delegated the powers to recover the irrigation charges from beneficiaries. Considerable land is available with the Department and the management or sale of this land will have to be done according to this Land Revenue Code.

8.2.23 According to clause 20 of this Code, land under the sea, estuary, rivers, *nallas,* lakes, ponds and all canals belongs to State Government, if it is not owned by some body else. Similarly all stored or flowing water 'belongs to State Government unless it is owned by someone else.

8.2.24 If the land owner or anyone else uses water on which the Government has a right and if there is no provision for charging for such use of water under the Irrigation Act or anywhere else, then the State Government can, under the Land Revenue Code clause 70 delegate the powers of assessing such charges to the Collectors.

8.2.25 Under clause 25 of the Code, the land holder has the right on all trees on the land - standing or which may come up in future, but if the Government feels that for preventing soil erosion it is necessary to restrict the felling of trees under the rules relating to the same, then it can prohibit or restrict the felling of trees.

8.2.26 Under clause 50 of the Code, any encroachments on the State Government land can be removed.

8.2.27 In 1976, all the works relating to the recovery of water charges were transferred from the Revenue Department to the Irrigation Department. They could not be carried out effectively because officers in the Irrigation Department had not been delegated the powers under the Revenue Code. After nearly 22 years, the Executive Engineers in the Irrigation Department have now been delegated the requisite powers. The notification delegating these powers has been published in the Maharashtra Government Gazette of July 1998. All the powers under clauses 180, 181, 182, 192, 193, 204 and 212 of the Revenue Code have now been delegated to the Executive Engineers.

Really speaking, clauses akin to the foregoing clauses present in the Revenue Act could have been incorporated in the Irrigation Act and such powers separately delegated to the officers of the Irrigation Department. Officers in departments like Sales Tax Department, have been conferred powers under the respective acts. The Commission recommends to follow suit.

8.2.28 These revenue powers have recently been conferred on the engineers in the Department. The Department is still to acquire experience as to their use. While using these powers in every notice or order of forfeiture a mention has necessarily to be made of the above powers and the clauses of the Revenue acts under which the notice or order has been served. The Commission recommends that in the context of these delegated powers, the relevant clauses of the Revenue acts and the process of recovery etc. should be included as a subject in the syllabi of Engineering Staff College and WALMI.

8.2.29 Where the. Executive Engineers have used the powers delegated to them under the Land Revenue Code, the appellate authority for any decision given by them appears to begin all probability the Divisional Commissioner. None the less it is desirable that clarification on this issue be made in time.

Mumbai Land Improvement Schemes Act, 1942.

8.2.30 This small act of 1942 is comprehensive and multi-purpose. The objectives of this act are construction of tanks and other works, preparing different schemes of land improvement and executing the same, prohibiting or controlling grazing and thereby protecting and improving the land and the crops and charging the expenditure thereon to the Revenue account of the State.

8.2.31 In the past, the implementation of this act used to be under the Agriculture Department. The Corporation formed pursuant to this act and administration thereof are, of late, entrusted to the Irrigation Department.

Several works of command area development are being accomplished only after formulating schemes under this act. There is a considerable scope for the extension of all these activities. It appears the work is not gaining momentum as there is no clarity of the division of responsibility between departments of Irrigation and Agriculture. A better coordination between the two departments for that is called for.

Two amendments to the Constitution pertaining to the *Panchayat Raj* and the two acts of the State:

The Maharashtra Zilla Parishad and Panchayat Samiti Act, 1961.
Mumbai Gram Panchayat Act, 1958

8.2.32 The component of rural administration was not so influential during the British period. Therefore administration at the State level and the acts enacted therefor were used to exercise control over all activities related to water and irrigation management. Now two amendments to the Constitution of India, i.e., No. 73 and 74 have been approved unanimously by the Parliament in 1992. This has given rise to *Panchayat Raj* as a third-tier in addition to Central aid State Governments. It has acquired a constitutional status. The State administration has also become three-tiered. The Constitution of India now incorporates these new provisions: To have an independent State Election Commissioner for *Panchayat Raj* elections and to appoint a finance commission at the State level to decide the annual allocation to be apportioned to them from the state revenue. Such provisions are binding on all the states, but the Constitution has left the decision appertaining to few subjects to the state governments only. Pursuant to the aforesaid Constitutional amendments, the State Government has effected important amendments in the acts of *Zilla Parishads, Gram Panchayats* and Municipalities in 1994.

8.2.33 Recently the Government has announced in March 1999 decisions on the recommendations of the First State Finance Commission. Accordingly a fixed proportion of State revenue, will be transferred to the panchayats annually and those institutions can utilise part of this allocation for the needs of drinking water and irrigation. The main purpose of this bifurcation of revenue is to enable to have the reflection of priority of local needs in the structure of local development. It is, therefore, desirable that the subjects in the jurisdiction of *Panchayat Raj* be carefully identified. As per the amendment to the Constitution, this decision is left to the State Government. According to the Sr. No. 62 of the District List in the erstwhile act, the jurisdiction of the *Zilla Parishads* is restricted to "only those minor irrigation projects which irrigate an area of 100 hectares or less and such lift irrigation schemes which cost less than Rs.5 lakh." In addition, in the Village List at Sr. No. 46, there is an entry: 'Minor Irrigation" under the category of Irrigation.' Both these entries have not undergone any change even after the 1994 amendments regarding *Panchayat Raj* and have remained unaltered. Therefore *Zilla Parishads* or *Gram Panchayats* do not beget additional powers regarding irrigation automatically because of the two amendments to the Constitution and the new constitutional status of *Panchayat Raj*. There is no clear legal obligation in the constitutional amendments pertaining to Irrigation. Which responsibility of Irrigation should be halted over to the *Panchayat Raj* has been left solely to the conscience of the state government.

8.2.34 In the mean time, the Government has created a new Department of Water Conservation and transferred minor irrigation projects with a potential of 100 to 250 hectares to, this separate State level Department. This sector of irrigation is called as Local Sector Irrigation. The irrigation system in the State as such is planned presently in six sectors.

1. Major irrigation projects (command area exceeding 10000 hectares)
2. Medium projects (command area from 2000 to 10000 hectares)
3. Minor irrigation projects (command area from 250 to 2000 hectares)
4. Local Sector minor irrigation projects (command area from 100 to 250 hectares)
5. District level minor irrigation projects (command area less than 100 hectares)

6. Minor irrigation (small projects to be handed over to gram panchayats).

8.2.35. The Eleventh Schedule under Article 243 g of the Constitution of India gives the list of 29 subjects in the jurisdiction of *Panchayat Raj*. But the state government is free to decide which of these subjects and which of these powers are to be entrusted and vested at what levels of the *Panchayat Raj* institution. However, provision in the original Article 243 g is that the powers entrusted to the *Panchayat Raj* institution should enable them to work as an independent constituent of self-government. It appears desirable accordingly that the responsibility of irrigation should be appropriately decentralised. As it is necessary here-in-after to accept the objective of sub-basinwise integrated management of irrigation, problems of coordination will increase because of the formation of several tiers and several levels. It is therefore desirable to reduce the number of tiers to three. Accordingly a new classification is suggested in Topic 5.1 of the Report.

8.2.36 Irrigation upto 100 hectares generally falls within the ambit of a single village only. Therefore from the viewpoint of strengthening the local panchayat organisation, it is desirable to entrust the planning and management of such irrigation entirely with the gram panchayats.

8.2.37 No different objectives seem to have been achieved by handing over the irrigation category of 100 to 250 hectares to an independent State level organisation called Water Conservation. Projects with a command area of 100 to 1000 hectares generally fall within the purview of a single *taluka*. Apparently there is no difficulty in transferring planning and management thereof to the *taluka* level panchayat samities. Generally, a *taluka* mostly spreads over the same sub-basin. Therefore, from the viewpoint of sub-basinwise planning also, there will be no difficulty in water account if these projects are made to belong to the jurisdiction of a *taluka panchayat samiti*. Since all the three - watershed development, recharging & regulation of groundwater and construction & management of minor irrigation tanks - are closely interrelated' on the field and are interdependent, it is necessary they be handled together by proper coordination. As village cannot be an independent unit from hydrological point of view, a *taluka* will be an appropriate-unit for planning and management.

8.2.38 It is felt that district as a unit is uncalled for in planning and management of water. It does not match with the disposition in nature. No need, therefore, appears to allot a separate jurisdiction or sector of irrigation independently to that unit. The main function of the *Zilla Parishad* in this regard will be technical & administrative coordination and extending guidance to staff required for irrigation management. The *Zilla Parishad* administration will have to look after administrative arrangement of staff and officers deployed on irrigation projects, groundwater management and watershed management handed over to *taluka panchayat samities* and *gram panchayats.* Moreover one dam safety unit will have to be created in the *Zilla Parishads* to look after the safety of dams, and the *Zilla Parishad* administration will have to take over the duties of regular inspection-betterment-repairs of dams of height more than 15 m in the district. This dam safety unit will work under the technical guidance of the State's Dam Safety Organisation.

8.2.39 It is suggested in sub clause (a) & (b) of Article 243 g of the Constitution of India that *Panchayat Raj* should accomplish planning for economic development and social justice and that the *Panchayat Raj* institution should have the powers for implementation of the programmes under the plan. The *Zilla Parishad* Act or the Gram Panchayat Act have not so far been amended to include the provisions to match the two sub-clauses, through the 1994 amendments. It is felt that the two acts will be amended in accordance with the foregoing suggestions soon so that they will be in tune with the fundamental objectives of the *Panchayat Raj* System.

8.2.40 The original clause 100 (4) of the *Zilla Parishad* Act (old) is regarding planning and it continues in the original form even today. According to this clause, the *Zilla Parishads* have to strive for the development of the district as planned. There is a provision that for this purpose, maximum use of local resources should be made and annual and long-term plans be formulated Accordingly the district had been considered the basic unit of planning but not a unit for implementation and management of development. On the other hand under the *Panchayat Raj* System, the responsibility for development to the extent possible not only of planning but also of implementation and maintenance is to be entrusted to *panchayat* level. In water resources planning, district cannot be a natural unit; the *Zilla Parishads* are, therefore, not able to carry out any long-term planning of water. Therefore even otherwise there is no justification for entrusting this responsibility to them. It is appropriate to entrust this responsibility to *taluka panchayat samities* instead. It is easier to integrate the jurisdiction of the *taluka* panchayat samities into the State level sub-basinwise set-up. The *Zilla Parishads* will have to play an important role in extending guidance to *taluka panchayat samities* pertinent to planning.

District Planning Committees Act, 1998

8.2.41 Article 243 has been introduced by the 74th amendment of the Constitution of India. It is regarding the district planning committees. The provisions in this Article are binding on the state governments. The State Government has enacted a new act (1998-24) in 1998 as a sequel to that Article. Accordingly the erstwhile District Planning and Development Councils have been dissolved. New district planning committees will soon be formed in their place. The new committee will have 30, 40 or 50 members depending upon the population of the district. Out of these 4/5 of the members will be by election. Among the elected members, the representation of rural and urban areas will be in proportion to their population. In clause 10 of the District Planning Committees Act of the State Government, there is a description of functions of the planning committees. Some of the sub-clauses among others are:

(a) Consideration and consolidation of the district annual plan framed by the *panchayats* and the municipalities in the district and preparing the draft development plan for the Whole district.

(b) To consider the Five Year Plan and the perspective plan framed by *panchayats* and municipalities and coordination of the draft of the Five Year Plan and the perspective plan of the whole district and finalisation of the same.

(c) Reviewing the progress of the district plan, monitoring and suggesting the reappropriation of the sanctioned provisions, district annual plan according to the guidelines laid down by the State Government. Accordingly for planning, the basic unit is no longer the district but the *talukas* and municipalities. The district level responsibility is going to be mainly of coordination, monitoring and administration. From that count also, it will be more useful to give a place to *taluka panchayat samities* in the new working system of sub-basinwise water management. District as a unit for planning or the district headquarters as a centre for day-to-day business will not be useful, for the systems of development which are based on natural resources like forests, mines, water etc. or for the network systems such as power, roads, railways, post or telephones. In any further set-up district as a unit will have to be utilised primarily for administrative coordination.

8.2.42 The following subjects relating to water are mentioned to be within the purview of the district planning committees:

1. Irrigation development (among that mainly minor irrigation).
2. Drinking water (both rural and urban components).
3. Groundwater development.
4. Watershed development.
5. Development of agriculture.
6. Pollution control.

However, as '*taluka'* being the unit for the basic field planning of the area, the work of the district planning committees will be primarily of coordination. Some sort of an extended scheme of drinking water, groundwater or watershed area like that of irrigation, on an area of a district is not possible - within the geographical setting of Maharashtra. These schemes will be confined within the geographical boundaries of *taluka panchayats.* It is, therefore, necessary to make the *taluka* as a more effective unit also for groundwater development, watershed development, drinking water supply, etc.

8.2.43 However, major and some medium irrigation projects form beyond the boundary of extent of a *taluka.* Because of high level technical and management planning needs of these projects, it appears desirable to entrust their responsibility at the State level. Moreover, in view of the fact that hereafter the planning of marketing and processing centres will be on the basis of contiguous irrigation areas and such overall planning will be difficult to accomplish at *taluka* level, it will be useful to handle irrigation projects of more than 1000 hectares at the State level only.

8.2.44 Participation of water users' associations (WUAs) will be a very important element in irrigation management hereafter. A WUA is basically a representative institution which works in accordance with the agreement with the Irrigation Department. While entrusting the increased responsibility to *gram panchayat* organisation as suggested in the foregoing, the Commission recommends the following so that there be no internal conflict between this set-up (WUAs) and the constitutional powers and responsibilities of the *gram panchayats.*

(1) It be clearly stated that *panchayats* have to discharge their responsibility of observance of the State Irrigation Act which appertain to watershed development, pollution and groundwater in accordance with the guidelines of the State.

(2) The Act should also give freedom to the *panchayats* to retain the revenue in this respect wholly with them.

(3) *Panchayats* should maintain their accounts in accordance with the guidelines issued by the State and these should be published alongwith the annual reports of the *panchayats.*

8.2.45 From the provisions in the District Planning Committees Act it appears all the *gram panchayats* and municipalities will consider the district plan from their own view and will send draft of the plan to the district planning committee. The jurisdiction of the district planning committees will be limited to the programmes at the district level and below. Even then, the size of the annual plan of all the district committees together will be about 30 to 35% of the State Annual Plan. If the prevailing size of the Annual Plan is taken as Rs. 12000 crores, then the total annual plan of all districts together will be Rs. 4000 to 5000 crores. In addition, *Panchayat Raj* institutions can make their own investment in the programme. In most of the *talukas*, a major portion of these local resources will be available for the work of irrigation development, it appears. The overall set-up of irrigation development will have to be decided keeping in view the combined outlay made available from the *talukawise* allocation of State level projects and the exclusively appropriated outlay from *Panchayat Raj* System.

8.2.46 Once the work of sub-basinwise planning is commenced by the Irrigation Department, these new district planning committees will be of help in that work or their help wily be sought. Especially, once the draft plan is formulated and put before those committees and their suggestions for improvement therein are sought and are taken into account, then the planning will go on attaining perfection. Also, the acceptance of people to the planning in the sub-basin will gain more ground. To be actively associated with the district planning committees in the process of sub-basinwise planning from this viewpoint will be desirable.

8.2.47 Measures for pollution control will have an automatic wider acceptance by the people if they are proposed with the concurrence of these district committees. In case the utilisation of groundwater is taking place beyond the limit, the restrictions to be put or the punishment to be inflicted or the fine to be imposed if are backed by public acceptance through this committee, then they can be effectively implemented.

The Forest Conservation Act, 1980.

8.2.48 Till 1977 the subject of 'Forests' was a State subject as per the Constitution of India. As per the 42nd amendment to the Constitution, that subject has found its place against the Entry 17A of the Third Schedule which identifies subjects jointly dealt with by the Central Government and the state governments. After this amendment the Central Government passed the Forest Conservation Act, 1980.

According to clause 2 of this Act of 1980, following restrictions are put on the powers of the state governments. Without the prior permission of the Central Government, no state can

(1) exclude any forest area already declared to be restricted forest from the term 'restricted forest';

(2) use area recognised as forest area for non-forest work of whatsoever kind;

(3) give on lease or transfer in a more of whatsoever kind any forest area to any person, organisation, authority or corporation;

(4) indulge in afforestation of any naturally growing forest area by embarking on deforestation.

8.2.49 In the land records of five districts of Vidarbha (Bhandara, Chandrapur, Gadchiroli, Nagpur and Wardha) nomenclature of *'zudupi jungle'* (shrubby forest is in vogue. Similarly in the four districts of Yavatmal, Amravati, Akola and Buldana the nomenclature of 'C Class' *Jungle* is in vogue. The provisions of the Forests Conservation Act of 1980 have become applicable to the area befalling under both these categories in the 9 districts of Vidarbha, Difficulties are besetting with in acquiring land for development projects - especially irrigation projects- in these 9 districts. As a result, there has been continued resistance to the enforcement of this act. This has resulted in inordinate delays. Several proposals of development remained pending and consequently there has been a tremendous increase in their probable costs.

8.2.50 Policy of giving alternative land in lieu of forest land going under submergence has now been accepted. The responsibility of deciding whether the alternative land is suitable for forest or otherwise has been entrusted to the Forest Department.

Discussion of such difficulties caused by the land with the Forest Department has also been undertaken in Chapter 5.

Acts Pertinent to Groundwater

8.2.51Groundwater is being used traditionally. But after 1960, availability of electrical power in the rural areas went on increasing and boosted up the use of groundwater manifold. In some watersheds, it has reached to an alarming level also. Because of such an uncontrolled and relentless use of groundwater, public sources of drinking water have dried up at several places. At places there is danger of land collapsing under ground and at some places near the seashore, there is a danger of sea water ingress. The use of groundwater by an individual land owner though may not cause direct damage, the aggregate use of the same can surely compromise the public interest.

8.2.52 The fatal race of using up groundwater by taking deeper and deeper bore wells is going on and consequently bores of shallow depth are being drying up. This is leading to a kind of anarchy. In this situation there is a need for intervention in the public interest. It is ^U necessary, in the interest of social justice and environmental balance to control such relentless use of groundwater.

In this context in the 7th paragraph of the National Water Policy of 1987,the national policy has been laid down as: "Exploitation of groundwater should be so regulated as not to exceed the recharging possibilities."

The state governments have to enact legislation to implement this policy. For this purpose, the Central Government has circulated a Draft Bill in 1992 to the state governments. Even earlier, the Central Government had sent a similar bill to the state governments in 1971.

8.2.53 As on today the land owners have the right on groundwater. The rights of groundwater change hands with the right of land ownership. This means that up till now the right to groundwater has been considered as a movable property associated with the land.

8.2.54 Today there is no legal restriction whatsoever on the land owner as to how much groundwater under his land he can use. Nobody can take objection even if his use causes decrease in groundwater availability the neighbourer's land. Thus in today's situation the right on the groundwater is only of land owner. The landless has no right whatsoever on groundwater. It follows that if equitable distribution of groundwater is to be made, the rights to groundwater have to be separated from the rights over the land.

8.2.55 In Gujarat, the irrigation act has been amended for groundwater. So far that amendment' has been made applicable in only one district. It does not provide for rights appertaining to groundwater. But the government has taken over powers to control the number of bore wells and to control the sale of groundwater. It is binding on the land owners to obtain permission for old and new bore wells. These provisions are also in accordance with the Draft Bill circulated by the Central Government.

8.2.56 The Government of Maharashtra has also, in 1993 passed a small act regarding groundwater. It is called the Maharashtra Ground Water (Regulation for Drinking Purpose) Act, 1993. As the name indicates the purpose of the act is limited to the protection of public sources of drinking water only. The set of rules thereunder have been framed in 1995. The Collectors have been given controlling powers therein. The area within a distance of half a kilometer from the drinking water source has been decided for the purpose of control. Instances of action taken under those rules for specific drinking water sources have however not come to notice. The comprehensive provisions of the Draft Model Bill of the Central Government, 1992 have not been considered in Maharashtra. Drafts therefor had been prepared in Karnatak and Tamilnadu States. They have, however, not been converted into law. Two basic difficulties might have beset with the state governments in enacting as per the Draft Model Bill namely:

1. The state governments may be sensitive in the matter of exercising controls on the Water resources which were freely available to the land owners till now.
2. They might be finding it difficult to raise an organisation for effective implementation of such a control.

If the participation of water users' associations can be obtained as recommended by the Commission in Topic 7.8 of Chapter 7, it will facilitate implementation of an effective control on groundwater alongwith the management of canal water.

There is a need for such associations for pollution control also. This has been discussed later in this very Chapter.

Water (Prevention and Control of Pollution) Act, 1974

8.2.57 As stated above in Para 8.2.5, the Water (Prevention and Control of Pollution) Act, 1974 has been passed by the Central Government under special provisions of Article 252 of the Constitution of India as the subject of water pollution was not within the purview of the Central Government till then. The subject of protection of environment did not appear in all the three lists of Constitution of India.

8.2.58 Definition of water pollution is offered in clause 2(e) of this act. The aspects of pollution - chemical, physical and biological - are included in the definition and this concept is not limited to the possible danger to the health of human beings only but life and health of trees, animals and aquatic culture have also been considered in the definition. Clause (3) includes the provision for a central board for prevention and control of pollution. Clause 17 gives the jurisdiction of state boards.

8.2.59 Provision for fine, etc., is included in clause 41. In a way this act of 1974 is extensive. The Central Government had appointed the Tiwari Committee for taking a review of its implementation. The shortcomings of this act have been brought out in that report. In particular, the difficulties in implementation of the act have been discussed. That committee has suggested mainly the strengthening of state boards and allocation of adequate finance for this work. It has suggested that the work of prevention and control of pollution should be given adequate publicity. Similarly awareness and alertness should be created amongst the public and particularly for the industrialists about the dangerous aspects of water pollution.

Maharashtra *Khar* Land Development Act, 1979

8.2.60The present act regarding *Khar* Land Development is in force from 1979. Earlier there was another act called '*Khar* Land Act 1948'. The new act includes provisions for formulating schemes for development of *khar* lands and powers for implementing the same and of imposing tax and cess on land.

Following provisions of the act are worth mentioning:

1. Under clause 12 (3) there is a ban on the lands included in the scheme from being used for any other non-agricultural purpose.
2. Under clause 14 (1) the *gram panchayat* has been responsible for supervision maintenance and repairs of *bandharas.*
3. The *gram panchayats* have the right of receiving the amount spent on schemes under (2) above from the State Government.
4. Under clause 20 there is a provision for charging a cess on such lands as are benefited from the schemes.

Till 1980, the entire work of development of *khar* lands was under the Public Works Department. Thereafter all that work has been transferred to the Irrigation Department. As all such lands lie mainly along the Konkan coast, all that work is under the administrative control of the Chief Engineer in Mantralaya.

Five Acts of the Basinwise Corporations

8.2.61 The five acts for the five corporations were passed during the period of three years from 1996 to 1998. Each of the five acts contains 71 clauses. Generally provisions regarding the organisational structure and procedure of work of the corporations are similar. Significant dissimilarities have only been dealtwith in what follows.

The Godavari water disputes have been mentioned in the objectives of the act of Vidarbha Corporation but not in that of Godavari Corporation.

There is a considerable difference as far as jurisdictions of the corporations are concerned. The jurisdiction of the Krishna Corporation has been notified as the entire area of Krishna Basin in Western Maharashtra and Marathwada. But Vidarbha and Konkan Corporations are entrusted with some specified projects instead of the entire area in those regions. The Tapi Corporation has been entrusted with the area in Dhule and Jalgaon Districts instead of the entire area in the Tapi River Basin. The Godavari Corporation has been given to cover the entire area of Godavari Basin in Nashik, Ahmadnagar and Marathwada. Soyagaon *Taluka* and some villages in three other *talukas* of Aurangabad District of Marathwada lie in Tapi Basin but are not therefore covered in the jurisdiction of any of the corporations.

Management of old projects in the basins is included in the jurisdiction of Krishna, Godavari and Tapi Corporations, but not in the case of Konkan and Vidarbha Corporations. Krishna and Vidarbha Corporations include three representatives each from three well known financial institutions on their boards - a provision not applicable to the Tapi, Konkan and Godavari Corporations.

There is a lot of difference in the financial share of, the Government [clause 31(1)]. The Krishna Corporation will get a contribution of Rs. 3500 crores in five years with an initial contribution of Rs. 700 crores; Vidarbha Corporation will get Rs. 1300 crores in five years with an initial contribution of Rs. 150 crores; Tapi Corporation will get Rs. 1400 crores in 10 years with an initial contribution of Rs. 100 crores; Konkan Corporation will get Rs. 173 crores five years with an initial contribution of Rs. 28 crores and Godavari Corporation will get Rs. 1300 crores in 10 years with an initial contribution of Rs. 185 crores.

There is no similarity in administrative and technical powers also. Powers of administrative approval and technical sanction have been delegated to Krishna Corporation ^U only. [Clause 119 (1)]. The other four Corporations do not have powers of administrative approval or of modifying the provisions therein.

The organisational structure and transactions of the corporations have been discussed in Paras 13.4.5 through 13.4.30 of Chapter 13.

Environment Protection Act, 1986

8.2.62 For the protection and improvement of environment, the Central Government passed this act in 1986. It is in consonance with the resolution passed in the United Nations Council in its meeting held in Stockholm in 1972.

The definition of environment given in clause 2 (a) of the act embraces water.

The Central Government has powers to stipulate norms pertinent to pollutants affecting the environment. Violation of any rule made under this act is punishable. However, only the Central Government can take cognizance thereof or else, action can be taken on the basis of a notice served by somebody.

Maharashtra Fisheries Act, 1960
Maharashtra Marine Fisheries Act, 1961

8.2.63 The Constitution of India came into effect from 26th January 1950. The subject of development of inland fishery resources has been transferred' from the jurisdiction of the Central Government to the jurisdiction of state governments since then. Accordingly the State Government enacted a legislation on the subject replacing the Indian Fisheries Act, 1897. In accordance with this, the Government of Maharashtra passed the Maharashtra Fisheries Act in 1960 and it is made applicable to all the fisheries barring marine one. The second act in the State is the Maharashtra Marine Fisheries Control Act, 1961. It is applicable, to the fisheries in the sea limited to a specified distance from the coast. The main objectives of both these acts are protection of areas of fish breeding, protection of some species of fish and proper control of marine fisheries. The State Government has powers to put a restriction or to put a total ban on some kind of boats in specified marine areas. The method of control used by the Government to achieve this objective' should be based on modern Science and Technology. While doing so, the Government has the responsibility of protecting the interests of the other professionals engaged in fishing.

The subject of control and development of fishing beyond the limits of coastal area falls under the jurisdiction of the Central Government and the Indian Fisheries Act, 1986 is to force therefor.

8.3 Earlier Pattern of the Irrigation Acts

8.3.1 During the British rule, the First Irrigation Act with reference to irrigation management on irrigation projects was enacted on 12th April 1845 for the North West Province by the Governor General of India. The purpose of this act was protection of canals from loss or damage in the North West Province, regulation of the canal for recovery of water charges, tolls and in respect of some canals recovery of arrears of water charges and tolls and to confer powers on the canal officers to make rules under the act. Under this act powers were conferred on the canal officers which included punishing those responsible for damage to the canal and to recover the arrears of water charges as arrears of land revenue. According to this act water was considered as a state property and rights of the state were established on water and water sources and all powers on water use were centralised with the Government. During British rule acts on the same lines were introduced in different provinces of India subsequently.[2]

8.3.2 The contemporary law pertaining to irrigation management of systems existing prior to the British period is not extant in a consolidated form even today. Some scattered information is extant of the traditional rules of the *Phad* System that h ad been in vogue in Panzra /Girna Sub-basins and the group management system of beneficiaries on the Gond tanks in Wainganga Basin. But one thing is clear from this information that the decision making process was entrusted to the groups of beneficiary farmers and there was least Government interference. The irrigation system of the '*Khajana* Well' in Marathwada during the Nizam era had been continuously in operation for the last 300 years. In this; though there was a rotation system of water distribution, instead of handing over the same to the beneficiary group, it was kept under the Government

2. Source: 'Irrigation in India' by Herbert M. Wilson, P - 52.

control. The responsibilities for the collection of water charges/repairs were not fully handed over to the groups of beneficiaries but were under the control of the Government officers. This difference is clearly evident. Chapter 41 of the *Arthashastra* (Economics) by Kautilya explains the functions of *Seema Adhyaksha* (the chief officer of farming operations). The emphasis on maintaining and increasing agricultural productivity has been brought out very clearly therein. Similarly in chapter 19, in the procedure of community development there is a concept of encouragement by the king to the community works to be undertaken by people like *bandharas*, diversion of water, etc., but there is no concept of taking up these works or maintaining and managing the same as the Government property. There is a tax on them payable into the Government treasury but management is of their own. It appears no Government officer was used to be appointed therefor.

8.3.3 Before its formation, the State of Maharashtra had been divided into three provinces / states. Therefore in these areas the irrigation acts of the respective erstwhile provinces were in vogue.

i) Bombay Irrigation Act, 1879 for the area covered in the erstwhile Bombay State.
ii) Central Provinces Irrigation Act, 1931 for Vidarbha Region.
iii) Hyderabad Irrigation Act, 1357 *Fasali*, (i.e., 1948 A.D.)[3] for the Marathwada Region.

1) The rights of the Government on water in public irrigation systems were established according to the aforementioned acts. But there is no mention about the right on groundwater in any of the acts. At that time use of groundwater was entailed mainly by means of a *mot*. The capacity of the *mot* for lifting water in a day was negligible in comparison with the Pumps of today. Use of *mot* was not used to bring about any immediate perceptible influence on the groundwater status of the adjoining farmland. Therefore within these limits groundwater began to be considered as a property of the land owner. Now however the public nature of groundwater has become evident necessitating passing an act for reasonable use of groundwater.

2) Under all the aforementioned three acts, the canal officers had been conferred the powers to regulate irrigated crops; to sanction the water applications of irrigators and to impose fine for wastage of water and for taking water without permission. According to these acts there was a ban on mixing of canal and well water. In addition, sanction of irrigation water was limited to a specified sanctioned crop. Under all these acts the construction and maintenance of field channels and development of land for receiving irrigation was made compulsory for beneficiaries. Unless this was ensured, sanction would not, in fact, be given for the use of irrigation water.

3) There is a provision in the above three acts for supply of water to the crops from the date of sowing to the date of harvesting. There however is no mention as to how much water be given nor the quantum of water to be delivered has been defined. Therefore in practice this came to be interpreted to mean that water can be taken till the farmer is satisfied. As the canal officers did not have the powers to stop irrigation water to crops in sanctioned irrigation area, this encouraged excessive use of water. The canal officers had the powers to stop irrigation water only if the irrigator had not paid irrigation charges or if he was in arrears of these charges or if the field channels were not properly maintained. There was no provision for stopping of water to improve the efficiency of water use or to stop wastage of water.

3 Source: Letter from the Osmania University, Hyderabad, dated 27.8.1999.

4) There was a provision in the Central Provinces Irrigation Act to have irrigation agreements with the land holders in a village / *mahal* or under an outlet in command area for one or more crops for a maximum period of 10 years. There are many old tanks in Vidarbha Region and mainly 'paddy' crop used to be grown thereon. Therefore in this region there used to be effected irrigation agreements with the land holders mainly for the crop of 'paddy'. In the new Irrigation Act of Maharashtra, 1976 the system of such irrigation agreements has been introduced for the first time.

5) In the Bombay State, the Bombay Irrigation Act, 1879 had empowered the administration to construct works of drainage schemes in command area where it was found necessary to execute such drainage works. There, however, was no similar clear provision in the Hyderabad Irrigation Act, 1357 (*Fasali*) and the Central Provinces Act, 1931. Later this provision has also been incorporated in the new Irrigation Act of Maharashtra of 1976.

6) There was no provision of betterment levy in all the three original acts, (i.e., the Bombay Irrigation Act 1879), the Hyderabad Irrigation Act, 1357 (*Fasali*) and the Central Provinces Irrigation Act, 1931. But later in the post-independence period, the provision for exacting betterment levy was added in the original acts in 1950, 1952 and 1956 respectively. The Barve Irrigation Commission had recommended that there should be no separate provision for betterment levy or its recovery -and water charges should include the component corresponding to betterment levy. In practice, however, it appears that irrigation charges have not been enhanced thereafter towards this end. There is no mention at all of betterment levy in the new Irrigation Act of Maharashtra, 1976. It is, therefore, to be assumed that the component has been incorporated in the irrigation charges itself.

7) There is a provision in the Central Provinces Act, 1931 for the formation of water *panchayats* in each village concerned with the irrigation agreements. The members of water *panchayats* comprise the village *sarpanch,* two or more representatives elected from land holders concerned with the irrigation agreement and representatives nominated by the Deputy Commissioner. Such water panchayats were given the work of helping the Irrigation Department officers in their administrative work carrying out repairs to the field channels, collecting the revenue and remitting the same into the treasury etc. and the powers relating to such work. The members of water panchayats were deemed to be Government servants to the extent of use of these powers. But these provisions or alternative provisions have not been incorporated in the new Irrigation Act of Maharashtra, 1976. Provision for the system of irrigation agreements of Madhya Pradesh was incorporated in the new Maharashtra Act of 4976; but the group system for implementation of these agreements was not incorporated in the Act. To some extent, this is a sheer contradiction. It is also a major contradiction that inspite of the fact that Government, in principle, accepted the recommendations of promoting and improving the people-oriented systems contained in the reports of the Visvesvaraya Committee of 1938, the Bombay State Government Resolution of 1947 and later the same of the Barve Commission, the officer-oriented system reflected in the Irrigation Act of 1879 continued in toto in the Act of 1976.

8) The Bombay Canal Rules were framed in 1934 in the context of Bombay Irrigation Act, 1879. These, rules contained the details of application forms in use in irrigation management practice, powers of canal officers, sanction of applications for irrigation water, irrigation water charges, irrigation cess, assessment and remissions in water charges, etc. After the formation of the Maharashtra State, different irrigation acts in force in the different regions of the State .were

integrated into a new irrigation act called the 'Maharashtra Irrigation Act, 1976' and it came into force from 1st January 1977. As new rules have not been framed thereunder, the Bombay Canal Rules of 1934 continued to be in force till date. Most of the provisions in the Bombay Irrigation Act, 1879 except that the provision regarding 'irrigation agreements' from the Central Provinces Act, 1931 have now been included in the new act.

8.3.4 There is a nominal provision regarding the participatory irrigation management in the new act of 1976 according to which the measured volume of canal water is to be supplied to the water committees and the latter is to distribute the same amongst the irrigators. On the basis of this provision only, water users' associations (WUAs) are being formed in Maharashtra and irrigation management on minors is being handed over to the beneficiaries. In October 1992, the State has issued Guidelines for Water Users' Association. It contains detailed information regarding the Government policy, pertinent Government resolutions and documents required for getting such associations registered / formed, etc. According to these guidelines beneficiaries in the area of a WUA have no restriction as to mixing of canal and well water and are made free to grow any crop. These new provisions are definitely progressive and pragmatic. From the formal point of view these nevertheless are not consistent with the provisions in the present Irrigation Act of 1976. Considerable improvements for the introduction of irrigation management invoking participatory approach statutorily all over are called for in the present Irrigation Act.

8.4 Supportive Legislation for Irrigation Management

8.4.1 The main objective of irrigation projects - small and large - is hereafter going to be ensuring total maximum agricultural production for the society through equitable distribution of water stored in reservoirs. The irrigation management system and supportive legislation is required to be founded pertinent to that.

8.4.2 The irrigation management in Maharashtra is not that simple and straightforward as in North or South India, but is more complex. Because of the undulating topography, diversity of crops in command, variation in the sowing time of crops, different types of soils in command, the consequent different water-holding capacities of lands in different areas of command, different capacities of different crops to extract water from the same type of soil, rotation periods of different crops in the same soil and the doses of water required are varying. The irrigation management has to be organised by taking all these aspects into consideration and coordinating the same. In deciding the canal capacities one has to take into consideration the proposed cropping pattern, rotation period and water requirements of crops. On the other hand the variation of soils in North India is small and topography is uniform, the variety of crop is limited as the rivers are perennial, water is diverted into canals via *bandharas* and is distributed in proportion to the land held by irrigators and therefore the irrigator can take any crop of his choice according to water quota made available. If the Irrigator does not take water during the prescribed time, he looses his claim on that water. Irrigation proceeds from the head of a distributary to the tail. In South India also, generally one type of crop is grown by the irrigators in an area and there is no difficulty in determining the rotation period.

8.4.3 The situation in Maharashtra is different. The water available in a reservoir depends on rain and as there is a large variation in rainfall, there is also a variation in water stored in an irrigation reservoir. In a deficit year, water in the reservoir has to be regulated. As drinking water schemes are, not reliable (barring a few), the irrigation management is burdened with the load of drinking water. Consequently it has become necessary that irrigation management is flexible. As per the Government in Irrigation Department Circular No.1089/1131/IM/(Policy) dated 1.1.1991, the Government has issued guidelines for the regulation of water in reservoirs in years of average rainfall and deficit rainfall years. However, the policy as to now equitable distribution of water has to be accomplished amongst beneficiaries during deficit years has not been framed. This tie framed and rules formulated accordingly. Notwithstanding, it is expected that discussion with the beneficiaries be held before that year's *rabi* season as to how should the proper distribution and apportionment of that year's water; and the procedure for forthcoming months be streamlined accordingly. In practice, however, whether water will be equitably distributed or not will depend on whether meetings of farmers as suggested therefor are held or not.

8.4.4 Presently the irrigation practice on the eastern side of Sahyadri is the same as that on Western Maharashtra which has been established by the Britishers almost a century ago. To face the scarcity condition, the Britishers have built reservoirs across Krishna, Mutha, Nira. Godavari and Pravara Rivers. (barring Krishna River) in a half century from 1875 to 1929 and brought about 350000 hectares of land under irrigation. The purpose of these projects was limited to the protection of crops in times of scarcity. The inclination of beneficiaries was to grow rainfed crops and to save water charges if there was a satisfactory rainfall. Consequently reservoir water was not being fully utilised and water remained unused. On the other hand, at some places excessive use of water resulted in waterlogging and consequent damage to land. To remedy this situation, the then Executive Engineer Sir Visvesvaraya made efforts in 1905 to introduce in command areas of irrigation projects, the traditional and ideal Phad System of irrigation management which has been in operation in. Nashik and Dhule Districts prior to 3 to 4 centuries. According to the principles of this system, efforts were made so that every village in command was to get benefit of perennial irrigation; there should be a rotation of crops and there should be a reasonable distribution of water. Because of practical difficulties, however, such a system based on the Phad System could not be implemented. Notwithstanding this, as a culmination of all these efforts the block system came in practice and the sugarcane area had been stipulated to be 1/3 of irrigation area. As a consequence clear provisions regarding blocks, their sanctions and regulation could find their place in the Irrigation Rules. Later, in accordance with the recommendations of the Sir Visvesvaraya Inquiry Committee (1938), perennial blocks of fruits and vegetables also included and a system of sanctions to blocks of 6 years and even for a longer period came into existence. The Barve Commission had recommended in 1962 a change in the proportion of seasonal and perennial crops and also the implementation of six other types of blocks. They had also recommended a change over to 1:4 sugarcane blocks and introduction of the block system on all projects in the State. They had also suggested a change in procedure instead of sanctioning the blocks limited to availability of water in reservoir on the basis of 75% dependability, blocks should be sanctioned to the extent of 85% of water that is available at 50% dependability. The- recommendations of the Barve Commission in respect of the block system were accepted by the Government. But it appears that the recommendations of the Barve Commission were not implemented except on old projects and the Mula Project. The block system remained in force on old projects and was newly introduced on the Mula Project only As a result, this system though provided in the Rules could survive in practice only partially in the new period.

The block system was originally suggested with a view that water use be economical; distribution of water be accomplished equitably amongst the villages in command area and also amongst the beneficiaries in each village. However, it appears, this objective is not realised in course of time. For many years now the revision of blocks also does not appear to have taken place. After studying the irrigation management on the Deccan Canals in 1938, Sir Visvesvaraya Committee had also made a far-reaching recommendation of supply of measured volume of water to groups of farmers as the ultimate alternative to ensure equitable distribution and economic use of water. The said Inquiry Committee had recommended that for the time being in absence of measuring devices on all canals, joint stock companies of sugar factories should be supplied with measured volume and accordingly volumetric supply came into effect for the joint stock companies. In this system the water level at the S.W.F. near the head of a distributary was used to be noted jointly by the Government staff in irrigation management and company staff, three times a day. But this far-reaching recommendation was not reflected in the Irrigation Act (1976).

Methods of Irrigation Water Supply

8.4.5 In Maharashtra, water is presently supplied for irrigation in three ways:

1. By supplying of water for seasonal and perennial crops on the basis of applications from tendered by irrigators.
2. By entering into irrigation agreements for water supply to one or more crops.
3. By going in for joint agreements with water users' associations regarding supply of measured volume of water according to the allocated quota.

System methods (2) and (3) have not been properly developed and at present on most of the irrigation projects barring a few, the system in vogue is to supply water mainly after applications are tendered by irrigators. In this system of water supply, applications are invited, from irrigators one month in advance of the beginning of each season through a public notice. The applications must be received before a specified date. The irrigators have the freedom of taking any crops from within the specified group of crops. Water applications are scrutinised and sanctioned according to water available in the reservoir. In fact, orders standing since 1947 that this decision of water supply be evolved by mutual interaction with the beneficiaries. Notwithstanding this, the officer-oriented system appears to have continued even after the British period.

In the present system of water supply, all powers have been centralized with the irrigation manager. That is why there are many complaints about irrigation management. Shortcomings in the physical conveyance system and the resulting difficulties in operation, irregularity-deficiencies and carelessness in maintenance and repairs of the conveyance system, inequity in water distribution amongst the beneficiaries and the resulting lack of cooperation from them, absence of consistent rules for the implementation of the Irrigation Act, theft of water and malpractices - all these have led to a disordinarliness in irrigation management. Efficiency of water supply is related to social as well as technical issues. Without the cooperation of beneficiaries, many things like proper, distribution of water, economic in water use and prevention of malpractices in water distribution are far from realisable. A notable shortcoming is apparent that though awarness in this regard has been inculcated right in the period of rigorous management of British days, no changes have been introduced in the field procedures or details in the acts.

8.4.6 Sanctions are given to lift water from river even for area within the command of a project (where water is available by flow through canal). Thus the same area gets water facility from two sources. In such cases, it is difficult to know whether the area is irrigated by flow from canal or by lift. The Commission had noticed such instances in the command of Bhima Project. To ensure proper distribution and use of water, it is desirable that control be exercised over such cases. With the construction of a series of Kolhapur Type weirs on the river in a command, there is a possibility of increase in such cases. It is, therefore, desirable to divide command area into two parts; the area below a certain level to be irrigated by lift from the river and the area above that level from the canal. The concerned Administrators/Superintending Engineers will have to be delegated with the powers of changing such command maps.

8.4.7 Considerable administrative efforts are spent in obtaining and sanctioning individual applications from thousands and lakhs of beneficiaries in each irrigation season. Moreover, beneficiaries do not tender applications for water before the stipulated date as per public notice, but ask for water when they see the canal running. This affects the time schedule of a rotation. The rotation period has to be extended and the discharge in the canal increased. This affects the subsequent rotation. The Canal Inspector has, to get in touch with the beneficiaries individually and get the application forms duly filled in. Therefore, instead of irrigation allowing to remain as an optional item dependant on the individual seasonal applications (of the beneficiaries), an awareness for social commitment among the community of all the farmers in a command should be created. It is necessary to make a clear provision in the related acts and the corresponding rules that once the command area of a Project is decided, the available water be allocated in proportion to the command and that the minorwise and seasonwise normal average volumetric quota be declared and the distribution of water so allocated be effected amongst the beneficiaries through water users' associations of theirs.

8.4.8 During the field visit of the Commission to the Pench Project in Vidarbha, it came to notice that according to irrigation agreements a rate of Rs. 100/- per hectare was charged for *kharif* paddy whereas the water users' associations (WUAs) are bound to charge a rate of Rs. 160/- per hectare in accordance with the cropwise rates separately decided by the Government. Therefore, though the farmers are convinced about practical utility of WUAs, the same are being formed with a slow pace. As it is quite necessary to promote a multi-seasonal cropping pattern for the rural economic development in Vidarbha and as the system of volumetric supply of water is inevitable hereafter, there should be a complete change over be brought about in phases from the irrigation agreement system to WUA system. The water rates hereafter should also be sub-basinwise instead of being the same throughout the State. This issue is further discussed in Chapter 9 of this Report

8.4.9 The real boost to the implementation of Participatory irrigation management was received after the announcement of the National Water Policy by the Government-of India in 1987. The work of formation of WUAs in the State is accelerated after the Government of India circulated guidelines for the participation of farmers in irrigation management. At present WUAs are being formed in the State on the basis of provisions in clause 60 of the Irrigation Act, 1976. So far 206 WUAs are in operation catering volumetric supply of water to 78356 hectares of area. This area is only 2% of the total area under irrigation. As it is necessary to have participatory irrigation management on all irrigation projects in the State, it becomes necessary to amend clause 60 of the Irrigation Act of 1976 to lay down a legal provision that this will be the sole reasonable lawful way of begetting irrigation water.

8.4.10 In areas of heavy rainfall where paddy is grown mainly in low lands, the development of WUAs will not take place in true sense unless the present distribution system, i.e., field to field irrigation is changed over to field channel distribution system. After the provision of irrigation facilities, the crops are not dependent on water that is flowing through low lands as in the past.

As the canals are aligned along much higher level than the low lands, the planning of agricultural crops between canals and the low lands also assumes importance. As the protection of minors and field channels on the slopes from rains and maintenance & repairs thereof are both expensive and difficult, experiments on piped water supply system are at present being conducted by the Department. Instead of adopting only one approach out of the three alternatives at the disposal, viz., water supply only through canal-minors and field channels, growing paddy only in low lands and water supply only through pipes - it appears desirable to evolve with the consent of beneficiaries a method which is a combination of the three; is suitable to the topography of low lands and is economically affordable to them. Unless provisions are made in the Irrigation Rules and in the water rates to encourage the same and unless necessary flexibility is provided in the Act, this process of experimentation will not get develop. Irrigation in heavy rainfall areas is a difficult part of irrigation management. It is, therefore, necessary to have separate provisions for the same in the Irrigation Act. Procedure of work and provisions in the Act which may be suitable for drought prone areas do not apply to heavy rainfall areas.

Irrigation Seasons

8.4.11 According to the recommendations of the Barve Commission, the Irrigation Year in the State has been suggested from 1st July to 30th June. But while accepting the recommendation of the irrigation season within the year, the Government made a slight change and stipulated the irrigation season to be as under:

1. *Kharif*- 1st July to 14th October.
2. *Rabi*- 15th October to 28th February.
3. Hot weather-1st March to 30th June.

It is not convenient to apply beginning and end of the seasons as above uniformly to all the regions of the State. In the Konkan Region crops are raised only in two seasons. Because of the characteristic climate rabi and hot weather seasons merge into one. The period from 1st December to 30 th April is called as Konkan *Hangam.* In view of the climatic variations from sub-basin to sub-basin, it is desirable to give the freedom to the canal committees of projects to decide the period of the season. From this point of view there should be a provision in the Act spelling out their powers in this regard clearly.

Assessment and Recovery of Water Charges

8.4.12 Before the formation of the State of Maharashtra, different procedures for, assessment and recovery of irrigation charges prevailed in. Vidarbha, Marathwada and the erstwhile Bombay Province. With the formation of Maharashtra, necessity has been felt of streamlining this procedure. When the modified irrigation act came into existence in 1976, the very purpose was stated at the beginning of the Act in these words: "Whereas it is expedient to unify arid amend the law relating to irrigation in the State of Maharashtra, to provide for charging water rates on lands under the irrigable command of canals and, to provide for matters connected therewith". As a matter of fact, the purpose of the original irrigation, act of 1879 was comparatively wider and it had been expressed as : "Whereas it is necessary to make provision for the construction, maintenance, and regulation of canals for the supply of water therefrom and for the levy of rates for water so supplied in the Bombay Presidency".

The Hyderabad Irrigation Act, 1357 *Fasali* (1948 A.D.) which was in force in the erstwhile Hyderabad State, was applicable to Marathwada Region. The purpose of this act was to make adequate provisions for construction and maintenance of irrigation projects. Like the Bombay Irrigation Act (1879), this act was also pro-Government. Before Marathwada was merged in the Bombay State, the water charges in Marathwada Region were used to be collected by the Revenue Department alongwith the land revenue. A note of land that would be irrigated was used to be taken in the 7/12 record. There was a provision in the Irrigation Act for this purpose for the appointment of an 'irrigation *patawari'*.

8.4.13 In Vidarbha Region also, the Central Provinces Act, 1931 was in force earlier. According to this act, the powers of recovery of water charges were bestowed on the *pani panchayats* wherever they were in existence. For every village/*mahal*/outlet command which had entered into an irrigation agreement, there was a provision in the act for the election of members of the *pani panchayats* through an election. Powers had been conferred on the *pani panchayats* to recover water charges and to remit the same into the treasury. According to this act, there was a provision for the appointment of a revenue officer as a Canal Deputy Collector and he had powers to take action in regard to land revenue cases and if it was beyond his jurisdiction to send them to the Collector through the Executive Engineer.

8.4.14 In the area of the erstwhile Bombay State, before 1976 the recovery of charges of water supply other than irrigation were used to be carried out through the Irrigation Department, while the recovery of water charges for irrigation was used to be through the Revenue Department. There was no separate procedure for recovery of non-irrigation water charges as the number of such consumers was very small. No separate accounts were used to be kept of such recovery. But under Maharashtra Government in Irrigation Department Resolution No. RRS/1075/1119/T-13/298 dated 29th May 1976 the work of recovery of water charges for all kinds of water supply made through the Irrigation Department has been entrusted to the Irrigation Department and the assessment & recovery of all types of water charges is made through the Irrigation Department only. As of now assessment of water charges is accomplish in two ways.

Assessments for water supply for agriculture made to the different land holders by the canal administration is based mainly on both irrigated area and the type of irrigated crop. Assessment is made for the area as measured at the rate per hectare of crop irrigated. For domestic uses, viz., drinking and industrial purpose, the total volume of water supplied is measured and assessment is made thereon. Similarly, in the case of WUAs and the Agricultural Corporation, the assessment is made on the volume of water used in each season instead of area irrigated as per their joint agreements/request. As the participation of farmers in water management is essential _water will have to be supplied to them hereafter in measured volume only. However, they will have to follow the system of assessment of water charges based on area in their internal management. At present there is no clear provision in the Act for adopting this dual system. It will have to be made clear therein.

Assessment of Water Charges and the Present Status of the System of Recovery

8.4.15 Before the Maharashtra Irrigation Act 1976 has been made applicable in the State; the work of irrigation management in different regions of the State was based on the acts applicable to the respective regions. After the new act was made applicable in 1977 procedure and proformas based on the earlier acts became defunct in principle. However, the procedures and rules of irrigation management based on the new act had not been formulated. As a result, the work of preparing assessment statements in different regions is being carried out in accordance with the earlier traditions only. The old proformas are being used for this purpose. Procedural details of assessment statements in different regions are different and the proformas are also dissimilar. For bringing uniformity in the procedure of work of assessment and recovery of water charges and for formulating the rules of the assessment system and recovery of water charges, the Government had appointed the S.V. Raikar Study Group in 1991. The study group has submitted its report to the Government in 1992 bringing out alongwith a manual for procedure for assessment and recovery of water charges. No action thereon appears to have been taken. An early action is desirable so as to enable 'WUAs adopt suitable proformas in their internal transactions.

8.4.16 In case of beneficiaries who take water in an entirely unauthorised manner and who do not beget sanction whatsoever for any crop, even if penal charges are levied they do not pay to the Government and continue to take water unauthorisedly with the connivance of lower level irrigation staff. As such arrears of penal charges continued to accumulate. Now under the notification issued on 17 th July 1998, powers have been conferred on the Executive Engineers for enforcing recovery of such arrears under clauses 179 to 189 and 192,193,204,212,218/1 of the Maharashtra Land Revenue Code, 1966.

8.4.17 In fact such a provision in the Act in a way amounts to penal action against the beneficiaries. In fact for expanding the irrigation area and increasing the use of irrigation water on more and more area of the command, it is desirable to have an arrangement which will provide incentive and encouragement to use irrigation water extensively. In practice, to ensure proper use of irrigation water many important aspects such as construction of irrigation projects, interest of local people in the same, awareness amongst them for community management, etc., are prerequisite. To provide an irrigation system on their lands without their clear consent, to take penal action against them on the ground of non-use does not appear to be justified. Therefore, it is not desirable to take up the construction of a project or the distributaries here-in-after unless the layout of irrigation projects so conceived are made public. A resolution through the medium of *aam sabha* (general meeting) and a majority of beneficiaries have offered a favourable consent in writing about the necessity of that distributary at the time of planning the same. It is desirable to take recourse to penal action under penal provisions only in the case of those beneficiaries Who are reluctant to form WUA even after giving concurrence as above and are reluctant to take water even when it is made available. In the powers conferred on WUAs under the Act, there should be a clear mention, that such penal action can be taken against the beneficiaries who accept the membership of a WUA and still do not go in for water use later.

8.4.18 Under clause 93 of the Maharashtra Irrigation Act (1976), every offense of an unauthorised use of water attracts a fine upto Rs. 500/- or imprisonment upto 6 months or both. Similarly, there is a provision under clause 94 that any offense of causing harm to the stability of .canal attracts a fine of Rs. 1000/- or imprisonment upto one year or both. Under clause 98 there is a provision that irrespective of the provisions made in the Criminal Procedure Code (1973), offences punishable under clause 93 and 94 are cognisable and bailable.

In view of the aforementioned clauses, it is necessary to file a criminal case in the instance of unauthorised use of water and also damage caused to the distribution system. Notwithstanding this such a provision, no action beyond holding a *panchanama* is being taken by the Government owned canal administration for an unauthorised water use. If the matter of exercising a control on an authorised use of water is to be viewed seriously, it is necessary to give a serious thought for taking an effective action according to the foregoing provisions. A clear provision in the Act is desirable that after the formation of a WUA, such provisions be used by the elected office bearers of the WUA as a representatives of canal administration.

8.4.19 Under clause 3 of the Maharashtra Irrigation Act (1976), there is a provision to notify in the Government Gazette lands in command area of the canal. Under clause 46 (3) the following provision is made:-

"Notwithstanding anything contained in sub section (2), there shall be levied on all those holders or occupiers of land within the irrigable command of a canal (not being lands irrigated on wells within irrigable command) who do not avail of the facility of water supply during *kharif* and *rabi* seasons (being seasons determined as such by an order of the State Government) from such canal at water rate equal to fifty percent,' of the seasonal water rate applicable and in force in that season." But if water is not made available in spite of demand so extended then such water charges cannot be levied. According to this provision, on those projects where water is not being fully utilised, it is necessary to levy 50% of the seasonal water charges and recover the same from those beneficiaries in the command of the project who do not take water for irrigation. For this purpose, it is necessary to notify the command area of the project under clause 3. But on many projects notification under clause 3 has not been issued and 50% charges under clause 46 mentioned above are also not being levied. The Accountant General, Maharashtra State has raised this issue in his inspection report and has taken objection that there is a loss of Government revenue.

8.5 Changes Required in the Irrigation Act

8.5.1 On 1 st January 1977, the Maharashtra Irrigation Act, 1976 came into effect in the State. It is the first irrigation act after the formation of Maharashtra State. Under the Reorganisation of States on lingual basis, different parts of different states - some parts of the States of Bombay, Hyderabad and Vidarbha from the Central Provinces were amalgamated and the Maharashtra State came into being on 1st May, 1960. The irrigation acts applicable before independence to the merged component parts were as follows:

1. Bombay Irrigation Act, 1879 (for the Bombay State)
2. Central Provinces Irrigation Act, 931 (for Vidarbha)
3. Hyderabad Irrigation Act-1357, Fasali (1948 A.D.) (for Marathwada)
4. Central Provinces and Berar Water Regulation Act, 1949 (for Vidarbha)
5. Hyderabad Irrigation (Betterment Contribution and Inclusion Fees) Act, 1952.

The last two acts belong to post-independence period.

8.5.2 As it was desirable to amend and unify the aforementioned acts which were in existence in Maharashtra State in relation to irrigation, the Maharashtra Irrigation Act, 1976 was passed. The main purpose of this Act is limited to levying water charges on the lands in command area (In Marathi rendition of the Irrigation Act, the word command area is translated as *jalpraday kshetra*. Instead, the word *labhakshetra* is proper in translation and is as such established in Marathi.) and to make pertinent provisions regarding the same. This is clear from the preamble of the Act and the provisions contained in the Act itself.[4]

8.5.3 Even though the Irrigation Act which is in existence today was drafted in the post-independence period, it is mainly an integration of the acts framed in the British period and reflects the pro-authority attitude of the British period. The main purpose of the British rulers in framing acts and rules was of continuing their sovereignty

4. Preamble to the Maharashtra Irrigation Act, 1976, English Edition: P-9627 of the Maharashtra Gazette, 1975, Part V, Extraordinary; pp. 71-129.

and maintenance of law and order. Participation of Indian citizens or community-oriented development of different available resources in India was not their purpose. In this Act, there are no provisions for improving water use efficiency or for an overall increase in agricultural production.

8.5.4 As the policy of the Britishers was to keep all the administrative powers centralised, this is reflected in the contemporary acts as to how the beneficiaries (farmers) will remain completely dependent on the Government and how they will be controlled by the administration. The beneficiaries were not given self-evident responsibilities or pertinent powers in irrigation management. As a result, during the past 4-5 generations, the tendency of beneficiaries of depending on the Government in matters relating to irrigation increased. This nurtured psychology of the beneficiaries that Government to look after all works of irrigation management and projects belong to the Government and they have no stakes therein. That is why bad practices also took root like that of poorly maintaining field channels, entailing wastage of water and allowing gates of outlets not to remain in place. It is absolutely essential to change the psychology of beneficiaries to relying on the Government. It is not going to change merely by enacting legislation. Movement of mass awareness will also be required to be undertaken. None the less, the foundations of the new pro-people set-ups can be laid by making provision in the Act ensuring participation of beneficiaries in irrigation management by conferring on them suitable powers appertaining to such management. A clear recommendation has been made in the National Water Policy, 1987 (clause 12) to this effect.

8.5.5 Before the formation of Maharashtra State, in the drought prone areas of Bombay State, an irrigation system with an irrigation area of 350000 hectares built by the British rulers had already been in existence.[5] No as large as that much area under irrigation had there been in the remaining part of Maharashtra. Therefore there was obviously a tremendous influence of the Bombay Irrigation Act, 1879 enacted for this irrigation system on the irrigation management in Maharashtra and also on newly enacted Irrigation Act of 1976.

Provisions in the Maharashtra Irrigation Act, 1976

8.5.6 Even though the formal nomenclature bf this Act is Irrigation Act, it is limited to a system of supply of irrigation water from canals only. No consideration of irrigation through lift arrangement, irrigation from groundwater, irrigation on percolation tanks, irrigation being catered through sources like drip and sprinkler irrigation or irrigation by other methods cats be found therein. Therefore, in the hierarchical set-up also the term canal officer continues in the Act of 1976. The concept of irrigation officer has not forthcome.

Changes Called for in the Irrigation Act

8.5.7 The Commission had invited thinkers, knowledgeable people, social institutions related to water, experienced persons, subject experts and experienced officers from the Irrigation Department in Maharashtra to express their views on the changes called for in the existing Irrigation Act to improve the efficiency of irrigation management. On the basis of analysis of the response received to the Commission's Appeal, 'Sinchan *Sahayog,* Dhule' - a voluntary organisation came out with a draft on the amendments to the Irrigation Act. While making suggestions about amendments to the existing Irrigation Act, the Commission has made use of this draft and also

5. Technical Paper No. 49 on The Development of Irrigation in Deccan Areas by C.C. Inglis and V K. Gokhale.

critical views which were presented in a workshop held at Aurangabad regarding changes in the acts for legal implementation of participatory irrigation management.

8.5.8 Hereafter as water is to be distributed to the landholders through WUAs, the concept of canal officer in the existing Act has to be changed to make the relevant provisions in the Act applicable to WUAs. Nevertheless, to ensure a proper distribution of water, it will be desirable to include in clear terms the concept of a specified command area in to the new act even and to continue the system of notifying the proper command area. Otherwise water distribution will be beset with more, disorderliness. At present, there is an inordinate delay in notifying command area. As the Government has assumed the work of executing land development works in command areas and because of some shortcomings remained therein causing delays, a view is being taken that it is not desirable to notify the area unless these works are completed. It is not proper. At many places commands have not been notified even though actual irrigation started more than 20 years beck. Instead of linking the process of notification of command area with land development works, it will be desirable to notify the overall area as soon as the distribution network is completed and to make a separate provision for excluding some areas if that is to be executed owing to some difficulties. Then only there will be a clear geographical demarcation for the WUA of land holders in notified areas.

8.5.9 One of the important provisions in the Irrigation Act is about the assessment for area sanctioned but water not taken, i.e., *'Pokal Akarni'*. Accordingly when water is not used in spite of its being available, there is a provision to make assessment at 50% of the rate from the concerned land holder. The WUA will also have to face a similar situation and therefore it is desirable that this provision continues to be applicable to their members. In the case of wells, however, as the conjunctive use of canal water and groundwater has to be promoted hereafter, the provisions related to non-mixing of canal and well irrigation will have to be deleted. The responsibility of keeping accounts of the number of wells and lifting of water that takes place therefrom will have to be entrusted to WUA so that irrigation that takes pixie from that source will get a lawful and authorised status.

8.5.10 As in the case of wells in command, integrated development and regulation of water flowing in rivers and *nallas* in command is also necessary so that there will be a proper development of entire water in command and the irrigation intensity can increase. With a view to provide encouragement to this process, it is desirable to vest with the WUAs the powers of storage and use of water from streams / *nallas* in the area of their jurisdiction. A provision in the agreement will have, however, to be made that a consolidated account of all such wells and *nallas*/streams brought into use is be presented in the annual report of the association.

Even though there is a provision in the existing Act to issue notification about streams/*nallas* as above, the Irrigation Department has issued orders for notifying only those rivers/streams concerned with major and medium projects at present. (Irrigation Department Circular No. MLA 1078/11422/10680 IMG dated 4.8.1978). In pursuance to the circular dated 4.8.1978 instructions have been issued not to issue notification of rivers/streams where minor irrigation projects have been constructed. In fact, the instructions regarding regulation of storage of water and recovery of water charges on minor irrigation projects are inconsistent with such provisions in the Act. In any case it is not desirable to deprive the WUAs on minor irrigation projects from integrated use of canal water, groundwater and water from *nallas*/ streams. Therefore, it is necessary that there should be only one type of provision for all kinds of projects.

8.5.11 The provision of supply of water is effected under the Irrigation Act in the following four ways:

1. On application (clauses 57 to 59).
2. On volumetric basis subject to formation of water committees and irrigation management to be accomplished through the committees as provided in clause 60.
3. Under irrigation agreements (clauses 61 to 71).
4. Water supplied under a scheme (clause 72 to 74).

Out of these four ways, water supply on volumetric basis but practising irrigation management through a water committee is a very important provision in the existing Act of 1976. The principle of involving the beneficiaries in irrigation management has been accepted in this provision. In fact, the concept of handing over irrigation management to the beneficiaries and supplying water on volumetric basis has already been advocated in principle right from the First National Irrigation Commission (1901). In addition, the recommendation of various irrigation commissions/committee formed from time to time in relation to irrigation have also one theme in common, viz., there should be participation of beneficiaries in irrigation management. For example, the Royal Agricultural Commission, 1928 had suggested the formation of irrigation *panchayats* for water distribution on a cooperative principle. The Sir Visvesvaraya Inquiry Committee, of 1938 had suggested that the work of water distribution should be entrusted to the cooperative societies of beneficiaries or water *panchayats* duly formed for this purpose and water be supplied in a measured quantum, if possible. The Barve Commission of 1962 had also recommended that cooperative societies of beneficiaries be formed and irrigation management entrusted to them. They had also mentioned that it should be binding on every beneficiary to become a member of the cooperative societies. The National Irrigation Commission of 1972 has attested importance to, formation of cooperative societies for accomplishing irrigation management and suggested that the states should enact necessary acts for the same.

8.5.12 The Government in Irrigation Department has, in principle, accepted the recommendation of the Barve Commission that cooperative WUAs should be formed and irrigation management be entrusted to them. But this is not reflected in the subsequent actions of the Department or in the new Act of 1976. Consequently, the rules for formation of WUAs have presently been made on the basis of clause 60 only Incorporation of clear provisions in the Irrigation Act as to the formation of WUAs and vesting with them the powers of canal Officer pertaining to irrigation management as also the concessions extended to WUAs, freedom of crops, concessional water charges, freedom of conjunctive use of canal and groundwater on irrigated farm, grants for accomplishing irrigation management etc, is called for. Expansion of WUAs in Maharashtra cannot take place in a proper manner merely involving the clause 60. Core of the exiting Act is still officer-oriented management which is required to be changed by making a fundamental change in the orientation and to make it clear that the entire management is a joint responsibility of the administration and WUAs.

Deficiencies in the Irrigation Act

8.5.13 Under clauses 72 to 74 of the existing Irrigation Act there is a provision for water supply under a scheme. There is a provision in these clauses for preparing and implementing a draft scheme of efficient water supply for those minor projects which possesses command of less than 200 hectares. It provides for the appointment of a committee of 5 members for executing water distribution upto a limited area of 200 hectares. This committee comprises four members nominated by the Government and the one concerned Sectional Officer. In this scheme of water supply, beneficiaries participate but members of the committee are appointed by the Government and are not elected by the beneficiaries.

8.5.14 Even in the composition of the canal advisory committees and other set-ups suggested through the important Government orders issued by the then Bombay State in 1947 there were Government-nominated representatives to some extent instead of those elected by the people. As it is difficult to apply specific criteria or norms to such appointments and as the Government is under pressure in the matter from different local quarters, truly speaking such committees cannot be representatives of the people. Therefore, whatever beneficiary representation is necessary for irrigation management, it will help matters hereafter if the representatives come through the WUAs. As the cooperative life style is well established at the rural level, care is required to be taken to see that objectives and influences other than irrigation do not cast their shadow on the irrigation system.

8.5.15 There is a provision in clause 55 (B) of the existing Irrigation Act to levy water charges not exceeding 50% of charges being levied on flow irrigation on area irrigated from a well which is within 35 metre of the nearest boundary of canal but lies within the command. In fact, according to Part (I) clause 2 (3), the scope of the word 'canal' is quite broad. That is why many wells in command area come within the limit of 35 metre. In any case, the figure of 35 metre is not arrived at by any definite mathematical computation and as the groundwater recharge in command area is invariably taking place everywhere, it is desirable to treat all wells in the command on equal footing. The limit of 35 metre distance should be made applicable only to those wells dug on the rising ground outside the command area. Even after handing over the irrigation management to WUAs, as it will also be necessary for them to regulate water taken from Wells and recover water charges thereof, it will be desirable to bring more clarity in this rule of the Act as explained above.

8.5.16 There is no clarity in the existing Irrigation Act as to who is the owner of irrigation tanks, who has the right on water in tanks, who tests from time to time quality of water in the tanks, who monitors the same, how water distribution be achieved equitably and so forth. The Act is silent speak also about the lands in vicinity of the tank banks and *galper* cultivation. Rather, the overall framework of the Act is failed to be mainly influenced by only needs of the system of canals directly off-taking from the weirs and which had been in existence around 1879 before the advent of reservoir creation period. The sense of regulation of 'irrigation projects' is not discernible through the provisions of the Act. From this point of view, reframing of the Act and bringing out a new act into operation immediately is called for.

8.5.17 Under clause 131 of the Irrigation Act, old rules can be continued to be applicable if they are not inconsistent with the new Act. Since the new Act came into force, the Government, from time to time, have however issued various progressive orders on irrigation management which are entirely contrary to the provisions contained in the Act. For example, in 1988 the Government issued the Draft. Agreement to be made for handing over irrigation management to WUAs. Also in 1990, according to the Government Circular of 1.11.1990 certain principles have been notified regarding the appointment of managing committees/outlet committees on selected minor irrigation projects. According to these directives concessions have been extended on issues like freedom of cropping pattern, recovery of irrigation charges, conjunctive use of canal and groundwater on irrigated farm being legal etc. whereas the same are not legally valid under the Irrigation Act. Therefore, to get a strong support for enforcement of the progressive orders, it is necessary to amend the Irrigation Act forthwith.

8.5.18 The Central Government looked into this matter and with a view to lend a legal form to the participatory irrigation management has got drafted amendments to the irrigation acts so framed from 'SOPPECOM'- an experienced institution- and issued the same in 1998 for the guidance of the states. Barring a few, most of the provisions, can be made applicable to Maharashtra.

8.5.19 The SOPPECOM has come out with a concept which embodies that one confederation of water users' federation on distributaries/ branch canals be constituted at regional level. This regional level confederation will receive water in measured quantum from the canal officers like that of water users' federation and will get it distributed amongst the component water users' federations. Such type of broad experiment of people-oriented management is not conducted earlier. This broad change will have to be brought into effect step by step. Therefore, the management be entrusted the field level founding WUAs firstly.

For the present, the federation representing WUAs in the command area of a canal or irrigation project/confederation will function as a canal advisory committee. The works like undertaking repairs expected to be carried out by the Irrigation Department at canal/project level accomplishing annual, seasonwise planning of canal/project water etc. should be performed by the joint committee of federation of WUAs/confederation and Government officer by duly taking decisions.

8.5.20 It is our recommendation that with a view to achieve economical water use and accrue an optimum agricultural production therefrom, it be made obligatory on all irrigation projects to supply water in measured quantum and to entrust the same to the WUAs of beneficiaries for irrigation management. For this, formation of WUA of beneficiaries in the command will be obligatory. But for that, it will be necessary to make an evaluation of the carrying capacity of the conveyance system on all irrigation projects and to install forthwith measuring devices on the canal system wherever required. Unless this is provided for the canal system cannot be handed over to WUAs for irrigation management and for this, the Government will inevitably require some time. A period of 10 years is sufficient for this. Accordingly the Government should announce that by the year 2010 participatory irrigation management will be the only system that will be practised in commands of all irrigation projects and inspection & repair works of the systems of all projects be planned accordingly. It calls for incorporating the provisions in the new Irrigation Act of progressively switching over from the prevailing management practice to the new system by the year 2010.

8.5.21 As stated in Para 8.5.20 land holders holding land not less than 51 % of the . command of the canal or not less than 51% of the land holders in the command can form a WUA. Besides irrigation management, WUA can take up such work as are in the interest of the members of the association and complimentary to irrigation and agriculture so that the water use of canal will be optimum. For example, drip and sprinkler irrigation methods, construction of farm ponds, small tanks, nalla bunding, check dams, underground bandharas, groundwater use, procurement & distribution of improved seeds, fertilizers & pesticides, marketing & processing of agricultural produce, etc. It is necessary to have a provision in the bye-laws of the association to take up such works.

Even inclusion of the following objectives in the same are WUAs will the useful: publications and audio-visual aids relating to irrigation and agriculture (which will be useful to the members for guidance in irrigation and agriculture), permission to incur expenditure on training of beneficiaries in irrigation management and crop technology.

8.5.22 It is essential to make it biding on the canal administration / canal officer to extend guarantee to the command of supply of water in commensurate with the applicable quota (guarantee offered by canal officer as to how much water will be supplied in years 'other than an average year' at a certain point of canal specified in the joint agreement) in any irrigation year. In an average year there will be no difference between the applicable quota and sanctioned quota. However, irrigation administration is required to make rules as to how applicable quota will be decided in the deficit and surplus years. There should be a provision in the Act that the applicable quota of water be guaranteed to be delivered in a specified period and at a specified discharge.

8.5.23 It will be the responsibility of the WUAs to supply water equitably to all land holders/cultivators in the jurisdiction of the association whether they are members of it or otherwise. The Act should place an obligation that the WUA should not make any distinction between members and non-members in distributing water equitably.

Other Provisions in the Act Relating to WUAs

8.5.24 Land holders/cultivators in the jurisdiction of WUAs will enjoy the freedom of growing any crop on their land, this freedom of cropping will however be within the limit of water supply, i.e., in commensurate with the applicable -quota. It is necessary to ascertain that no other clause in the Irrigation Act pertinent to cropping pattern will affect this right.

8.5.25 If reuse of water once used for irrigation by pumping or other means by WUA and land holders/cultivators in the area of the WUA is likely to adversely effect the environment, then such type of reuse of water will not be permitted to them. The WUA will not be required to pay any extra charge to the irrigation administration for entailing such a reuse. Also, the WUA should have the freedom of using groundwater in command for agriculture. The irrigation administration should not recover any charges for the same.

8.5.26 The WUA will enjoy the right to recover from the members such water charges as are approved by their general body. Also, the association should have authority to recover from non-members at the rates in excess of rates applicable to its members. There should, however, be a provision in the Act that the irrigation administration should have the authority to stipulate the maximum rates be made applicable to the non-members. While deciding the irrigation charges to be recovered from the members, the WUA will take into consideration the water requirement. of crop, cost of irrigation management and the net income from the crop. While considering the use of groundwater, the WUA will take into consideration water percolating from the canal and the associations will have the right to recover irrigation charges on account of use of such water.

8.5.27 If the WUAs desire, they can carry out the repairs/rehabilitation/renovation of the canal system to be handed over to them. The amount required for carrying out such repairs will be transferred to the associations by the canal officer.

8.5.28 Water received by the WUA will be distributed amongst the landholders/cultivators extending demand for water in accordance with the guidelines laid down by the irrigation administration for effecting equitable distribution. The WUA will not have the right to sell water to any person other than land holders/cultivators in the command. Also, water cannot be used for any purpose other than irrigation. If the WUA wants to use water for any purpose other than irrigation, it will be necessary for the association to take appropriate permission from the irrigation administration.

8.5.29 It will be necessary for the WUA to send before the prescribed date the annual accounts duly audited to the irrigation administration. It will also-be obligatory for the WUA to send their statement of assets and liabilities to the irrigation administration before 31st March.

8.5.30 The WUAs will incorporate in their annual reports the information prescribed by the irrigation administration as to how much area, to which crops and to how many beneficiaries water was supplied in each irrigation season in command, also the groundwater table therein, etc.

8.6 Legal Support for Comprehensive Water Resources Management

8.6.1 At present there is no separate act for the integrated management of water. At national level, the National Water Council (of which Chief Ministers of states are members) chaired by the Prime Minister framed the National Water Policy and placed it before the. Parliament and circulated all over the country. The procedure that was adopted was different from the formal constitutional procedure of legislation. Even for the Indian Standards, the Bureau of Indian Standards has adopted the procedure of issuing the standards prepared through the medium of experts on the various subject committees of the Bureau. Therefore, it is not that the provisions will carry prestige only after they pass through the formal process in the legislative assembly. But it is necessary that such processes should at least have the necessary legal support. Looking to the various complexities in an integrated use of water, it is felt that instead of compiling powers and responsibilities appertaining to the detailed actions in the form of a formal act, it will be more useful to draft and circulate a water management code through the media of the standing Maharashtra Jal Aayog and Maharashtra Jal Pradhikaran as suggested further in Chapter 13. The help of experts and scholars required therefor may be taken in the process.

8.6.2 Contemplating the act relating to irrigation practiced so far has been limited to the extent of controlled water being supplied through canal only However, if the total water use is viewed, that entailed through lift from the reservoirs, withdrawal from wells is coming on par with the use envisaged through canal. It is, therefore, desirable that even from are point, of view of agriculture the. Irrigation Act should not be limited to water supplied through canal but it be made to include all sources of irrigation like lift from wells and reservoirs and lifts from canals. Accordingly the objectives of the Act should be defined to embrace these broad objectives.

8.6.3 In the National Water Policy, water has been considered as a national wealth. The quantum of and the procedure for its allocation for various purposes will have to be decided upon in accordance with the needs and availability of water on the field. Therefore, whether at the national level or at the state level, it is not possible to frame a simple straight act pertaining to such kind of water use Besides, water is not an immovable stationary entity unlike land. It is a movable entity which changes from season to season and from year to year. On the premise of such a movable in entity, it is therefore difficult to formulate rights of holding and ownership as in the case of land or any other immovable entity. Therefore the water management code can be limited only to defining the principles as to how and who can participate in utilising water.

Detailed action thereafter can only be taken by the sub-basinwise planning regulation committee in accordance with the rules that may be laid down for sub-basinwise planning and regulation. It will be desirable that these committees are vested with such powers by an act. The immediate need for such committees is not being felt presently in all the basins as the scarcity of water does not exist uniformly in different basins. There can be a provision in the Act itself that the sub-basinwise planning and regulation act can progressively be made applicable to sub-basins.

8.6.4 Both from the scientific and practical point of view, planning of groundwater is a very complex issue. As it is very difficult to estimate and measure all the different aspects of water flowing underground - direction, movement and extent - it has not so far been possible to make clear legal provisions relating thereto. Water is not a stationary inert mineral unlike other minerals, and as it is immovable, ever-changing and invisible entity lying underground, its regulation is also difficult. It is, therefore, difficult to frame a meticulous act relating to it. Accordingly what is possible by an act in this context, is to treat water as a common property owned by a community in a specific area and to vest with this community powers (of accomplishing its planning and regulation) to be used according to the exigency of the situation. From this point of view, a mini watershed area is a very useful natural unit for planning of groundwater. Therefore as is to be followed in case of conferring powers on sub-basinwise planning and regulation committees, similar powers of groundwater planning and regulation be conferred on the watershed committee by constituting the same thereunder. The secretary of the committee being an officer from the Groundwater Department and chairman being officer of Water Resources Division who is responsible for keeping an overall account of water so that other associated issues of recharge, water use and percolation relating to groundwater can be left to this committee. As such, provision will have to be made in the Act for conferring planning and regulation powers on the committees of scientists and technologists in the first instance whether it is a sub-basin or a watershed.

8.6.5 Once water is treated as a common property it is necessary that detailed information of the subject becomes easily available to all concerned. Conflicts and misunderstanding have been given rise through that today as that kind of information does not become easily available to the society. In the act proposed in this connection responsibility should therefore be put on the concerned committee and the watershed committee for publishing a exhaustive annual report of water that would be available and its use entailed in the concerned sub-basin or watershed. Arrangements should be so made that this report available to anybody at a reasonable price like any other Government publication. Similarly the committee will have to shoulder the responsibility of disseminating information of water availability to the people from time to time through media.

8.6.6 Regulation cannot fulfill the demands of all in its entirety. It is possible that some of them will feel that injustice has been inflicted on them. It appears necessary to have a judicial tribunal to give a hearing to them regarding their grievances and to examine whether their needs have really been passed over. In countries like Spain there are local irrigation tribunals for considering such complaints, misuse and crimes relating to irrigation all such field complaints are openly heard on the field and decisions are given then and there only. As distribution of water is dynamic in nature if a considerable delay in decision is caused, the common man is more often deprived of true justice if his grievances are redressed outright. It is, therefore, desirable to form sub-basinwise (or sub-basin group - specific) independent Water tribunals, for registering complaints in this regard and for correcting any mistakes, if any, in water distribution, after examining the same. They can be vented with powers for receiving writ petitions and giving decisions thereon in respect of all matters arising in relation to the Irrigation Act, Ground Water Act, Watershed Development Act and Sub-basinwise Planning and Regulation Act.

Such three member tribunal can comprise a District Judge and two technical experts namely one expert on Irrigation or Agriculture and another on Hydrology or Ground water.

8.6.7 Thus in the new legal set-up at the apex there will be Maharashtra *Jal Pradhikaran* and the Maharashtra *Jal Aayog* and there below the that sub-basinwise water planning and regulation committees followed furtherbelow waterwhed-wise committees and water tribunals for removing shortcomings in the Irrigation Act and other water management practices. It appears that such a set-up will meet the needs of the time to come. Mainly WUAs will hereafter look after the management of canal system. The proposed act will have to provide for permission to these associations or irrigation administration to present their case before the proposed tribunal especially if there are any disputes regarding agreements arising out of changes in the seasonwise distribution of water because of the changed availability of water.

8.6.8 If any dispute arises about use of urban and industrial water, it will be proper that such a dispute is resolved by a tribunal so long as it is related to the use and distribution of water. However, as there is an independent act regarding pollution and as there is an independent system for the same, it does not appear necessary for the tribunal to resolve such issues.

Chapter - 8
Irrigation Act & Rules
List of Annexes

Annex: 8.1.1

Classification of Agricultural Land & No. of Land Holders According to the Land Holding (General Class) - (1990-91)

Area: ha.

Sr. No.	Division	Marginal Less than 1 ha.		Small 1 to 1.99 ha.		Semi Medium 2 to 3.99 ha.		Medium 4 to 9.99 ha		Large More than 10 ha.		Total Landholders		Average Area of Land-holding
		Nos.	Area	Nos.	Area	Nos.	Area	Nos.	Area	Nos.	Area	Nos.	Area	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1	Konkan Division (Mumbai, Dhule, Raigad, Ratnagiri and Sindhudurg Districts)	582137 56.09%	214809 11.22%	187405 18.06%	269872 14.10%	144774 13.95%	407781 21.30%	99024 9.54%	597838 31.23%	24541 2.36%	423819 22.14%	1037881 100.00%	1914119 100.00%	1.84
2	Nashik Division (Nashik, Dhule and Jalgaon Districts)	278605 25.92%	160242 6.15%	351967 32.75%	515588 19.78%	274574 25.55%	760636 29.19%	151088 14.06%	883868 33.91%	18582 . 1.73%	285864 10.97%	1074816 100.00%	2606198 100.00%.	2.42
3	Pune Division (Ahmadnagar, Pune, and Solapur Districts)	515869 32.83%	266174 7.20%	444190 28.27%	649720 17.57%	376455 23.96%	1042311 28.18%	198186 12.61%	1168102 31.58%	36428 2.32%	572336 15.47%	1571128 100.00%	3698643 100.00%	2.35
4	Kolhapur Division (Satara, Sangli and Kolhapur Districts)	832589 57.74%	341316 16.82%	317771 22.04%	454915 22.42%	196476 13.63%	540932 26.66%	82848 5.75%	479738 23.65%	12183 0.84%	211778 10.44%	1441867 100.00%	2028679 100.00%	1.41
5	Aurangabad Division (Aurangabad, Jalna and Beed Districts)	273524 26.78%	159153 6.91%	344783 33.76%	505719 21.95%	261283 25.58%	717624 31.15%	128858 12.62%	741785 32.20%	12818 1.26%	179363 7.79%	1021266 100.00%	2303644 100.00%	2.26
6	Latur Division (Parbhani, Nanded, Osmanabad and Latur Districts)	268809 22.05%	165738 5.42%	400126 32.83%	586565 19.17%	340670 27.95%	945178 30.88%	190338 15.61%	1099940 35.94%	19001 1.56%	263108 8.60%	1218944 100.00%	3060529 100.00%	2.51
7	Amaravati Division (Buldhana, Akola, Amaravati and Yavatmal Districts)	197796 17.44%	134928 4.26%	395680 34.89%	578251 18.25%	312174 27.53%	859641 27.13%	196946 17.37%	1165293 36.77%	31392 2.77%	431013 13.60%	1133988 100.00%	3169126 100.00%	2.79
8	Nagpur Division (Wardha, Nagpur, Bhandara, Chandrapur and Gadchiroli Districts)	325432 33.55%	175257 8.17%	285665 29.45%	422636 19.71%	219438 22.63%	605646 28.25%	123688 12.75%	719861 33.58%	15668 1.62%	220497 10.28%	969891 100.00%	2143897 100.00%	2.21
	Maharashtra	3274761 34.58%	1617617 7.73%	2727587 28.80%	3983266 19.04%	2125844 22.45%	5879749 28.10%	1170976 12.37%	6856425 32.77%	170613 1.80%	2587778 1237%	9469781 100.00%	20924835 100.00%	2.21

Reference Paragraph: 8.1.15.

Annex: 8.1.2
Planned Water Use of Irrigation Projects

Water Use : Mm^3
Projected Irrigable Area : ha.
Water Use per ha.: m^3
Water Use at Property head.% m^3/ha

Sr. No.	Name of Project	Projected Water Use	Projected Irrigated Area	Water Use per ha.	Water Use at Property Head (Project Efficiency 45%)	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Major Project					Cropping pattern consists of perennial crops.
1	Bhima (Ujjani)	2197.32	182683	12026	5412	
2	Manar	243.322	23310	10438	4697	
3	Lower Terna	158.553	15587	10172	4577	
4	Pench project	965.640	104476	9242	4159	
	Medium Project					
5	Hinganipangaon	45.310	5625	8051	3525	
6	Sina Nimgaon	67.960	6270	10839	4878	
7	Lahuki	7.049	992	7106	3198	
8	Upper Dudhana	26.051	3400	7662	3447	

Inference: It is seen from the above information that the planned rate of water use per ha of irrigated area for a cropping pattern consisting of perennial crops (2 to 5%) is not far more than 3000 m^3/ha.
Reference Paragraph: 8.1.15

CHAPTER 9
FINANCIAL ASPECTS

The proportion of workers engaged in agricultural sector is about 60 per cent in the State of Maharashtra (cultivators 33 per cent, agricultural labourers 27 per cent). Taking into consideration cultivator and agricultural labourers together, the per capita State income from agriculture & allied sectors for the year 1996-97 was Rs. 12781[1] The proportion of workers working in secondary and tertiary sectors works out to 16 per cent and 22 per cent respectively; but their per capita State income is about 6.50 to 6.75 times that of agriculture and allied sectors. In order to improve the economic status of the State it is necessary to increase the income from agriculture and allied sectors; and for this purpose there is a need to increase agricultural production.

Irrigation is one of the major factors for increasing the level of agricultural production and this can be achieved by extending flow irrigation or well irrigation facilities to the maximum number of farmers. In the State, facility of flow irrigation is provided by the Government through irrigation projects only and wells are acquired by farmers on their own.

Financial aspects from that count include the capital already invested in irrigation projects and that required to be invested in future, fund raising, returns to be accrued from irrigation projects, operation and maintenance costs, determination of water charges that would be adequate to cover these costs and recovery thereof. AIongwith this, aspects such as additional sources of income from reservoirs, the possibility of privatisation of irrigation projects, etc., will also have to be considered. While undertaking this consideration, firstly

1. Economic Survey of Maharashtra, 1997-98.

it is necessary at the beginning to review and estimate the ultimate irrigation potential of the State.

9.1 Ultimate Irrigation Potential

9.1.1 (1) The common citizen understands Irrigation potential' as the total agricultural area likely to be benefited by irrigation. However, because of the methodology of measurement of crops and related irrigation area during the British period, irrigation potential was considered as annual average area under crops. Under this method seasonal, two-seasonal and perennial crops area is measured only once in a year The aggregate of these three is reported as 'irrigation potential'. The total of these three more often exceeds the area of land under irrigation because if on the same area of land seasonal/two-seasonal crops are taken one after other, the area of land remains constant, area under crops being measured twice the gross area exceeds at under irrigated land.

As per the current practice of estimating the irrigation potential, one hectare of *bajra* in *kharif* season which requires only supplementary water and one hectare of perennial crop like sugarcane which entirely depends on irrigation water, are considered equal for the measurement of irrigation potential and are added together: This method of aggregation does 7 not appear to be correct for assessing irrigation potential.

(2) Land area which gets benefit of irrigation depends on total availability of water, Management skill, distribution system, selection r of crops, irrigation method and climatic condition, etc. Out of all these, variation in any one of the factor would lead to a change in the probable irrigated crop area It means that as per the current practice, irrigation potential would automatically vary.

Having considered the scenario in Maharashtra, the Commission thinks that wherever the irrigation facility is made available for taking at least two crops - *rabi* & *kharif* - such area would be termed as 'irrigation potential'. On the basis of this new concept, sub-basin wise review of ultimate potential be taken. For estimating the irrigation potential, the Commission has considered the basis of two-seasonal crops (*kharif* and *rabi*) as in Konkan or Vidarbh Regions of the State receiving ample rains, the perennial crops have not yet been stabilised. No encouragement should be given for perennial crops whenever the availability of natural water in a basin is less than 10000 m^3 per ha, and wherever the availability of water is more than 10000 m^3 per ha, only there perennial crops be encouraged. Wainganga Basin is favourable for growing sugarcane. Konkan Region is more so for banana. The recommended crops need natural hospitable conditions. In drought prone area of Western Maharashtra the growth of area under sugarcane has increased not because of natural hospitable condition but it is attributed to social and economic factor. In which basins to encourage perennial crops should be determined on the per hectare natural availability of water (Statement 9.1.1).

(3) In the context of irrigation projects, gross area of a project means total broad geographical, area of the irrigation system complex of the proposed irrigation project. This includes area from canal to the river bed and the area up to which water supply is possible through canal from the dam. In the same manner, it includes the area designed to be irrigated by lift irrigation system either from reservoir or from canal. It doesn't mean that irrigation water is to be provided for the entire land. For example, it cover area under roads, fallow land by the side of the roads, arid land, area of gaothan and other uses. Therefore instead of calling it as total area, it would be appropriate to call it broad geographical area of an irrigation project. In this Report, references are made in that sense and in the same manner. Gross

irrigable area means area which can come under irrigation out of the total area The area which is naturally unsuitable for irrigation be excluded therefrom.

(4) Gross command area means out of the total geographical area of the project the area of land to which irrigation water can be supplied by the existing irrigation system. Such area also includes agricultural and non- agricultural land. However, this excludes hilly areas where water cannot be reached, but it does not exclude non-agricultural area. Out of this gross command area the land which is suitable for cultivation is called culturable command area. Initially the development of irrigation system has been through flow canal, and therefore gross command area was related to the land which was getting water by virtue of its slope. That is how the concept of gross command area became prevalent. Now it is possible to accomplish irrigation with the lift through a public system or each farmer individually can, lift water from flow canals and therefore it seems desirable that the usage '*labhakshetra*' be brought into practice instead of the '*samadesh kshetra*' in Marathi (Translator's Note: *In English for both labhakshetra and samadesh khshetra the equivalent is 'command' and serves the purpose.*) Moreover, the former term is comprehensive in meaning. All area which accrues benefit not merely of irrigation but also the overall one of availability itself appear to be appropriately recgonised as *'labhakshetra'* as such Hence in this Report the term labhakshetra is invariably used in Marathi version.

(5) Out of the culturable command area, only that much geographically area for which irrigation is actually contemplated is called as culturable irrigable area It is exclusive of area which is unsuitable for irrigation on culturable area that is to be excluded from irrigation owing to paucity of water. While assessing irrigation potential this irrigable area is to be taken in to consideration. As only some part of total geographical area of command area or culturable area of projects is to be 'irrigated' in practice, the irrigable area usually comes to 80% of the culturable area and 50% of the total geographical area of the project From the point of view of development, however, both the command area and the project area goes on 'developing' and, therefore, the figure of developed area is considerable larger than that of irrigated area. This finer point needs to be kept in mind while looking at the statistics pertaining to irrigation area.

(6) All cultivable area is not supplied water in every season at full capacity. As per availability of water, the sequence of cultivation necessitated due to cropping pattern, etc., some land has to be kept fallow and hence actual seasonwise irrigated area is much less than the total irrigable land area 'Intensity of irrigation' of respective seasons is determined on the basis of the land area actually irrigated out of the total culturable command area. Summation of irrigation achieved in all the three seasons helps give an idea of annual irrigation intensity. Annual irrigation intensity is the simple index of measuring the extent of irrigation being achieved in command area. This includes land under cultivation as well as the proportion of irrigation water supplied. Therefore, 'annual irrigation intensity' brings home the real state of irrigation.

(9) In Panzra Basin of Dhule District the *Phad* system, has been in operation since long. The total irrigation area is usually divided into four equal *phads.* In one of them, there would be a provision for perennial, in another for two-seasonals, then in one for a single-seasonal and irrigation would be provided for the rest of the area only if additional water is available. In case of, scarcity of water it becomes necessary to keep the area of fourth or third *phad* fallow. Still, the whole area under irrigation system is measured as irrigated

area In general, taking into consideration perennial crops under the system of *phad*, annual irrigation intensity of canal comes to 1/4+(1/4x 2/3) +(1/4 x 1/3) + 0 = 50% only.

Assessment of Irrigation Potential

9.1.2 (11) For assessing irrigation potential of the State there are a number of factor which are necessary to be taken into account. Measurement of rainfall in various parts of the State, depends on how much infiltrates into soil, out of this how much reaches to wells, proportion of water which is not absorbed in the soil but flows away, out of the flowing water in different sub-basins how much water can be stored by constructing minor, medium and major dams, how much quantum of water can be utilised for irrigation and non irrigation purposes from water available in wells and reservoir, which crops are raised in irrigated area, what technique will be employed for supplying water to crops and so on.

As per the assessment made by the Barve Commission (Maharashtra State Irrigation Commission) in 1962, out of the available surface water 52 lakh hectares and from underground water 9 lakh hectares of land, thus totaling 61 lakh hectares of land could be brought under irrigation, it had appeared. At that time adequate statistics about rains, river discharges, information about aquiferwise geological formation was not extant. It was assumed that even though at 75 per cent dependability, 113268 Mm^3 (4000 billion ft^3) water was available in nature, hardly 56634 Mm^3 (2000 billion ft^3) water would be available for utilisation. In high rainfall region of Konkan, it was never thought that it would be necessary to provide different facilities for making water available for irrigation and that this would be technically possible. No survey of underground water resources had ever been conducted. On the basis of irrigation catered through wells and irrigation experience on borewells, probable land which would therefore come under irrigation was broadly estimated for forthcoming 20 years; The National Irrigation Commission[3] of 1972 had estimated that as far as Maharashtra is concerned, 50 lakh hectare of land would come under irrigation from surface water, 15 lakh hectare from groundwater and therefore totally 65 lakh hectare of area would come under irrigation.

(12) Subsequently in the year 1980, the World Bank[4] scrutinised some irrigation projects in Maharashtra for extending financial assistance, which provided new estimates of the area which can be brought under irrigation in the State from surface .Water. As per World Bank's revised estimates, 62 lakh hectares of area would generally come under the canal irrigation (49.57 lakh hectares of area from major & medium and 12.35 lakh hectares from small projects). During the same period, the Groundwater Surveys and Development. Agency published in 1973 its first report for Maharashtra opining that about 27 lakh hectares of land can be irrigated with the help of groundwater. This estimate was based on the inference as to how much rainwater infiltrates into the ground and how much return flow is induced in the command as a result of flow irrigation. The quantum of water that is going to be infiltrated into the ground had been assumed to be 20966 Mm^3. It was expected that total irrigation be 89 lakh hectares.

(13) The construction of a good number of minor, medium and major projects has been completed since then and the area under flow irrigation is increased. This has, therefore, caused an increase in the quantum of return flow generated in command area over and above the earlier estimation. Besides, works allowing water to

3. Report of the National Irrigation Commission, Ministry of Irrigation and Power, New Delhi, 1972.
4. Report of the High Power Committee, Irrigation Department, Government of Maharashtra, 1981.

percolate into ground by undertaking soil conservation, water conservation works in catchment area and by constructing percolation tanks have been started on a large scale. The Third report of the Groundwater Surveys and Development Agency pertaining to groundwater resources was made available in 1981. In that report it has been stated that annual groundwater recharge to the tune of 34996 Mm^3 takes place and on the basis of this, the Jain Committees[5] arrived at the conclusion that 36 lakh hectares area can be irrigated through groundwater. It was estimated that total 98 lakh hectare area can be brought under irrigation out of which 62 lakh through surface irrigation and 36 lakh through groundwater. But the Fifth Groundwater Estimation Report of 1990 is now published (Groundwater Surveys and Development Agency,[6] Pune). In that report, it was stated that though groundwater recharge that is taking place is 32187 Mm^3 the total area which can be brought under irrigation through 31545 m^3 groundwater, is 41 lakh hectares. (Statement 9.1.1). It was also stated in the report that, out of 8 lakh hectares would be irrigated through wells in the command area and the balance of 33 lakh hectares would be irrigated through the wells lying outside the command area In this approach, variations in potential of wells as per the location was not taken into consideration. This estimation is based on the average irrigation potential of the wells.

Revised Overview

9.1.4 (17) The average surface water availability from incident rainfall In Maharashtra, is 163820 Mm^3. In view of the interstate constraints on use owing to water allocations, 126387 Mm^3, water will be available for use Deducting water requirement on account of non irrigation uses, water that is available for irrigation would be 112568 Mm^3 (Statement 9.1,1).

The quantum of water available for irrigation varies in comparison with the area under cultivation. On the basis of botanical studies, if the additional irrigation requirement is calculated by deducting the availability of natural rainwater for *kharif* & *rabi* seasons, it in principle terms to be 4000 m^3 per ha to 5750 m^3 per ha in different basins (Statement 9.1.2). If availability of irrigation is less than this then planning of such basins should be basically undertaken as two-season basins. On the contrary, the scientific requirement of perennial crops comes to 11000 to 13500 m^3 per ha It means the basin in which average availability per ha is more than the requirement of two-seasonal crops, planning will have to be accomplish basically for, perennial for that basin. This is because, the basin in which per ha water availability is higher, some water remains available even after supplying water to *kharif* and *rabi* crops in that basin. To raise perennial crops on some area at such places will be desirable. Basins in which per ha availability of water is more than 12000 m^3, cultivation of perennial crops can be undertaken on a large scale. From this point of view, planning, of these basins will have to be undertaken basically for perennial crops and even after that if Some water remains surplus, then it can be said that these basins are in areal sense abundant and surplus water basins. In those basins, entailing water-intensive activities will have to be transferred.

(18) In the context of such a natural water availability and taking in to consideration per ha irrigation requirement of *kharif* and *rabi* two-seasonal crops in Basin Nos. 1 to 19 (barring Nos. 8 and 9) and similarly of perennial crops in Basin Nos. 20 to 25 and 8 & 9, generally 56 lakh ha irrigation potential will be created from the available water. Out of this, in Basin Nos. 1 to 19 (save 8 and 9) considerably large extent of land would be deprived of irrigation. In Basin Nos. 8 and 9, there is surplus water available after

5. Report of the High Power Committee, Irrigation Department, Government of Maharashtra, 1981.
6. Report o the Estimation Groundwater Resources and Irrigation Potential on Groundwater in the State, 1992.

meeting the water requirement of the *kharif* and *rabi* for the entire area under crops. On the other hand in Basin Nos. 20 to 25, surplus water would be available even after providing perennial irrigation for the entire area.

For this irrigation efficiency, in general, is assumed to be 42.5 per cent. While taking into account the revised assessment of irrigation potential, water requirement for non-irrigation uses by the year 2030 is excluded in the beginning. Of the remaining available water (from reservoir) generally 15 percent of water would be lost due to evaporation and rest of the water would be utilised for irrigation. As in future, roughly 25 percent of water in reservoirs is going to be used by way of lift irrigation (even presently water of Bhima and Jayakwadi Projects is being utilised by way of lift) the efficiency of lift irrigation would be 80 percent and as 75 percent water is going to be utilised by flow irrigation, its irrigation efficiency would be 40 percent. Actually how much water would be available for irrigation, and at the root zones would be clear from the following example:

Total available water for irrigation Water lost by evaporation	100 (-) 15
Net availability for irrigation 25% by way of modern irrigation	85 75%by way of flow irrigation
21.25 (80% irrigation efficiency) 17.00	63.75 (40% irrigation efficiency) 25.50
42.50	

Conclusion: Project irrigation efficiency 42.5%.

For *kharif* and *rabi* or for the perennial cropping, by considering the water requirement at the root zone (Statement 9.1.2) and water availability for irrigation in that basin area coming under irrigation through surface water is assessed. That itself is the ultimate irrigation potential.

(19) In the same manner, due to the net annual recharge taking place at the rate of 31546 Mm^3, 41 lakh hectares of *kharif* and *rabi* area can be irrigated with the help of groundwater. In this way irrigation benefit can be provided to total 97 lakh hectares of area out, of which 56 lakh hectares can be irrigated through surface water and 41 lakh hectares through groundwater. In view of the planning of Basin Nos. 20 to 25 and 9, it would be possible in principle to bring 18.18.1akh hectares of area (19 per cent) out of it under perennial irrigation. In a way, this is a broad limitation of ultimate irrigation area on the basis of natural availability. This is the combined limitation on irrigation which can be made available through the irrigation projects, private 1:ft schemes, groundwater and watershed are development. To utilise that much potential would depend on the topography, cropping pattern and on economic status of that basin. Basins which are recognised as two-seasonal, not necessarily give rise to a two-seasonal system s there. Instead, perennial system may evolve on a smaller area Even the annual irrigation intensity will not surpass the two seasons' irrigation and even it does, it may be reduced though to a smaller extent.

(19 A) Irrigation potential based on total water and total land in a basin falls short of the project wise planning of the Irrigation Department. I has, however, excluded the nominally exceptional support accruable to *kharif* crops. Therefore in practice, it is reasonable to accept this reduced figure. If every farmer could raise at least two seasonal crops ^W one of rain & other of *kharif*, then only that farm is going to be stabilised in the real sense as irrigated 'area. Only a single season crop can not be able to stabilise the farmers' economic condition. Once the *kharif* crop is taken by a beneficiary, for, rest of the eight months he has to search for job like landless labourer elsewhere The practice of agriculture will here-in-after have avoid this kind of seasonal farming.

Impact of Modern Irrigation System

9.1.5 (20) While measuring the irrigation requirement as discussed above, it is assumed that 4000 m^3 to 13500 m^3 water would be used on farms as per the traditional flow system. In Basin Nos. 1 to 19 (excluding 8 & 9) where there is scarcity of water, in future it would be appropriate to implement drip and sprinkler systems. With the help of this modern irrigation system, it is possible to save water in general upto 50 per Cent. This means, for two-seasonal cropping system, per hectare requirement of water would be reduced to 2400 m^3 to 6000 m^3 for perennial crops. At present, the area which is irrigated with the help of this modern irrigation system is just 1.68 lakh hectares. But this area has been increasing at a very fast rate. As per the present estimate, in the next 30 years drip irrigation system would be popular for the crops like banana, grapes, orange, sweet lime, lemon, coconut, sapota, pomegranate, papaya, cotton, sugarcane, chili, brinjal, etc., and the use of sprinkler irrigation system would be adopted in increasing proportion for crops like onion, groundnut, vegetables, flowers, etc. If we take into account the cropping pattern of various basins, then it appears desirable to employ drip and sprinkler systems on 35 to 45 lakh hectares of area during the next 30 years, Out of this, roughly 15 to 20 lakh hectares would be the area of wells outside the command area Out of this savings, if it is decided to take only perennial crops, then out of the saved water 10 to 12 lakh hectare of additional area can also definitely be brought under irrigation.

Reuse of Water Being Used for Non-irrigation Purposes

9.1.6 (21) Out of the present available water, ordinarily 15 per cent of it is used for non-irrigation (drinking, domestic; industrial uses). Planning will have to be undertaken in order to treat water which would be provided to urban areas and for industries. Schemes will have to be formulated which will entail reuse of water so treated for irrigation. For this purpose, the wastewater of cities and water used by the industries will have to be treated and brought near the, industrial centres where a 'small irrigation project' can be conceived and the treated water can be used for irrigation. At least 50% to 75% of water so used can again be systematically used for irrigation. At present, this kind of reuse of water is very limited. But with planned efforts, irrigation through reuse of water can possibly be increased. In this manner, by using water made available for non-irrigation uses, generally 3 lakh hectares area can independently come under irrigation.

Improvement in Flow Irrigation

9.1.7 (22) At present, *rabi* jowar, *kharif* jowar, *bajra*, pulses, rice, wheat, sunflower, groundnut are some of the seasonal principal crops which come under irrigation. For most of these crops water is provided at present by wild flooding method or by forming *phad*akis. There it considerable wastage of water in this system. It is possible to bring out changes in farm water management practices by arranging demonstrations and providing equipment like bund formers through the agricultural extension service. Even if 10 to 20 per cent of water is saved by that generally 6 to 8 lakh hectares additional area can be brought under irrigation in area where fare water delivery is being practiced by flow method.

(23) As such if all factors such as availability of land and water augmentation of groundwater, addition taking place because of watershed development, modern irrigation techniques and improvement in farm water management practices in various basins are taken into consideration, the ultimate irrigation potential of the State can possibly be increased up to 126 lakh hectares. In this, only availability of water / land and water use techniques have been considered. The economic aspect thereof is no longer taken

in to account. Due price escalation, irrigation water is going to be more costly, expenditure for providing water would also go up. Actually how much area would come under irrigation will therefore depend upon the proper intertwining of crop economics and the economics of processes thereon. Notwithstanding this, it will be desirable to keep in view this figure as an objective of overall planning for the forthcoming 30 years. The total irrigation potential in a sub-basin would be the sum total of the following factors a consolidated account of all of which be maintained.

A) Surface Water Lakh

1	Area under irrigation through surface storages (after deducting water required for non-irrigation uses)	56
2	Rainfed area benefited by irrigation through wells in project commands (as per the Fifth Groundwater Estimation Report)	8
3	Area under effluent irrigation through reuse (50% of water supply) of domestic and industrial wastewater (because of which 6 lakh ha irrigation area is being reduced)	3
4	Additional area that can possibly be brought under irrigation on account of 15 lakh ha proposed to be covered through modern irrigation methods out of the (aforementioned 56 + 8 + 3 = 67 lakh ha) irrigated area combinedly (broadly 33% of the 15 lakh ha area)	5
5	Additional area brought under irrigation through wells in commands benefited by flow irrigation (15% of the 52 lakh ha being irrigated through flow method)	8
6	Increasing irrigated area resulting from water saved on account of improved (developing land for receiving irrigation) irrigation practices (will be 10% of the area under flow irrigation method)	5
	Total (A)	85

B) Groundwater (beyond canal command)

1	Total area in Maharashtra brought under irrigation through groundwater is 41 lakh ha. (As per the Fifth Groundwater Estimation Report). The area being catered through groundwater will be 1 lakh ha from project command and 33 lakh ha from outside the command. (It is inference-based. Presently this statistics lacks corroboration from field observations. No method of precisely delineating the irrigation area catered through groundwater is yet to be established.)	
	a) Irrigation likely to be achieved through completing watershed development works (25% of 98 lakh ha area to be covered by watershed development activities).	24
	b) Groundwater-supported irrigation from area where watershed development works can not possibly be undertaken {12% of [308 -(56+64+12+98)]} (Paras 2.4.3 and 11.5.1).	9
2	Increase in irrigation as a result of saving (generally 33%) in water due to adoption of modern irrigation methods on 20 lakh ha irrigated area outside the command.	7
3	Increase in area on account of improved irrigation practices in areas outside the project commands (10% of 33-20 = 13 lakh ha)	1
	Total (B)	41
	Total (A) & (B)	126

Gross area likely to be benefited (ultimate irrigation potential) as a result of scientific irrigation management (assuming 90% irrigation intensity is 140 lakh ha. It means 85 lakh ha area out of 225.42 lakh ha cultivable area cannot be brought under irrigation. Other supporting industrial undertakings will have to be independently setup for such an exclusive miffed land in rural part.

9.2 Economics of Irrigation Projects

By the end of December 1998, 1392[7] large dams with height 15 m or more have been constructed 8 in the State. In the country till May 1994, 3596[8] large dams were constructed and construction work of 695 dams was in progress. This includes dams which are constructed in the beginning of the century. Out of this, 1229 dams are in Maharashtra State alone. This comes to 34 per cent of the total number of large dams in the country and is the highermost in proportion to other states. Similarly, live storage capacity of 26.2 Mm^3 has been created through the completed large and medium projects with 10 Mm^3 or more live storage capacity. In consideration of all the states, this capacity is the highermost.

From the information available from the Performance Budget of the State Irrigation Department for the 7 years' period from 1990 to 1997, the proportion of average annual water use (Statement 7.3.4) for different purposes is seen to be as follows:

Evaporation	14%
Non-irrigation use	10%
Irrigation use	55%
Carry over	9%
Balance storage	12%

Considering the expenditure incurred on large, medium and small irrigation projects by the end of the Eighth Five Year Plan and the irrigation potential created in different states of the country, the per hectare expenditure incurred on large and medium projects in Maharashtra State works out to Rs. 28028 (Annex 9.2.1). Barring Gujarat, this expenditure, compared to other states is very high. This is because the topography of Maharashtra is entirely different than other states. The expenditure in Gujarat is Rs. 40721 which is highermost in the country whereas the overall per hectare expenditure in the country, in general, is found to be Of the order of Rs. 15060. Similarly in Maharashtra, the per hectare expenditure incurred on small projects is Rs. 16242. Excluding Punjab and Haryana, the state having per hectare expenditure higher than Maharashtra is Uttar Pradesh where this expenditure is Rs. 17719. In the country per hectare expenditure, in general, is Rs. 11730.

Criteria for Approving an Irrigation Project

9.2.7 During pre-independence period, the acceptability of irrigation projects once they are completed was used to be decided on the basis of receipt of financial returns from such projects. Financial returns meant the net profit received after deducting the operation and maintenance cost of the project and interest on capital invested. For examining financial returns to be received from the project, the Government used to determine such rates from time to time. The project from which the financial returns expected were as per the stipulated rates were considered to be productive projects. The Irrigation Commission of 1901-03 had suggested the classification of irrigation projects as (1) Productive and (2) Protective. The protective projects were small projects which were used to be financed through funds which were mobilised from tax recovery. For such projects no separate exclusive fund was used to

7. Superintending Engineer, Dam Safety Organisation, Nashik.
8. Water and Related Statistics, June 1996, Central Water Commission, New Delhi.

be provided on the lines of productive projects. The difference between productive project and protective project arises due to two items, i.e., source of finance and financial returns. As the objective of protective project used to provide protection, a difference used to be made in the management of an irrigation project h) supplying water to standing crops. In order to meet the entire demand for supply of water for the rainfed crops, the area under sugarcane or other high class crops or perennial crops was restricted during such a year in which rainfall proved scanty at the fag period. In post-independence era, irrigation development was speeded up and the works of irrigation projects were undertaken in large number. But it was felt that due to criterion of financial returns or productivity test, the irrigation development was being restricted. Hence for suggesting ways and means for increasing financial returns from irrigation projects, a committee was appointed under the chairmanship of Prof. Dhananjayrao Gadagil. As per the suggestion of this committee, the system of economic benefits instead of financial returns was adopted from the year 1964 for approving the irrigation projects. Accordingly the benefit-cost ratio is being adopted as a criterion. While arriving at this ratio, the standard discount rates are taken into account. In the year 1983, the Planning Commission had appointed a committee under the chairmanship of Shri Nitin Desai.[21] to review the method of working out benefit-cost ratio. This committee had recommended that instead of the criterion of benefit-cost ratio, the criterion of internal rate of return should be adopted. The discount rate which makes the net present worth of investment equal to zero is said to be the internal rate of return. The higher the internal rate of return, the more viable that project is deemed to be.

At present for judging the economic viability of an irrigation project, the method of benefit-cost ratio is being used. The benefit cost ratio is worked out after considering the net annual profit, interest rate at 10% on project cost and 1% depreciation and operation & maintenance cost as well as annual cost of project construction taking into account cropping pattern presumed by the Agriculture Department after full development of the irrigation project In this system, the following deficiencies are observed:

(1) The condition of the area before and after the irrigation project is taken into account. The condition of the area with and without irrigation project is not taken into account. Even if irrigation project does not exist, the development of that area takes place through other activities.

(2) The increase in productivity of agricultural production during transitory period is not taken into account.

(3) The duration of construction of dam, canals and other works is not considered.

(4) The change in the value of money according to time factor is not taken into consideration.

(5) The benefits received and costs incurred in reality are not taken into account.]

(6) The changes taking place in the benefits accrued are not taken into account. Hence even though the benefits accrued in the first ten years are also accrued in subsequent ten years, their value is much less compared to the value of benefits during the first ten years. Yet, the benefit-cost ratio appears to be higher.

The above deficiencies can be removed if the discounted cash flow methods is adopted. The economic rate of return or internal rate of return is worked out by using the discounted cash flow method.

21. Report of the Committee to Review the Existing Criteria for Working out the Benefit-Cost Ratio for Irrigation Projects. Central Water Commission, Government of India, February 1983.

The internal rate of return and the economic rate of return are the two methods which are comparatively much better. A discounted rate is assumed in the beginning for working out figures of annual benefits and costs from the project from the first year till the expected / estimated life of the project for arriving at the internal rate of return and thereafter present worth of benefits and costs is worked out by iteractive procedure. When the figures of present worth of benefits and the present worth of costs are mutually at par with, that discount rate is known as internal rate of return for the project. If this rate is more than 12 per cent, that project is considered to be economically viable. Taking into account the opportunity cost of capital (normally the interest rate on long-term deposits in bank), 10% to 12% is assumed as the minimum rate. According to economic situation in the country, this 10% to 12% rate can also fluctuate.

The economic rate of return is different from the internal rate of return in the following ways

(1) In the internal rate of return the rate of materials used for project construction is calculated as per market prices, (i.e., actual expenditure). But while working out economic rate of return market prices are multiplied by a certain cofactor and new economic prices arrived at accordingly are adopted. While determining this cofactor instead of considering the actual market prices, their equivalent international values are taken into account. At present this cofactor is 0.75 for construction.

(2) While working out both the rates of return, the concept of ‘with the project’ and ‘without the project’ is taken into account. The changes in benefits and costs during the period of actual construction work are also considered.

It seems from the conclusions (Annex 9.2.4) drawn on the basis of some studies carried out by the Water and Land Management Institute regarding the benefit-cost ratio and economic rate of return that in case of some irrigation projects even though the benefit-cost ratio is less than one and if its internal rate of return is more than 12% and economic rate of return is more than 10%, such a project can be viable from economic point of view.

9.9 Assessment and Recovery

9.9.1 Since the time of Kautilya, the concept of treating water as a part of social system has been put forth. In the National Water Policy, it has been mentioned that water is primarily a natural resource. Hence, the question arises as to whether price should be charged for water or should it be given free of charge. If price is to be charged, it is necessary to consider as to how much should it be and in what form should it be charged, e.g., tax, price, fees, service charges, recovery, revenue or cess.

In the literature available with the World Bank and other development banks and also in academic circles, water charges are presumed to be irrigation service fees, water fees or irrigation fees. Recently in the judgment (September, 1996) delivered by the Monopolies and Restrictive Trade Practices Commission, it has been mentioned that water rate is an irrigation service fee.

In the paragraph 11.36 of vol. I of the report of the National Irrigation Commission of 1972, the view expressed is that irrigation projects should not be undertaken largely for earning revenue but should be taken as a part of social welfare activity and the irrigation rate should be kept low. This view could have been accepted if the benefits of the irrigation projects were equally available to the entire farming community. This, however, is not the case. The beneficiaries of irrigation projects are some farmers in command area of the project. Hence to ask the rainfed farmers and general tax payers to pay tax for the farmers who receive benefits of irrigation appears to be unjust. That commission has also expressed the view that the revenue received by entire irrigation work should be equal to its expenditure on annual operation and maintenance, The burden of making available the irrigation facility should not fall on a general tax payer.

In fact, tax is an amount which is to be compulsorily paid without taking into account the benefit or facility received therefrom. While fixing price, the proportion between water sold and its price has to be considered. Fee is an amount legally payable for some special benefit received. In service charge, it is expected that the cost of operation & maintenance is recovered. Considering these factors, the water rates charged at present, cannot be considered as tax, nor can they be treated as price. This is because no consideration is given here for depreciation cost, return on project investment and also amount of loan raised. It is expected that the cost of operation & maintenance work of supplying water to farmers should be recovered from the existing water rates. Hence, we think that it is reasonable to treat it as service charge.

Water Rate Structure

9.9.2 In order to increase the income from supply of water, the National Irrigation Commission (1972), suggested that water rates should be revised every five years and those rates should be between 5 to 12 per cent of the gross income received by the farmers from foodgrain crops or ‘cash crops’. Similarly, while fixing the irrigation water, irrigation should be divided into three types - A, B and C taking into consideration quantum of water delivered and punctuality in water supply. Where the demand for irrigation water is low due to good rains or the places where water supply is short and uncertain, the water rates should be kept low. At the same time it is suggested that the general water rates should be such that the burden of irrigation project should not fall on the general revenue of the State.

The Central Government in its Water Policy announced in the year 1987 made it clear that water price should be fixed in such a way that the beneficiaries will become conscious of its scarcity and their tendency to economise the use of water will be strengthened. The rates should be so reasonable that from the amount received as irrigation revenue, the entire cost of maintenance and a part of the fixed cost should be recovered.

The Fifth, Sixth and Seventh Finance Commissions had suggested that from the amount received From water rates, instead of recovering only the operation & maintenance cost, the interest charges on capital expenditure should also be recovered to some extent. The Eighth and Ninth Finance Commissions expressed the view that at least operation & maintenance cost should be recovered from the income received through water charges. The Tenth Finance Commission suggested that from the income received from irrigation projects, the cost of maintenance and annual return of at least 1 per cent of capital investment should be recovered.

The Vaidyanathan Committee (1991) had suggested that a high level autonomous board should be constituted by the states to take a review of operation & maintenance cost and water rates from time to time and it should be incumbent on them to take review pertinent to this every five years.

The First Irrigation Commission of Maharashtra State (1962) has made the following important suggestions regarding the water rates:

* The water rates should be related to the benefits accrued by the farmers instead of linking the same with cost of the irrigation project.
* The water rates should be according to crops and seasons.
* The water rates should be determined taking into account the need of the crops in the State.

* The water rates should be between 6 and 12 per cent of the gross income received by the farmers.
* The water rates should be revised every five years.

Existing Water Rates in the State

9.9.3 The Central Government announced the National. Water Policy in the year 1987. According to it the annual maintenance cost should be recovered from the water rates.

Barring Assam and other eastern states, in all other states of India water rate is levied directly or indirectly. In some states (Tamilnadu, Andhra Pradesh), water rates are not separately charged but additional revenue tax is imposed on irrigated agricultural lands.

These water rates charged are extremely low. But once the rates are fixed, there is resistance to increase the same in all the states. In Kerala, Tamilnadu, Haryana, Punjab, etc., the rates have not been increased during the last 20-30 years. Only in Maharashtra, rates have been increased twice during this decade.

During the six year period from 1991 to 1996, there has been an increase of about 12 per cent every year in the wholesale price index. Taking this into account the State Government issued orders as per G. R. No MISC 1096/418/IM/(Policy), dated 28th August 1998 to increase water rates charged for different crops for the use of canal flow water, The same came into force w.e.f. from 1 st July 1998. This increase is to be implemented by stages for sugarcane during five years commencing from 1998 and in case of other crops during four years from the year 1999.

Water Rates Charged and the Present Status of Recovery

9.9.4 The scenario pertaining to the water rates charged and the recovery effected during the last eight years appears to be as follows:

The non-agricultural uses include among others three uses, viz., power generation, industrial use and drinking water. The water rates were revised from the year 1991. Hence, the period 1989-97 of 8 years has been divided into three years of 1989-92 and five years of 1992-97.

Sr, No.	Item	Period		
		1989-92	1992-97	1989-97
(1)	(2)	(3)	(4)	(5)
1	Average annual assessment of water charges.			
	A. Irrigation	20(74)	32(27)	27(33)
	B. Non-irrigation	7(26)	86(73)	56(67)
	Total (A+B)	27(100)	118(100)	83(100)
2	Average annual recovery of water charges			
	C. Irrigation	11(69)	23(31)	18(35)
	D. Non-irrigation	5(31)	51(69)	34(65)
	Total (A+B)	16(100)	74(100)	52(100)
3	Ratio of recovery to assessment of water charges			
	E. Irrigation	55	72	67
	F. Non-irrigation	71	59	61
	Total (A+B)	59	63	63
4	Ratio of recovery to total dues outstanding			
	G. Irrigation	12	16	15
	H. Non-irrigation	29	29	29
	Total (A+B)	14	23	22

Source: Irrigation Department, Government of Maharashtra, (Annex 9.9.1).

It seems that out of the total income of the Department 60-65 per cent recovery is from non-agricultural uses.

The process of assessment of water charges and recovery thereof in respect of agricultural use of water is a pretty lengthy one This system has been in existence since British period. There must have been a considerable loss of Government revenue because of inadequate staff and administrative lethargy induced by many other reasons. In its note sent to the Commission, the Krishna Valley Development Corporation has stated that according to the information received through the satellite from the Remote Sensing Unit, the actual area under sugarcane crop appears to be more than about 2.5 times the area recorded at the corporation for recovery.

The entire system of measurement, fixing the rates and recovery to be made need to he reformed with a view that it will be compatible with the new era. For this and for preventing the corruption and, loss of Government revenue, such review must be undertaken periodically at least for major project areas (contiguous 10000 hectares). The requirement of measurement, of cropped area for each crop of every season appears to be the weak link in this process. The season wise average irrigated area during the three years of 1994-97 and the expected water charges there from are presented in what follows:

Sr.No.	Season	Irrigated area (%)	Distribution of water charges (%) [@the rates prevailing in 1998]
(1)	(2)	(3)	(4)
1	*Kharif*	29	6
2	*Rabi*	40	14
3	Two-seasonals	10	1
4	Hotweather	3	9
5	Perennial	18	70
	Total	100 (12.08 lakh ha)	100 (Rs 79.57 crores)

Source: Irrigation Department, Government of Maharashtra.

Taking into account the distribution of water charges seasonwise as indicated in the foregoing, it will be necessary to find out an alternative system of measurement limited only to area Under perennial crops (for 18% area).

The loss of revenue is likely to be due to the assessment based on crop area. A remedy must, be found for this. The only one appears to be supplying water on the basis of measurements. The capital expenditure needed for the same and the increasing responsibility of management will have to be given due consideration.

Reasonable assessment and prompt recovery are the hallmarks of evaluation of management efficiency. Since the available water supply goes on changing, it is necessary to evolve a flawless system of assessment. At some places, the measurement of area under every crop is separately made; at some places the assessment is based on estimates. Land revenue is being levied in respect of all the lands permanently. If, due to some reasons, during some year it is exempted, separate orders for the same have to be obtained from the Settlement Officer. It will have to be considered as to whether pattern of assessment can be evolved for water on the same lines.

Year	O & M cost including that on management establishment	Assessment of water charges & recovery						
		Irrigation		Non-Irrigation		Total		Percentage of recovery to assessment
		A	R	A	R	A	R	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1992-93	130	30	19	67	27	97(75)	46(35)	47
1993-94	128	26	23	25	59	121(95)	82(64)	66
1994-95	142	28	21	88	48	116(82)	69(49)	59
1995-96	184	36	21	86	59	122(66)	80(43)	66
1996-97	189	39	32	93	62	132(70)	94(50)	71
Average	155	32	24	86	51	118(76)	74(48)	63

Note: Figures in bracket indicate the percentage To O & M.
Source: Irrigation Department, Government of Maharashtra.
A = Assessment, R = Recovery.

For the flow irrigation schemes the expenditure on annual O&M cost including that on management establishment, actual annual assessment and recovery during the period 1992-93 to 1996-97 are shown in the foregoing tabulation.

From the statement, it is clear that O&M cost is not recovered from the irrigation assessment.

As in other states, in Maharashtra also, the scenario of recovery of water charges from farmers is disappointing. During the past few years, there has been some increase in recovery but fit mainly relates to non-irrigation uses of water.

The increase in management cost every year, the corresponding rise - though marginal: in water rates and decline in actual percentage of recovery have completely upset the economics of irrigation projects. This is obvious from the figures presented in the foregoing.

From the above figures, it seems if the assessment of water charges is made slightly on higher side of 1.25 times or if the recovery is doubled, it will be possible to meet the entire cost of O & M therefrom.

At present water charges are assessed on the basis of area of irrigated area. The percentage utilisation is near about 38 per cent of the irrigation potential created (Annex 9.8.1). If utilisation of created irrigation potential is raised to 80 to 85 per cent, the assessment of irrigation will increase by about 2.5 times. Similarly, if the present recovery ratio of 60 per cent is raised compulsorily to 80 to 100 per cent, it will be quite possible to meet the annual O&M cost therefrom. It is necessary to initiate efforts in this direction.

From the percentage of water rates to the per hectare income from major irrigated crops (Annex 9.9.3.), it seems that the percentage of prevailing water rates for the major crops recovered during 1995-96 to the gross income per hectare is between 1.5 to 4. In fact, the Government of Maharashtra has accepted the recommendation of the First ’Irrigation Commission (1962) that water rates should be between 6 to 12 per cent of gross income, Taking this into account and the rise in wholesale price index of about 12 per cent annually during the six year period from 1991 to 1996, the Government has revised the water rates from the year 1998. Notwithstanding that not even in case of a single crop these rates are found to be even 6 per cent of gross income. From this, it is observed that the rates increased by the Government during 1991 and 1998 are, in all probability, based on only the rise in wholesale prices. The Government, it appears, has not taken into account the increase that has taken place in the per hectare production of crops.

Principles of Assessment of Water Rates

9.9.5 While assessing the water rates, it will be useful to base them constantly on some principles. Considering the uncertainty of rainfall in Maharashtra, the measures adopted of storing water to overcome the same be treated as boric public infrastructure facilities based on non-commercial principles and any return on the capital invested and interest thereon need not be included in the water rates. At many places it is not possible to build large reservoirs. The main canals and main distributaries conveying water (giving benefits of irrigation to an area of more than 1000 hectare), i.e., distribution network upto 1 cumec discharge constructed, there should also be treated as basic public infrastructure facility and return on capital invested or interest thereon need not be considered while fixing the water rates. The distributaries which have a potential of less than this discharge, (i.e., minors) are, however, properly belong to local distribution network and as local participation is expected henceforth in raising the capital for the same, it is however, desirable to consider the investment therein on economic principles.

The factors which need to be considered while fixing water rates for irrigation are:

(a) Interest and depreciation of capital invested on canal and main distributaries.

(b) Annual expenditure on operation, maintenance and repairs of dams

(c) Annual cost of operation, maintenance and repairs of canals and main distributaries.

(d) Annual cost of operation, maintenance and repairs of minors.

In principle, the entire annual cost of maintenance, repairs and operation should be recovered from the beneficiaries. In this, no concession of any type can be granted But, so far as capital investment is considered, it seems desirable to grant concession in case of storage and main conveyance system (canals & main distributaries). Hence, while fixing water rates, the depreciation on capital invested for these facilities or interest thereon, should not he taken into account. This should be treated as a permanent grant to be given from the funds received by the Government from other tax sources. Then onwards, for other components like distributaries, minors, etc., interest, depreciation, annual cost should be taken into account at the time of assessment and the rate should be determined by adding royalty to it to water users have built the reservoirs, the principle of royalty to be received from them is there in the existing assessment system. It is necessary to apply the same principle here-inafter to all the benefits accruable from water like through hydropower generation, planning for groundwater and watershed development. While fixing the water rates the following factors heed to be considered.

(1) The construction work of dam, canal and main distributaries is a basic public infrastructure facility. Hence the depreciation on capital invested (1%) and interest (10%) should not be included in water rates.

(2) Henceforth, the construction work of minors (upto 1 cumec discharge) and maintenance & repairs thereof, etc., and related management functions are expected to be performed by the WUAs. While charging water rates to such WUAs on volumetric basis, the maintenance & repairs cost of minors should not be included.

(3) In case of projects in which the construction work of minors and beyond has also been accomplish through the Government, while fixing water rates for the WUAs, the

interest on capital invested in such construction work (10%), depreciation and royalty should be charged. Where the WUAs have not yet assumed the responsibilities of operation, maintenance and management, interest on investment for construction work (10%), depreciation and royalty should be charged while fixing the water rates, alongwith annual O&M cost.

(4) The topography, cropping pattern, the cost of maintenance & operation of dams, canals, distributaries being different in different sub-basins, the water rates should be fixed sub-basinwise.

(5) The water rates to be charged to municipal corporations, municipal councils, Jeevan *Pradhikaran* organisation, industrialists, other private & public undertakings for water supplied them for entailing non-irrigation uses should be stipulated by taking into account the capital investment (10 % interest), depreciation, expenditure on O&M thereon for works upto the source wherefrom such water supply is effected. In order to reduce the burden of O&M on the farmers, these water rates should be higher compared to-water rates for irrigation.

(6) We have recommended that different institutions, industries, etc., while reserving water units for non-irrigation uses as per their needs should also bear the burden of capital investment in proportion to the units of water they reserve. While charging water rates to them only cost of O&M upto the source of water wherefrom they receive it, should be recovered. In order to ensure that there should not be a greater burden of O&M on the farmers, these water rates should be higher than the water rates charged for irrigation.

(7) Royalty is charged for water supplied for hydropower generation to Maharashtra State ... Electricity Board or to other public and cooperative udnertakings. While determining water rates, the cost of construction of dam in proportion to the water units needed for power generation, the cost of construction work of structures upto the power generation plant and also O&M cost of structures upto dam and power generation plant should be taken into account as in the foregoing.

(8) We have recommended that the organisations generating hydropower should bear the cost of dam construction, in proportion to the water units needed by them. While charging water rates (royalty) to them, the cost of M&R of the structures upto the power generation plant should be taken into account.

(9) Henceforth water should not be supplied to individual farmers. Water should be supplied only to the WUAs on volumetric basis.

(10) It is mentioned in clause 55 (b) of the Irrigation Act 1976 that if land is irrigated by water from the wells which are within a distance of 35 m from the nearest border of the canal, water charges should be levied on such land. There is no mention in the Act about the irrigation from wells located at a distance of 35 m and beyond. During the field visits of the Commission, it has been observed that the farmers construct wells just beyond the 35 m border, these wells are recharged by the canals and this water is used for irrigation. But no water charge is levied on them. The Commission is of the opinion that all the farmers who are beneficiaries of the wells falling within the influence area of the irrigation project should be levied water charges. The influence area of the canal on the side of higher slope should be determined on the advice of the Groundwater Agency. When the normal natural level of groundwater rises because of the existence of canal, it should be considered as influence area.

Information was sought from some of the cooperative societies running the lift irrigation schemes about the crop wise water rates charged to the farmers, by the society, for meeting the cost of O&M and also that of the management establishment of the society apart from water rates being levied by the Irrigation Department On the basis of the information received from five societies in Sangli District, the scenario that emerged is as per the following.

Water rates: Rs. per ha

Sr. No.	Main crop	Water rates charged by society	Water rates charged by the Government	Total water rates charged
(1)	(2)	(3)	(4)	(5)
(A)	Perennial			
1	Adsali sugarcane	2750-8000	705(2625)	3455-8705
2	Suru, Khodwa, Nika sugarcane	2300-7750	705(2625)	3005-8455
3	Banana	4600	565(2625)	5165
4	Fruit garden (grapes, guava)	5500	375(2625)	5875
(B)	*Kharif*			
1	Turmeric	1000-8000	25(100)	1025-8025
2	Soyabean	875-2500	25(100)	900-2525
3	Hybrid, groundnut, etc.,	875-3000	25(200)	900-3025
4	Paddy	900-2000	25(200)	925-2025
(C)	*Rabi*			
1	Wheat	1000-2000	75(200)	1075-2075
2	Gram, jowar	1000-1500	75(150)	1075-1575
(D)	Hot weather			
1	Green jowar fodder	1250-3000	37.50(300)	1287-3037
2	Vegetables, etc.,	1250-2600	37.50(1125)	1287-50 2637.50

Note: Figures in bracket indicate the water rates charged to individual farmers for flow irrigation.

The water rates informed by these societies are per acre basis. They are got converted into per hectare and details are presented accordingly. The society constructs intake well in the river and water supplied to the members by through pipe line.

From the foregoing data, it is observed, that the, farmers pay much higher rates cropwise in different seasons compared to water rates fixed by the Government for flow irrigation: The following table makes this point more clear:

Season	Excess of water rates paid Compared to water rates for flow irrigation
Perennial	1.25 to 3.25 times
Kharif	4.50 to 15.00 times
Rabi	7.00 to 10.00 times
Summer (h.w.)	1.25 to 10.00 times

This means the farmers have a capacity to pay, higher water rates and they are psychologically prepared for the same.

Changes in Cropping Pattern

9.9.6 Considering the changes that have taken place in irrigated area under different major crops during the period 1961-62 to 1994-95, (Annex

9.9.4), the area under wheat and other cereals has increased by .6 per cent and 1 per cent respectively whereas the area under rice and *rabi jowar* has declined by 10 to 11 per cent. Thus area under cereal crops has declined by 14 percent. Though the area under gram has increased by 3 per cent, the total Area under foodgrain crops has declined by 18 per cent. The area under sugarcane-has increased by 6 per cent whereas the area under cotton and groundnut has declined by 1.5% and 0.75% respectively. Contrary to this, area under other crops like turmeric, potatoes; chilly and tobacco, etc., has increased by 7 per cent.

Considering the area of the major crops under irrigation compared to total area under those -crops during the year 1961-62 and, 1.994-95, there has been an increase of 9 per cent during this period. The highest increase is 60% under the area of wheat followed by 19% area under gram, 5% area under *rabi jowar* whereas 2% area under paddy.

The increase per hectare in production of different major crops during 1961-62 and 1994-95 (Annex 9.9.5) has been worked out taking into account per hectare production of total area under crops (rainfed & irrigated combined). From this it seems that production of wheat per hectare has increased by three times. The per hectare production of *kharif jowar, bajra* and cotton has increased two times. The increase in case of rice, *rabi jowar*, gram, Sugarcane and total food grains has been 1.25 to 1.75 times.

When the per hectare production accrued during the year 1994-95 in respect o different crops in total area during 1994-95 is compared to per hectare production of the crop in irrigated area in 1994:95, it seems that excluding rice and *kharif jowar*, per hectare production of all the major crops in irrigated area is higher by 1.25 to 1.75 times compared to per hectare production of the crops in total area. Hence there is enough scope for raising the water rates.

Similarly, compared to 1960-61, the area under banana, grape and onion, (the major fruit and vegetable crop) has increased during 1994-95 from 23000 to 37400 hectares, from 1000 to 21000 hectares and from 22000 to 93700 hectares respectively (Annex 9.9.6). This increase is 63%, 2100 and 326%, respectively. For observing the increase in production per hectare figures for 1960-61 were not available. Hence the figures for 1982-83 have been taken into consideration. From this it seems that production of banana was 48 tons per hectare in 1982-83.It increases to 56 tons in 1994-95(17 % increase). In case of grapes per hectare production increased from 13 tons to 22 tons (72 % increase). There does not appear to be any change in per hectare production of onion. It is constant @ near about 13 tons. The per hectare production of banana grapes and onion is inclusive of the area under rainfed and irrigated crops. Separate production figures for irrigated area are not available. It is possible that increase in production of irrigated area likely to be more than indicated above. It can be said that in case of these crops also, there is a scope for increasing the water rates.

Deficiencies in Water Rate Assessment

9.9.7 (1) The Accountant General[73] had carried out the audit of the accounts relating to assessment of water rates and recovery of the 17 irrigation divisions from different regions of Maharashtra State during the period December 1994 to March 1995. The following issues raised about assessment and recovery are of worth consideration. Water rate at 50 per cent was not recovered from those land holders in irrigation command area who had not taken water for irrigation.

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(2) As the command area was not notified earlier minimum water rate was not levied in command area.

(3) Some village *panchayats*, municipalities, sugar factories and other organizations/individuals use water for non-irrigation purpose without obtaining permission for non-irrigation use and without entering into agreement. In such cases, it is necessary to recover three times the water rates as compared to the prescribed rates. However in such cases the water rates as per the prevailing rates only are levied presuming that subsequently Government permission would be granted.

(4) It is necessary for the farmers to apply for supply of water for irrigation and for the Canal Officer to grat permission for the same. If water is used without obtaining prior permission (unauthorized use), it is necessary to charge rates which do not exceed three times the prescribed rates, But in some cases, water is supplied without obtaining application from the farmers and without estimating the actual units of water required. On such unauthorized use it is necessary to impose penal rates. However, such action seems to be not taken.

(5) For assessing the water rates seasonwise and for remitting the water charges, the Government has fixed the following dates for demand statement notice to be sent to the farmers *Kharif* - 1 February, Rabi, 1 May. Hot weather - 1 October. However due to delay in assessment of water rates and obtaining approval for *panchnama*, three times the water rates are not recovered from the farmers who unauthorized use water.

(6) The dates for remitting water tax seasonwise are as follows: *Kharif*- 30 April Rabi, July, Hot weather - 31 December. If the water charge are not remitted during this period, 10% additional water charges on the assessment be recovered by way of fine. But no such action is being taken.

(7) As per the agreement for supply of water for non-irrigation purposed even if the concerned one has used less than 90% of water as compared to demand, it is necessary to levy water rate for 90% of the water units sanctioned. But no action is being taken according to this.

(8) It is expected that according to the Act, water charges are to be levied on the irrigation area from the wells which are within 35 m from canals. But no such water rates are being levied.

According to Officers of the Irrigation Department, all those deficiencies arise mainly due to the following reasons:

(a) No separate staff has been appointed for recovery.
(b) The powers which are vested in revenue officers for taking punitive and compulsory measures of recovery are not vested in the canal officers of the Irrigation Department Some of these powers are now given as per notification of Revenue and Forest Department No. PWR 1094/PN198/L-5 dated 17.7.98.
(c) The recovery of the outstanding dues of the Irrigation Department is not being made by the concerned cooperative sugar factories on priority.
(d) The water and electricity supply of those who outstanding dues id not being disconnected.
(e) Water use that is being entail for non-irrigation purposes far exceeds hat envisaged at the time of project formation.

The Government has issued instructions that in order to ensure fair assessment of water rates. It is necessary to keep farmers account books to record the cropwise irrigated area the measurement book; and to inspect at least 7% of the seasonwise crop area under irrigation by the Sectional Engineer, 2% of the area by the Sub-Divisional Officer and 1% of the area by the Executive Engineer and to record the certificate to this effect in the crop measurement book. However, except the Sectional Engineer, no other officer does carry out such inspection. This is evident from the record, Similarly, at some places update entries are not made in the account books of the farmers and even the measurement book is also not maintained this has been stated in the aforementioned audit report of the Accountant General.

At present the work of water charge assessment and recovery is done through the employees who are appointed for operating & maintain of irrigation project of the Irrigation Department As noted earlier there is no separate staff for water charges assessment and recovery. Out of the total provision made for operation & maintenance till 1974-75, the expenditure on salary and allowances of deployed for operation & maintenance and wages of workers on daily wages accounted for about 30% whereas the actual expenditure on maintenance & repairs had been 70%, After considering this, the substantial rise in salaries and allowances, leave travel concession, salary for surrendered leave and other office expenses, though the water rates were doubled during the period of five from years 1990 to 1994, it does not appear that due consideration had been given to this problem. The result is that out of the total financial provision for operation & maintenance 65% to 70% amount is now spent on establishment and only 30 to 35% is left from actual maintenance & repairs. This has adversely affected the maintenance & repairs of irrigation projects and led to declined of its capacity and services being rendered by the projects. The consequence id lower assessment of water charges and decline in recovery thereof.

Besides this the demand for water is continuously rising because of growing Population increase in industrialisation and the awareness amongst the farmers that due to irrigation the farm production can be increased. Hence water has no longer remained commodity which can be obtained free and in unlimited quantum as in the past. The question of availability of water is becoming critical day-by-day. Unless the total demand is not brought under control, this problem is likely to assumed quite serious proportion by the year 2030. From this viewpoint, it is necessary to undertake the following action:

(1) Henceforth water should be supplied on volumetric basis only.

(2) For irrigation, water should not be supplied to individual farmers but should be supplied only through the WUAs.

(3) The operation & maintenance of irrigation system beyond minors and the responsibility of water distribution, assessment of water charges and recovery should be entrusted to WUAs. A definite time period should be laid down for such transfer and it should be made clear to that the concerned farmers that will not hold right on that water afterwards.

(4) As per requirement of crop water units per farmer per hectare be fixed and water be supplied to WUAs as per availability of water.

(5) If WUAs go defaulters by not paying outstanding dues, the canal officer should have the power to disconnect their water supply.

(6) It has been observed during the field visits of the Commission that the command area of irrigation project and also area outside it derive direct arid indirect benefits from water of the irrigation project. For example, as long as there is water in the reservoir, the level of well water rises in that area. Hence, the influence zone of the irrigation project (command area + other

area deriving benefits) should be determined and water charges should be levied on that entire area For this, the additional units of water which have become available in area other than the command area will have to be determined. For this, water levels of the wells before and after the release of water from canal will have to be taken into account.

(7) By the end of the Eighth Five Year Plan, 13947 schemes of Local Sector minor irrigation. projects had been undertaken and the irrigation potential created there through was 4.32 lakh hectares in the State. It is observed that no Water charges are being levied on this area the water charges should be levied from the beneficiaries of these schemes also and the village *panchayats* should have the powers to retain this amount. This will ensure proper maintenance of the local projects.

Water Users' Associations

9.9.8 In the Maharashtra State, at present there are 645 cooperative water users' associations (WUAs). Out of these 206 are active, 250 are registered and have entered into an agreement and 189 are registered and proposed (Appendix 7.8.1).

These cooperative WUAs receive management grant of Rs 100 per hectare in the first year, Rs 75/- per hectare during the second and third years. This grant is reimbursement and hence cannot be claimed unless the societies incur the expenditure and submit he bills for the same As per government Circular of 1995, instructions have been issued that out of the management grant given to the WUAs 10% amount is to tube used for repairs of the water courses within the area of the society. Cut-throat-flumes, partial flumes are being used for supplying measured quantity of water to these societies on volumetric basis. Fourteen such societies have sent information about their difficulties, demand and suggestions. On the basis of that, it seems, they encountered the following difficulties:

(1) The works of field channels are incomplete.
(2) The discharge measurement equipment is not functioning efficiently.
(3) The Part, 1 and Part II works of land improvement are incomplete.
(4) Repairs, to minors are to be carried out.
(5) The schedule of rotation should be made available at least two days before the release of water.

It is necessary for the Irrigation Department to undertake take action immediately to remove the aforementioned difficulties. A separate provision for funds should be made for the same. Only then, these societies would be able to function properly and the expected objective could be achieved.

Cooperative Dam Societies

9.9.9 In Kolhapur area, eight cooperative (storage) *bandhara* societies are functioning Dam society is that which owns Kolhapur Type private *bandharas.* These *bandharas* are constructed on different rivers in that part. Out of these eight societies, three societies receive water on volumetric basis. For the K.T. weirs owned by them, water froth the project is released and supplied as per measurement: For measuring the water, a gauge Plate is fixed near the. *bandhara.* Water is released from the project located at the source of the river. Water supplied during the year is measured by the gauge plate and is debited to the account of the dam society at the rate of Rs. 667/- per mcft and local cess of 20% is added to it This amount is recovered from the dam society. The water charges for societies which do not receive water on volumetric basis are assessed, at the rate of Rs. 235 per hectare for irrigated area (this is 50% of the existing rate). In addition to this 20% local cess is to be paid the rates charged for the societies receiving seasonal water are Rs. 20 per thousand m^3 *kharif* for season and Rs. 30 or *rabi* season.

According to information received from the officers of the Irrigation Department about the supply of water on volumetric basis, it is observed that though these societies are supplied water at concessional rates and consequently the assessment of water charges is lower compared to the same charged area wise to that area, it is worth noting that the assessment and recovery in case of such societies is 100%. In ease of water charges assessed on the basis of area, the water charges are not levied on the entire irrigated area and the percentage of recovery is within 70% only.

In volumetric system, discharge measurement is being carried out the head of a distributor or canal and the responsibility of the distribution to farmers rests with the society Because of system, water is used most economically. Additional doses of water are not used consequently, there is no water logging nor are there incurred damages due to soil erosion. The beneficiaries avail the facility of raising any crop during any season.

If water is supplied on volumetric, basis, the only work that the employees of the Irrigation Department will have to perform is to maintain account of how much water has been used by the darn society or the WUA by just i measuring the water level. Similarly, for carrying out assessment according to the irrigated area supply Of water on volumetric basis appears to be proper in view of the Cost of measurement of area under all the crops, cost of stationery, the expenditure on irrigation employees carrying out measurement and assessment, etc.

Cooperative Lift Irrigation Schemes

9.9.10There were 119 cooperative lift irrigation schemes in the State in 1961. This number rose to 301 (two and half times) in 1971, 1188 (ten times) during 1981 and 3224 (27 times) in 1991. Thereafter the number rose continuously and reached 4380 in 1995. Compared to 1961, the number has increased 37 times. The rapid increase in cooperative lift irrigation schemes can be seen from the following information.

Growth of Cooperative Lift Irrigation Schemes

No. '00', Area: '000'. Rs. lakh

Sr. No.	Item	1961	1971	1981	1991	1993	1994	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	No. of societies	119	301	1888	3224	3583	3842	4380
2	No. of members	97	402	854	2820	3258	3945	4271
3	Share capital	22	153	324	1750	1883	1648	2544
4.	Owned funds	30	193	563	3004	4073	4116	6139
5	Loans due	59	400	1564	29774	36542	39457	43083
6	working capital	118	732	2710	39922	49408	62075	67856
7	Command area	183	516	1744	6301	7563	12438	13323
8	Area under irrigation	47	143	691	3636	2896	4116	4405
9	Societies accruing profits	41	95	313	984	1035	1109	1062
10	Profit	2	17	50	226	351	406	508
11	Societies entailing losses	62	147	411	1760	1995	2133	2834
12	Loss	2	20	466	1104	1603	2012	1903

Source: Cooperative Movement in Maharashtra at a Glance, 1996, Commissioner of Cooperation, Government of Maharashtra, Pune.

Out of these 4380 cooperative lift irrigation societies, 1462[74] (33%) are in Pune District alone (53 societies among get water from Ujjani Reservoir). Next to this, 555[75] societies (13%) are in Ahmadnagar District. In Satara and Kolhapur District, the number is 527[76] (12%) each. Excluding Raigad, Sindhudurg, Ratnagiri and Wardha - in all other districts the number of societies ranges between 11[77] (Yavatmal) and 28678 (Sangli). In Sindhudurg, Ratnagiri and Wardha District, the number is 1.7, and 6, respectively. There is no society in Raigad District, Besides, these, there are some private lift irrigation schemes of individual farmers having irrigation facility. (The number of such societies receiving water from Ujjani Reservoir is 8406.) The average number of members per cooperative society in 1961 was 82. It was found to be 98 in the year 1995. The proposed command are of the 4380 societies is 13.22 lakh hectares out of which 4.4 lakh hectare (33%) is under irrigation. The loan facility of these societies is Rs. 430.83 crores.

Water permit to provide water on volumetric basis is not given for such lift irrigation schemes. Taking into consideration the approved area of the scheme implemented and the area irrigated by the society during that season, the water charges are assessed according to the existing rules and rates fixed by the Government, Besides this, the society recovers water charges at different rates from its members independently for management of society and the scheme. The total water charges being paid by the members appear to be 1.25 to 15 times higher than the rates prescribed by the Government.

During the field visit of the Commission in Sangli area, it was told that due to lift irrigation schemes excess water was used which resulted in about 17414[79] hectares land becoming either saline or water logged. The details of the same are:

(a) Totally salined area3675 hectares
(b) Partially salined area7895 hectares
(c) Totally waterlogged area5844 hectares

Out of the total area of 1.22 lakh hectares in Sangli District, the proportion of affected area is 14%. Out of total 11.68 lakh hectares command area in the State 24777 hectares (2%) is affected. Taking this into account, it becomes necessary that in order to avoid use of excess water by the farmers the cooperative lift irrigation schemes should also be supplied water on volumetric basis on the lines of WUAs.

Control and Recovery of Water Charges

9.9.11 Prior to the year 1976-77, the work of recovery of water charges in Maharashtra used to be carried out through the Revenue Department. The Irrigation Department used to furnish them with details about the water charges assessed. On that basis the Revenue Department used to recover the same. In this system, there were difficulties in getting details from the Revenue Department about whether the beneficiary has remitted water charges or not for how much area the amount has been remitted and whether he should be supplied with water in the next season or not. Hence from the year 1976-77, the work of the recovery of water charges has been entrusted to the Irrigation Department. But for this work, no additional staff has been assigned. This additional work is being managed by the already existing employees of the operation & maintenance divisions of the projects. Hence, in this system also the difficulties about assessment of water as mentioned earlier do arise. The employees of the Irrigation Department do not

79. Superintending Engineer & Director, Directorate of Irrigation Research & Development, Pune.

have powers of recovery or forfeiture like the power vested in the Revenue Department. Hence no action could be taken against the defaulters. Recently as per the Government in the Revenue and Forest Department's Notification No. PWR 1094/CN 198/L-5 dated 17.07.98, this difficulty has been partially removed. Even then, the defaulters do not experience much difficulty in getting water, because the Irrigation Department does not have any power to disconnect water and electricity. As there is no separate staff for assessment is being made after actual measurement of cropwise and seasonwise irrigated area. Similar seems to be the case with recovery also. The ratio of recovery to total assessment during the period 1989-97 in case of irrigation is on an average 68% whereas it appears to be 60% (Annex 9.9.1) in case of non-irrigation.

During the period 1989-92, the ratio of assessment on irrigation to total assessment (irrigation + non-irrigation) was 74% whereas the same in respect of non-irrigation was 26%. During the period 1992-97 this ratio was exactly opposite i.e., ratio of assessment on irrigation was 27% whereas the same in respect of non-irrigation appeared to be 73%. Similar seemed to be the scenario in case of recovery also. During the period 1989-92, the ratio of recovery from irrigation to total recovery (irrigation + non-irrigation) was 69% whereas it was 31% in case of recovery from non-irrigation During 1992-97, the recovery, ratio was exactly opposite, i.e., recovery ratio on irrigation was 31% where as it appeared to be 69% in case of recovery on non-irrigation.

During the period 1989-92, the ratio of recovery to Assessment on irrigation was 55% whereas in case of non-irrigation it was 71%. During 1992-97, this ratio was exactly opposite, i.e., 72% in case of irrigation and 59% as regards non-Irrigation. The ratio of recovery to outstanding dues from irrigation was 12% during the period 1989-92 whereas it was 16% during 1992-97 (Annex 9.9.1). In case at non-irrigation, the ratio during both the periods appears to be 29 per cent.

The outstanding dues shown it the detail s about the region wise information by end of 31.03.95 (Annex 9.9. 2 are-three times that of onetime assessment Considering the existing outstanding, dues it is necessary to raise the ratio of recovery For this, the following remedies may be considered.

(1) It should be made obligatory one the part of the Revenue Department to record the outstanding dues of water charges in form 7/12 of the farmers. This will make it difficult for the concerned farmers to take loan from the cooperative bank or other commercial banks and the, farmers will be compelled to remit the outstanding dues.

(2) The powers which are vested in the Officers of the Revenue Department about the recovery of water charges should be fully vested in the Officers of the Irrigation Department. There are still following shortcomings in the powers delegated as per the Government Notification No. PWR 1094 / CN 198/L-5 dated 17.07.98 of the Revenue and Forest Department.

(3) The outstanding dues of water rates should be treated as arrears of land revenue It seems the powers of exacting recovery have not been vested in to Officers of the Irrigation Department.

(4) The powers to disconnect water and electricity of the defaulters and to stop rendering these services to them should be conferred on the irrigation Department. For this, the Maharashtra State Electricity Board should lay a separate dedicated line for the beneficiary farmers according to need and the control of the same should be entrusted to the Irrigation Department The cost of laying such a line should be borne by the Irrigation Department. Such an arrangement

can be easily made especially for the lift schemes on rivers, canals and reservoirs and should be immediately undertaken.

(5) Henceforth water distribution should be made through the WUAs only. The responsibility of operation & maintenance of works beyond minors, the assessment of water charges and recovery thereof should also be entrusted to those societies This will increase the proportion of recovery.

Prevailing Water Rates for Non-irrigation Uses

9.9.12 Water from an irrigation project is mainly use for irrigation Along with it water is supplied for non-irrigation uses like domestic and industrial uses. While preparing the outline of the irrigation project, a certain percentage of water is reserved for the foregoing two non- irrigation uses. But considering the water storage designed for non-irrigation Uses and the actual use of water, it seem non-irrigation use has increased almost by One and a half times From the information available (Annex 9.9.7) from the regional irrigation status reports (1994-95) of the Irrigation Department it seems out of the designed live storage of 28527 Mm^3 water, 2342 Mm^3 live storage was reserved for non-irrigation uses. The percentage of water storage reserved for non-irrigation uses to total live storage comes to 8%. On the contrary, the percentage of actual water used for non-irrigation purposes (2702 Mm^3) to the actual availability of live storage (as on 15-10-94) happens to be 13%. This means the demand for non-irrigation uses has increased by about one and half times. The demand for non-irrigation uses of water seems to have increased due to increase in population, increase in the number of livestock & factories.

The figures given in Economic Survey of Maharashtra, 1997-98 published by the Government of Maharashtra pertaining to population of Maharashtra, number of livestock & factories during the period 1960-61 and 1996-97 are given in what follows:

Item	Year 1960-61	Year 1996-97	Increase (%)
(A) Population (000)	28391	48396	70
1 Rural	11163	30542	173
2 Urban	39554	78937	99
3 Total	(Census 1961)	(Census 1991)	
(B) Livestock	26048	36,393	39
(i)Total livestock ('000')	(1961 Cattle Census)	(1992 Livestock Census)	
(ii) Total poultry and ducks('000')	10,557	32187	204
(C) Factories	8010	27668	345
Out of these sugar factories	78 (1981)	145 (1994-95)	86

From this information, it is observed that compared to 1961, the population in 1991 has become almost double. The urban population has increased by 173% whereas the increase in rural population is by 70%. This means the demand for water in urban areas has increased much more compared to the rural areas.

The number of livestock, poultry & ducks has increased by 39% and 204% respectively in 1992 compared to that in the year 1961. The number of factories has increased from 8010 in 1960-61 to 27668 in 1996-97, i.e., by three and half times. This includes sugar factories also The number of sugar factories was 78 in 1981. It increased to 145 in 1994-95, i.e., by 86%. From these figures, it is obvious that the demand of water for domestic and industrial uses has increased enormously. Alongwith this, the installed capacity of hydro-power generation which was 282 thousand kW in 1960-61 increased to 1602 thousand kW in 1996-97, i.e., an increase of about six times appears to have taken place. The production increased from 1365 million kW hours to 4707 million kW hours, i.e., by about three and half times. For this also (Koyna) water is being used.

As already noted, the annual cost of operation & maintenance of irrigation project is not covered from the assessment of water charges. Hence, the question of meeting some portion of capital investment (1%) and interest on capital investment does not arise. Considering this and the tremendous increase in demand for water for non-irrigation-uses, it seems that there is a scope for increasing water rates of non-irrigation uses.

The Government in Irrigation Department through the Resolution No. WTR 1088/745/IM/ (Policy) dated-10th September 1992 and No.MISC 1096/418/IM(Policy) dated 28th August 1998 has revised water rates for drinking water and industrial uses. These rates have been revised after 1964 in 1991 for the first time after a period of 26 years and they were revised second time in 1998 after a period of seven years.

Considering the different rates for the supply of water being catered from different sources, the minimum and maximum water rates and the increase therein are shown hereunder:

Item	Water rates (Rs. per 10000 litres)			Ratio of rates in 1993 compared to rates in 1964	Ratio of rates in 2003 compared to rates in 1993
	1964	1993	2003		
(1)	(2)	(3)	(4)	(5)	(6)
A) Domestic use					
(i) Minimum rate	0.20	0.25	0.50	[1.25 to	[More than
(ii) Maximum rate	0.20	1.50	2.40	[7.30 times	[1.5 to 2 [times
(B) Industrial use					
(i) Minimum rate	0.45	1.00	4.85	[2.25 to	[4.75 to
(ii) Maximum rate	0.45	7.50	36.30	[16.50 [times	[More than [4.75 times

Note: (1) The rates in 1964 were per 10000 cft. They are converted into 'per 10000 litres' basis.
(2) The revised rates in 1992 were implemented by the Government in 1993. The rates revised in 1998 step by step will be applicable in full from the year 2003.

The revised water rates of irrigation from 1.994 and 1998 appear to have been have been increased from the rates prevailing in 1975 and 1994 as shown hereunder:

Season	Ratio of rates in 1994 compared to rates in 1975 (times)	Ratio of rates in 2003 compared, to rates in 1994 (times)
(1)	(2)	(3)
(A) Flow Irrigation		
Kharif crops	2	1.5
Rabi crops	2	1.5
Hot weather crops	3	1.5
Sugarcane & banana	1.5	1.5
Other perennial crops	3.5	2.5
(B) Lift irrigation		
Sugarcane & banana	3	2.5
Other perennial crops	3	2.5
Kharif crops	2.5	1.75
Rabi crops	2	1.5
Hot weather crops	2	1.5

The rates revised in 1992 had been implemented by the Government from 1993 and the rates revised in 1998 in step by step reflect full increase in the rates from the year 2003.

The previous rates for domestic use were Rs. 5.50 per 10000 cubic foot whereas the rates for industrial use were as follows:

(1) During the first two years Rs.]8.00 per 10000 cubic foot.

(2) Next two years Rs. 10.00 per 10000 cubic foot.

(3) Thereafter Rs. 12.50 per 10000 cubic foot. The rate for domestic use works out to Rs. 0.20 per 10000 litres. For industrial use after five years, it comes to Rs. 0.45. Considering these rates, the rates revised from 1991 when compared to previous rates appear to have been increased to 7.50 times for domestic use and 16.50 times for industrial use.

From the foregoing exposition, it appears through the revised rates for domestic and industrial uses appear to be much higher compared to revised rates for crops, in reality the maximum rates are Rs. 36.00 per 10000 litres only.

Presuming that the water requirement for domestic use is about 200 litres per head per day the per year water needed by one person would be 73000 liters. The water charges for this at the rate of Rs. 2.40 per 10000 liters would be about only Rs. 17.50 per year. The per capita monthly expenditure (July 1993 to June 1994) for rural area as shown in Table No. 46 of Economic Survey of Maharashtra, 1997-98 published by-the Government of Maharashtra is Rs. 330.74. As per this account, the annual expenditure would be about Rs. 4000. The expenditure of Rs. 17.50 on water charges works out to only 0.44%. We are of the opinion that there is scope for increasing water rate for domestic use.

Similarly, the income from primary sector of the State (in which the major share is of agriculture and allied sub-sectors) was Rs. 668 crores in 1960-61. It increased upto Rs. 32444 crores in 1996-97, i.e., an increase of 48.5 times. Whereas the income from secondary sector (factories, etc.), increased from Rs 422 crores to Rs. 50929 crores - an increase of 120.50 times. If the All - India Wholesale Price Index is taken into account, as per 1960-61 prices these increments work out to three times and seven times, respectively. This means the income of secondary sector has increased more than two times than that of the primary sector. For this reason, there is a scope for increasing water rates for industrial use also.

9.10 Betterment Levy

9.10.1 Due to irrigation facility, there is an exorbitant increase in land prices in that area. Though it is justful to recover some portion of such unearned income from farmers for capital required for development; it has not yet become possible to raise capital for development from this source.

The National Irrigation Commission (1972) in its report has given the fol lowing information.

During 1888, in the Mysore State where monarchy prevailed, 1/3 or 1/2 of the difference in the market price of rainfed land and irrigated land was charged as betterment levy From 1930, betterment levy used to be charged at the rate of Rs. 30 Per acre. After independence, during the First Plan, instructions were issued to all the states to enact laws for assessment of betterment levy on all new projects. The Taxation Inquiry Commission (1953-54) accepted the principles of betterment levy and recommended that such a recovery should be limited to 50% of the increase in the prices and the recovery should be made over a reasonably long period. During the Second Plan, it was recommended that provision should be made in the act for assessment of betterment levy on the beneficiaries of bore wells and similar minor irrigation schemes.

All the states, excluding Uttar Pradesh, West Bengal and Jammu & Kashmir have enacted legislation for assessment of betterment levy In the states of Uttar. Pradesh, West Bengal and Jammu & Kashmir, such assessment is made possible on the basis of other acts. The assessment of betterment levy is done on the basis of one or more criteria. (1) As in Maharashtra, the rise in the market price of land which has accrued benefit during the period from the day of commencement of the project till the day of its commissioning. (2) As in Mysore, Rajasthan and Telengana region of Andhra Pradesh, the difference in the market price of rainfed land and irrigated land in that area after the project is completed. (3) As in Orissa and Kerala states, the increase in the price of land compared to increase in the price of agricultural production during the year after the project has been completed. (4) As in Punjab, to recover a part of capital cost of the project. In all these acts the proposal is to recover a part of the unearned income. In the states of Andhra Pradesh, Maharashtra, Mysore, Orissa, Punjab and Rajasthan, the landowners can remit this recovery in the form of land.

In most of these betterment levy acts, there is a provision that this recovery should be made at one time or during the period not exceeding the stipulated period of years fixed. In Andhra Pradesh, Kerala, Tamil Nadu and Mysore, the maximum period for this is 20 years whereas it is 15 years in Madhya Pradesh, Punjab & Bihar, and 16 annual installments in Orissa State. In different states this recovery starts after two, three or five years after the irrigation commences in the project area. Such recovery is made from the entire area suitable for irrigation even though that area has not actually derived benefit from irrigation.

The difficulties in the calculation of increase in the market price of land due to irrigation facility, transferring ownership of land to tenants as per the Tenancy Act, Land Ceiling Act, restriction on the transfer of land in order to avoid fragmentation of land, etc., are the factors which influence the market price of land. Because of this, it becomes difficult to, work out the increase in the market price of land due to irrigation. Due to these difficulties the betterment levy act could not be implemented.

Most of the states have not implemented this act and in some states, leave aside recovery, even the assessment has not been made.

The National Irrigation Commission in (1972)has recommended that it is just to recover some part of capital expenditure to be incurred on future projects from the beneficiaries of irrigation facilities in the form of betterment levy. Accordingly, the states should amend the acts. Such recovery should be made after three years from the beginning of irrigation in that area The recovery should be made during the period not exceeding 15 years so that a very large burden will not fall on the beneficiaries The ratio of recovery will differ naturally from project to project because such recovery will depend on per hectare cost of irrigation availability.

Maharashtra State Irrigation Commission (1962) in its Report has mentioned about the provision of betterment levy in the Maharashtra Irrigation Act and has noted as follows.

"In the Vidarbha Act (Madhya Pradesh) the recovery rate is not levied on the increase in the land prices as in Mumbai Act, but according to cost of irrigation work. For Marathwada, as in Hyderabad Act the betterment levy is linked to increase in land prices as in the Mumbai Act. But the dates from which the increase has to be taken into account are not indicated. There is no provision as in Mumbai Act about the announcement of the date of starting of the related work and the date of its completion. The concerned governments have not formulated the rules about assessment of betterment levy as per the Act prevailing in Vidarbha and Marathwada Regions. The Government of Maharashtra has not framed rules as per both these acts, because the question of unification of acts has been under consideration since 1956".

The commission has further said that though in case of Western Maharashtra, the act was announced in 1950, the assessment of betterment levy has not been made yet. The question of recovery is a long way off!

During that period the Tenancy Law and other land reforms were implemented and hence the market values had fallen. It was because of this reason that a part of the unearned increase in land price could not be assessed as betterment levy. Hence in all the three regions of the State, a situation has arisen to suspend the implementation of the act framed for the betterment levy. In the Maharashtra Irrigation Act (1976), no provision seems to have been made for betterment levy. In chapter 25 of the booklet (1984) brought out by the Public Works Department bearing on irrigation management, the following reference is made about the betterment levy.

"Western Maharashtra - In this area, for assessment of recovery, 50 per cent of the amount of difference between the increased price of land due to irrigation facility and price of land prior to facility of irrigation should be recovered as betterment levy. This amount is to be remitted within 60 days from the due date according to the act. Or, if the landowner has entered into agreement, this amount has to be remitted by installments not exceeding 20 annual installments at the interest rate of 5 per cent.

Vidarbha - As per the formula given in what follows, betterment levy is to be paid every year as per the rate fixed.

(1) R = E/(A x 100) x 3/1 (For the first five installment)

(2) R = E/(A x 100) x 9/2 (For the next ten installments)."

In this formula 'E' means the expenditure incurred on extension of canal or improvement or expenditure on excavating of new canal during the previous five years from the date announced as per clause 58. 'A' means the area of land which is benefited from the canal and 'R' means the rate of betterment levy per hectare per year.

Except the year in which the Government defers the recovery of levy, this betterment levy is to be remitted every year for 15 years. On the outstanding dues of the installment, interest is to be paid at the rate of 6% per annum. The Government has been given power to appoint a special officer for determining the exact rate of betterment levy.

According to the advice given by the committee appointed for determining the amount of betterment levy in Marathwada, the Collector fixes the amount. While fixing this, it has been decided that increase in the capital value of the land because of completion of work of irrigation or drainage or due to improvement or extension of it, the land which has been benefited or is likely to be benefited because it would be newly getting irrigation facility, should be taken into account. But the tax assessment should not exceed fifty per cent of this increased value. The limit has been fixed at 1/4 of the value at present. The betterment levy can be remitted in one installment or in equal installments not exceeding 15 without interest. If the entire amount of assessment is remitted within a period of six months from assessment, it is decided that a rebate of 10% would be granted.

The Government faced difficulties in deciding the lands to which guarantee could be given about supply of water every year Hence the Government could not assess betterment levy on such lands. This issue was referred to the Maharashtra State Irrigation Commission (1962) for its consideration. The commission has recommended that betterment levy should be incorporated in water rate itself and there should be only one assessment for water, that is, water rate. The commission also recommended that for different crops, the water charges should be between 6 and 12 per cent of the gross income derived from that crop. The rates should be higher for cash crops and lower for foodgrain crops.

The Maharashtra State, Irrigation Commission (1962) has also suggested that for the convenience of the Government, only one irrigation rate assessment is desirable and it should incorporate both the water rate and consolidated betterment levy. The income from water rate and betterment levy should be isolated (the recovery of betterment levy should be 20% of water rate) from irrigation charges and should be-deposited under different accounting head. But from the farmers only one type of tax, i.e., irrigation charge should be recovered. Considering this, from the information called for about the income from water under different 14 sub-heads during the last 20 years, it seems that nowhere any amount has been remitted under the head of betterment levy. Hence, it seems that betterment levy assessment has not been Included in the water rates. It is learnt from the officers of the Irrigation Department that betterment levy is not assessed anywhere in the State of Maharashtra.

9.10.2 As mentioned in Capital Mobilisation for Irrigation Development (Topic 9.5), it has been suggested from time to time that after the construction of reservoir and canals, the productivity potential of land in influence area and command area increases. Hence, betterment levy in proportion to that increase should be recovered from the farmers of the area But the definite principles of coordination between the policies of water charges to be recovered from beneficiaries and the betterment levy to be deducted from capital could not be evolved and therefore the principle of charging betterment levy could never receive adequate support. After receiving irrigation benefits, it is not seen that the transfer of land takes place on a very large scale and the farmers accrue cash benefits of actual rise in land prices. The benefits which the farmers accrue are not basically from the rise in land prices, but from the improvement and increase in the production system of land. Hence, it is more reasonable to increase the assessment of water rates in proportion to production and units of water required for the same (instead of separately charging water rate for maintenance & repairs and betterment levy). Therefore, in the context of mobilising capital in future, it does not appear to be possible for irrigation projects to think of charging betterment levy.

In the economic management of irrigation corporations, however, irrigation betterment levy should not be treated as a part of annual revenue income. It should be used for raising an independent fund for repairs/ innovation/ 'modernisation'. A detailed discussion pertinent to this subject has already been undertaken under the title 'Modernisation' independently.

Chapter 9
Financial Aspects
List of Annexes & Graphs

(Contd.)

Annex: 9.2.1

Statewise Financial Expenditure incurred on Irrigation Projects, Irrigation Potential Created and Per Hectare Expenditure incurred at the end of 8th Five Year Plan

Irrigation Potential: Thousand Hectare
Expenditure: Rupees in Crore
Per ha Expenditure: Rupees

Sr No.	State	Major and Medium Projects			Minor Projects		
		Irrigation Potential Created	Total Expenditure incurred	Per ha Expenditure (4/3)	Irrigation Potential Created	Total Expenditure incurred	Per ha Expenditure (7/6)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	Andhra Pradesh	3418	5512	16126	1418	721	5083
2	Bihar	3081	5060	16424	1519	1816	11952
3	Gujarat	1694	6898	40721	243	678	2791
4	Haryana	2331	1631	6997	39	270	69308
5	Karnataka	1778	3812	21439	779	811	10417
6	Madhya Pradesh	2412	4677	19390	1283	1798	14011
7	Maharashtra	2430	6811	28028	1031	1675	16242‘’
8	Orissa	1743	4145	23779	736	860	11683
9	Punjab	2543	980	3854	45	248	55323
10	Rajasthan	2288	2978	13014	495	432	8724
II	Tamilnadu	1555	903	5810	954	592	6205
12	Uttar Pradesh	7782	6265	8051	1083	1919	17719
13	West Bengal	1524	1660	6955	1381	753	5452
	India*	35829	53949	15057	12984	15230	11730

* Other States and Union Territories are also included.

Source: Water and Related Statistics Publication June 1996 (Page No 87,88,175 and 176),

Central Water Commission, Government of India, New Delhi.

Inference:

1) Per ha expenditure incurred on Major and Medium Irrigation projects by 8th Five Year Plan in do Maharashtra is Rs. 28028. It is higher most in Gujarat, i.e., Rs. 40721 and the over all per ha expenditure at Country levels is Rs. 15057.

2) Per ha expenditure incurred on Minor Irrigation projects by 8th Five Year Plan in respect of Maharashtra is Rs. 16242. Excluding Punjab and Haryana, the state of UP is having per ha expenditure higher than Maharashtra, i.e., Rs. 17719. The overall per ha expenditure in the country is 11730.

Reference Paragraph: 9.2.1

Annex: 9.2.2

Percentage of Gross Receipts to Working Expenses of Irrigation and Multipurpose River Valley Projects in Selected States

Investment, Receipts, Expenditure: Rs in Crores

States / Periods	Capital Investment	Gross Receipts GR	Current Expenditure WE*	Gross Receipts as %tage of Current Expenditure
(1)	(2)	(3)	(4)	(5)
Maharashtra				
1) 1988-89 to 1989-90	449.10	23.15	399.35	5.80
2) 1990-91 to 1991-92	475.15	19.80	546.20	3.63
Andhra Pradesh				
1) 1988-89 to 1989-90	281.45	20.30	403.25	5.03
2) 1990-91 to 1991-92	265.45	31.30	376.20	8.32
Haryana				
1) 1988-89 to 1989-90	38.00	14.55	105.00	13.86
2) 1990-91 to 1991-92	57.50	16.55	126.80	13.05
Punjab				
1) 1988-89 to 1989-90	86.70	17.00	71.75	23.69
2) 1990 91 to 1991 92	118.90	14.65	91.40	16.03
Tamilnadu				
1) 1988-89 to 1989-90	37.30	1.45	72.45	2.00
2) 1990-91 to 1991-92	45.95	2.20	84.80	2.59
Uttar Pradesh				
1) 1988-89 to 1989-90	282.30	33.50	327.50	10.23
2) 1990-91 to 1991-92	224.30	35.90	424.90	8.45
All India				
1) 1988-89 to 1989-90	2486.00	187.00	2175.90	8.59
2) 1990-91 to 1991-92	2770.65	219.00	2567.42	8.53

* The Current Expenditure is inclusive of interest on Capital at the end of year.

Source: Water and Related Statistics (June 1996), Central Water Commission, New Delhi.

Inference:

1) In case of Major and Medium Projects, even 10 percent of current expenditure (0 M&R expenditure) is not being recovered from the receipts earned there from

2) In the State (Maharashtra) 3 to 6 percent of current expenditure is seen to be realised.

3) The percentage of recovery in Punjab appears to be 16 to 23 percent.

4) During last decade, except in Andhra Pradesh and Tamilnadu, almost all the States exhibited declining recovery.

Reference Paragraph: 9.2.5

Annex: 9.2.3

Percentage of Gross Receipts to Working Expenses of Minor Irrigation Schemes, Soil & Water Conservation Schemes and Area Development Programmes in Selected States

Investment, Receipts; Expenditure Rs in Crores

States / Periods	Capital Investment	Gross Receipts GR	Current Expenditure WE*	Gross Receipts as %tage of Current Expenditure
(1)	(2)	(3)	(4)	(5)
Maharashtra				
1) 1988-89 to 1989-90	87.45	6.85	142.50	4.81
2) 1990-91 to 1991-92	94.15	5.95	165.50	3.59
Andhra Pradesh				
1) 1988-89 to 1989-90	40.60	2.60	49.60	5.24
2) 1990-91 to 1991-92	46.50	1.05	61.05	1.72
Haryana				
1) 1988-89 to 1989-90	14.30	0.45	29.55	1.52
2) 1990-91 to 1991-92	21.95	0.10	50.85	0.20
Punjab				
1) 1988-89 to 1989-90	2.20	0.25	41.75	0.60
2) 1990 91 to 1991 92	7.25	0.05	27.70	0.18
Tamilnadu				
1) 1988-89 to 1989-90	5.30	2.05	39.15	5.24
2) 1990-91 to 1991-92	3.45	2.30	57.30	4.01
Uttar Pradesh				
1) 1988-89 to 1989-90	111.00	12.70	305.75	4.15
2) 1990-91 to 1991-92	50.55	10.80	364.30	2.96
All India				
1) 1988-89 to 1989-90	588.50	43.24	1390.95	3.11
2) 1990-91 to 1991-92	600.10	40.95	1478.25	2.77

* The current expenditures is inclusive of interest on capital at the end of the year.

Source: Water and Related Statistics (June 1996) Central Water Commission, New Delhi.

Inference:

1) In case of Minor Irrigation Projects, in almost all the States percentage of Gross Receipts to Annual expenditure is declined during the by gone decade.

2) The decline in percentage of current expenditure to Gross Receipts is more than 25 percent in all the states except Maharashtra and Tamilnadu.

Reference Paragraph: 9.2.5

Annex: 9.2.4
Benefit Cost Ratio, Internal Rate of Return and Economic Rate of Return in respect of some selected Irrigation Projects and Lift Irrigation Schemes in the State

Sr. No	Project/ Lift Irrigation Scheme	B/C Ratio	Internal Rate of Returns	Economic Internal Rate of Returns	Economic Viability
(1)	(2)	(3)	(4)	(5)	(6)
1	Tembhapuri Medium Project	1.00	10	13	Viable
2	Ranjangaon Minor Project	1.00	10	13	Viable
3	Ashti (LIS)	1.44	17	21	Far More Viable
4	Barshi (LIS)	0.95	10	13	Viable
5	Brahmagavan (LIS)	0.72	5	8	not Viable
6	Ekrukh (LIS)	1.53	19	24	Far More Viable
7	Shirapur (LIS)	0.91	9	13	Viable

Note: Assumptions made for working out BC ratio (Col.3) and IRR/ EIRR (Col. 4 & 5) are same, being related to different periods.
Source: Water and Land Management Institute, Aurangabad.
Inference:
Even though BC Ratio of the project happen to be less than 1, they are regarded: economically viable in view of their IRR being more than 12 and E.I.R.R. being more than 9 percent.
Reference Paragraph: 9.2.7

Annex. 9.3.2
Requirement of Funds for Creation of Additional Irrigation Potential During Coming 30 Years

Rs in Crore, Irrigation Potential: Lakh ha

Sr. No.	Item	Targeted Completion Duration	Budgetary Provision	Bank loan/ Seed Capital	Total funds required (4+5)	Irrigation Potential to be created
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	Irrigation Department					
	a) Major & Medium Projects	20	15600	10400	26000	23.00
	Minor Projects (9.3.7)	10	2400	1600	4000	3.00
	Total (a+b)		18000	12000	30000	26.00
	c) Enhancing utilisation of irrigation potential in respect projects (9.3.8)	10	375	375	750	--
	d) Repairs to Ex. Malgujari Tanks (9.3.9)	3	98	--	98	--
	e) Drainage schemes for damaged area (9.3.15)	3	11	11	22	--
	Total (a+b+c+d+e)		18484	12386	30870	26.00
2	Agriculture Department					
	a) Watershed development programme (9.3.13)	10	6348	--	6348	8.25
	b) Adoption of drip and sprinkler methods of irrigation (9.3.10)	30	7750	5250	13000	12.00
	c) Drainage schemes for area damaged (9.3.15)	20	97	96	193	--
	Total (a+b+c)		14195	5346	19541	20.25
3	New Wells with Pumps					
	a) New Wells with pumps @ Rs 60,000 per well for 1171 Lakh wells. (9.3.12)	20	--	8225	8225	20.00
	b) Cost of electric Power generation for pumps @ Rs 30000 per well (9.3.12)	20	4115	--	4115	--
	Total (a+b)		4115	8225	12340	20.00

(Contd.)

Annex. 9.3.2 (Concld.)

Rs in Crore, Irrigation Potential: Lakh ha

Sr. No.	Item	Targeted Completion Duration	Budgetary Provision	Bank loan/ Seed Capital	Total funds required (4+5)	Irrigation Potential to be created
(1)	(2)	(3)	(4)	(5)	(6)	(7)
4	Recycling of Water used for domestic purposes in urban areas (9.3.14)	30	--	4478	4478	3.00
	Total(1+2+3+4)	--	36794	30435	67229	69.25

Note: Number indicated in brackets in the column No. 2 refer to related paragraphs.
Inference:
In order to create an additional irrigation potential of 69.25 lakh ha in the coming 30 years period in the State, funding required will be of the order of Rs. 68 thousand Crores. Out of this Rs. 37 thousand crores will have to be made available through the budgetary provision of the Govt. while Rs. 31 thousand crores through institutional finance.
Reference Paragraph : 9.3.16

Annex: 9.9.1. Assessment, Recovery and Total Arrears of Water Charges

Rs. in Crores

Year	Arrears at the Commence-ement of the year	Assessment during the year	Total recovery to be made (2+3)	Actual Recovery	Arrears at the end of year (4-5)	Actual recovery % of the total recovery to be made (5x100/4)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1) Irrigation						
1989-90	67	20	87	9	78	10.3
1990-91	78	14	92	12	80	13.0
1991-92	80	25	105	12	93	11.4
1992-93	93	30	123	19	104	15.4
1993-94	104	26	130	23	107	17.7
1994-95	107	28	135	21	114	15.6
1995-96	114	36	150	21	129	14.0
1996-97	129	39	168	32	136	19.0
Total	**772**	**218**	**990**	**149**	**841**	**15.0**
Average*	**96.5**	**27.3**	**123.8**	**18.6**	**105.1**	**15.0**
2) Non Irrigation						
1989-90	9	5	14	3	11	28.6
1990-91	11	4	15	4	11	26.7
1991-92	11	11	22	8	14	36.4
1992-93	14	67	81	27	54	33.3
1993-94	54	95	150	59	91	39.3
1994-95	91	88	179	48	131	26.8
1995-96	131	86	217	59	158	27.5
1996-97	158	93	251	62	189	24.7
Total	**47.9**	**449**	**929**	**270**	**659**	**29.1**
Average	**59.9**	**56.1**	**116.1**	**33.8**	**82.4**	**29.1**

(Contd.)

Annex: 9.9.1. *(Concld.)*

Year	Arrears at the Commence-ement of the year	Assessment during the year	Total recovery to be made (2+3)	Actual Recovery	Arrears at the end of year (4-5)	Actual recovery % of the total recovery to be made (5x100/4)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
3) Total (Irrigation + Non Irrigation)						
1989-90	76	25	101	12	89	12.9
1990-91	89	18	107	16	91	15
1991-92	91	36	127	20	107	15.7
1992-93	107	97	204	46	158	22.5
1993-94	158	121	280	82	198	29.3
1994-95	198	116	314	69	245	22
1995-96	245	122	367	80	287	21.8
1996-97	287	132	419	94	325	22.4
Total	**1251**	**667**	**1919**	**419**	**1500**	**21.8**
Average	**156.4**	**83.4**	**239.9**	**52.4**	**187.5**	**21.8**

Note: Total may not tally due to rounding off.
Source: Irrigation Department, Government of Maharashtra, Mumbai.
Inference:

1) Considering arrears of previous years, the recovery water charges is 22%. The recovery of Irrigation water charges is 15% whereas the samein case of non irrigation is seen to be 29%, i.e., almost double that of irrigation.
2) Actual recovery is 63% of the assessment dudes the year the same is 68% in case of irrigation while it is 60% for non irrigation.
3) The recovery in case of non irrigation use is on an average 70% of the total recovery over the 3 years period, i.e., 1994-97.
4) The assessment of irrigation was observed to be 75% on an average of that of total assessment over the period 1989-92, while the same was 27% over the period 1992-97. In respect of actual recovery, it is, however, 56 and 73 percent with respect to assessment for the respective periods, i.e., 1989-92 and 1992-97.
5) The assessment incase of non-irrigation use during the period 1989-92 is 25% of the total assessment, (i.e., for irrigation and non irrigation) while actual recovery was 75% of the total assessment. On the contrary, during the period 1992-97 the assessment in respect of non irrigation use is 73% of total assessment.

Reference Paragraphs : 9.2.6, 9.9.4 and 9.9.11.

Annex: 9.9.2 Arrears of Water Charges for Irrigation at the End of March 95

Rs. in Crores

Sr.No.	Region	Penalized assessment at prevailing rates			Assessment at double the prevailing rates	Pokal akarni, i.e., Assess-ment for non utilising water even after demanded	Amount of late fee for delay in payment of water charges	Total arrears (5+6+7+8)
		Total Amount	20% Cess	Total (3+4)				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	Konkan	1.90	0.38	2.28	0	0	0	2.28
2	Nashik	1.67	0.34	2.01	3.34	0.11	0.90	6.36
3	Pune	8.51	1.69	10.20	17.02	0.78	2.09	30.09
4	Aurangabad	13.91	2.77	16.68	25.36	0.84	3.11	449
5	Amrawati	0.51	0.10	0.61	1.01	0.01	0.18	1.81
6	Nagpur	0.88	0.18	1.06	1.79	*	0.51	3.36
	Total	27.38	5.46	32.84	48.52	1.74	6.79	89.89

* This amount is merely Rs 4000
Source: Irrigation Department, Government of Maharashtra, Mumbai.
Inference: The arrears of Irrigation ending 31st March 95 were Rs 89.89 crores. The same washigher most, i.e., 51% in Aurangabad Region, 33% in Pune Region whereas in remaining Regions, viz., Konkan, Nashik, Amravati and Nagpur it was 2 to 7 percent.
Reference Paragraph: 9.9.11

Annex: 9.9.3 Water Rates as Percentage of Gross Income per hectare of Principal irrigated Crops (1995-96)

Production: Quintal
Amount : Rupee

Sr.No.	Crop	production Per ha	Farm harvest price (per quintal)	Total gross income per ha	Water rates (per ha)			Water rates as percent of gross income		
					1996	1999	2003	1996	1999	2003
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1	Rice	16.99	412.55	7009	100-200	110-220	160-320	1.4-2.8	1.6-3.1,	2.3-4.6
2	Wheat	14.80	487.80	7219	200	220	320	2.8	3.0	4.4
3	Jowar (*Kharif*)	14.20	400.35	5685	100-200	110-220	160-320	1.8-3.5	1.9-3.9	2.8-5.6
4	Jowar (*Rabi*)	10.72	400.35	4292	150	165	240	3.5	3.8	5.6
5	Bajri	9.58	381.20	3652	100	110	160	2.7	3.0	4.4
6	Maize	15.37	338.50	5203	100	110	160	1.9	2.1	3.1
7	Gram	6.16	893.50	5564	150	165	240	2.7	3.0	4.4
8	Sugar Cane*	85.53+	829.57++	70950	1750	2890	4230	2.5	4.1	6.0
9	Cotton*	14.50	1063.35	15418	300	310	485	1.9	2.1	3.1
10	Groundnut (*Kharif*)	10.96	1128.70	12370	200	220	320	1.6	1.8	2.6

* The information under Col.3 & 4 in respect of these crops pertains to the year 1994-1995.

+ Tonnes, ++ Per Tonne

Sources: 1) Districtwise Agricultural Statistical Information of Maharashtra, Part II, (1995-96), (P-140, 141).

2) Epitome of Agriculture, Part - I Year 1995-96, (p-69)

3) Monitoring and Evaluation Unit (Training & Visit) Commissionerate of Agriculture, Maharashtra State Pune.

Inference: The rates appear to be not even 6% of the gross income in respect of even a single crop.

Reference Paragraph: 9.9.4

Annex: 9.9.4 Area under Principal Crops

Area: Hundred ha

Sr.No.	Crop	Total area under crops		Area under the crops as percentage of total area under crops		Area under crops		Area under the irrigated crop as percentage of total area under irrigation		Area under irrigated Crops as percentage of total area under crops	
		1961-62	1994-95	1961-62	1994-95	1961-62	1994-95	1961-62	1994-95	1961-62 (7 x 100/3)	1994-95 (8 x 100/4)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	Rice	13190	15380	6.92	7.18	2660	3495	21.56	10.59	20.17	22.72
2	Wheat	9070	7670	4.76	3.58	1413	5735	11.45	17.38	15.58	74.77
3	Jowar (*Kharif*)	24260	22620	1233	10.28	91	109	0.74	0.33	0.38	0.50
4	Jowar (*Rabi*)	37280	31480	19.57	14.70	2731	4000	22.14	12.12	7.33	12.71
5	Bajri	16880	17660	8.86	8.25	337	853	2.73	2.58	2.00	4.83
6	Maize	270	2010	0.14	0.94	109	888	*	*	*	*
7	Other cereals	4390	3090	2.30	1.44	25	888	1.09	2.69	2.88	17.41
8	Total Cereals	105340	99310	55.28	46.37	7366	15080	59.71	45.69	6.99	15.18
9	Tur	5620	10460	2.95	4.88	41	-	0.33	-	0.73	-
10	Gram	4040	7630	2.12	3.56	363	2154	2.95	6.53	8.99	28.33
11	Other pulses	14560	17870	7.64	8.35	35	-	0.28	-	0.24	28.23
12	Total pulses	24220	35960	12.71	16.79	439	2154	3.56	6.53	1.81	5.99
13	Total food grains	129560	135270	67.99	63.16	7805	17234	63.27	55.22	6.02	12.74
14	Sugar cane	1540	6120	0.81	2.86	1541	6120	12.49	18.54	100.00	100.00
15	Cotton	26920	27600	14.13	12.89	419	619	3.40	1.88	1.57	2.24
16	Groundnut (Khar	11180	4740	5.87	2.21	162	186	1.31	0.56	1.45	3.92
17	Other Crops	21340	40450	11.20	18.88	2409	8846	19.53	26.80	11.29	21.37
18	Total:	190540	214180	100.00	100.00	12336	33005	100.00	100.00	6.47	15.41

Note: * Included in other cereals.

Source: Epitome, of Agriculture Year 1995-96, Part II, Chief Statistician, Commissioner ate of Agriculture, Maharashtra State, Pune

Inference:- 1) Of the principal crops irrigated, area under Wheat and other Cereals during 1994-95 has increased by 6% and 14 respectively over that of 1961-62, while area under Rice and *Rabi* Jowar had decreased by 10 tot 1 percent. Area under gram has increased by 3% while area under sugarcane has increased by 6%. Area under other crops like turmeric, Potato, Chillies and Tobacco, etc., together has increased by 7%.

2) Considering the percentage of area under various principal irrigatted crops to total area under crops during 1994-95 is increase by 9 % over that of 1961-62. The higher most increase is in case of wheat, i.e., 60% followed by gram, i.e., 19% *Rabi*, Jawar 5% where as under paddy 2%.

References Paragraph: 9.9.6.

Annex: 9.9.5
Per Hectare Production of Some Principal Crops

Production: kg

Sr.No.	Crops	Production per ha pertinent to the total area under crops		Production during 1994-95 as compared to 1961-62 (times)	Per ha Production pertinent to area irrigated during 1994-95	Comparison of yield from irrigated area to that from total area under crops pertinent to year 1994-95
		1961-62	1994-95			
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	Rice	1145	1558	1.36	1464	0.97
2	Wheat	466	1449	3.11	1625	1.17
3	Jowar (*Kharif*)	594	1371	2.30	1272	0.93
4	Jowar (*Rabi*)	409	496	1.21	858	1.73
5	Bajri	256	631	2.46	988	1.50
6	Tur	613	495	0.81	-	-
7	Gram	338	614	1.82	795	1.29
8	Total food grains	498	852	1.71	1297	1.52
9	Sugar cane	67149	85527	1.27	-	-
10	Cotton	63	145	2.30	277	1.91

Source: Epitome of Agriculture: Year 1995-96, Part I Commissionerate of Agriculture, Maharashtra State, Pune.
Inference: The yield from irrigated area in respect of all the principal crops is 1.25 to 1.75 times to that of total area under respective crops.
Reference Paragraph: 9.9.6.

Annex 9.9.6
Area Under Major Fruits and Vegetable Crops and Their per ha Production

Area: Hundred ha
Yield: Tonne

Sr.No.	Fruit/ Vegetable crop	Area under crop		Increase in area under the crop	Crop yield		Increase in yield (%)
		1960-61	1994-95		1982-83	1994-95	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	Banana	230	374	63	48.3 (250)	56.700	17
2	Grapes	10	210	2000	12.8 (29)	22.000	72
3	Onion	220	937	326	13.451 (579)	12.883	(-)4
4	Total fruit crops	690	2440 (1991-92)	253	74.551 (858)	20.753	
5	Total vegetable crops	780	2390 (1991-92)	206			

Note: Figures in brackets indicate total area under the crop during 1982-83.
Source: 1) Epitome of Agriculture: Year 1995-96, Part-I Commissionerate of Agriculture, Maharashtra State, Pune.
2) Districtwise Agricultural Statistical Information of Maharashtra, Part II, (1995-96).
Inference:
1) The increase in yield in respect of Banana and Grapes during 1994-95 over to that of 1982-83 was seen to be 17 and 72 percent respectively. There is no sizable variation in the yield of onion.
Reference Paragraph: 9.9.6.

Annex: 9.9.7
Non Irrigation Use of Water from Irrigation Project, 1994-95

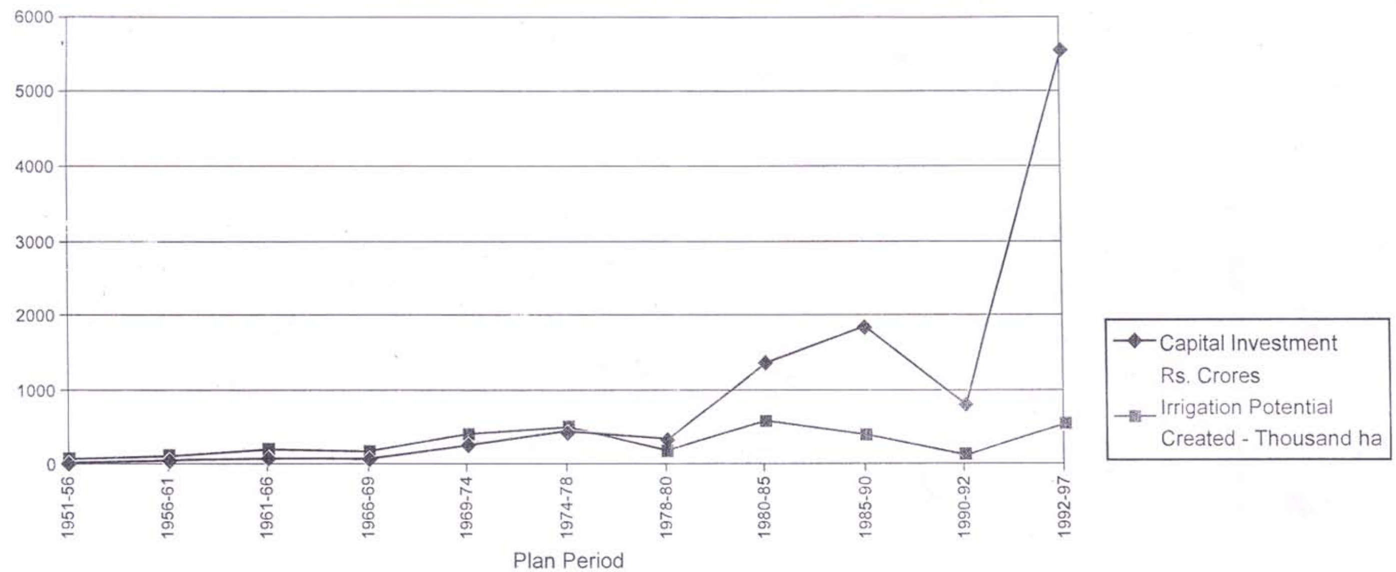
Water-Mm

Sr.No.	Region	Live Storage	Planned non-irrigation use	Planned Non-irrigation use as percentage (4/3) x 100	Actually available Live storage (15-10-94)	Actually use for Non irrigation	Actual non irrigation use as % (7/6) x 100
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	Konkan	2388.13	1113.86	46.64	1772.61	439.01	24.77
2	Nashik	7749.00	135.10	1.74	7281.00	882	12.11
3	Pune	7751.68	587.72	7.58	5410.47	840.61	15.54
4	Aurangabad	5432.01	19.27	0.35	2810.00	301.86	10.74
5	Amrawati	2012.95	161.06	8.00	1019.04	67.39	6.61
6	Nagpur	3193.18	324.77	10.17	2763.96	171.61	6.21
	Total	28526.95	2341.78	8.21	21057.08	2702.48	12.83

Source: Regional Irrigation Status Reports, 1994-95, Irrigation Department Government of Maharashtra.
Inference: The non-irrigation water demand (planned water use) is 1.5 times of non irrigation water use.
Reference Paragraph: 9.9.12.

Graph - 9.2.1

Capital Investment & Irrigation Potential of Irrigation Projects



Source : Irrigation Department, Government of Maharashtra

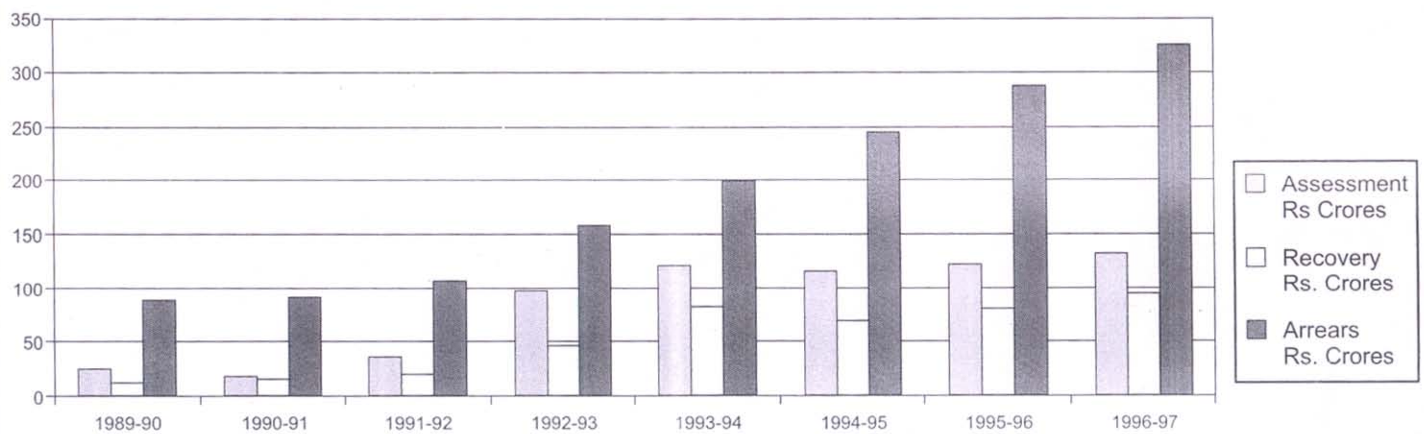
Inference :

The created irrigation potential is not commensurate with the investment made in various plan periods.

Reference Paragraph : 9.2.1

Graph - 9.9.2

Yearly Assessment of Water Charges, Recovery and Cumulative Arrears



Source : Irrigation Department, Government of Maharashtra

Inference :

The arrears appear to be in increasing trend. Therefore, it is atmost necessary to boost up recovery.

Reference Paragraph : 9.9.11

CHAPTER 10
NON-IRRIGATION USES OF WATER

This chapter incorporates information on non-irrigation uses of water like use for domestic consumption, industry, thermal power generation etc. It also discusses aspects of water pollution, purification, reuse of water and pertinent topics like water use, for tourism development, fisheries, etc.

10.1 Water Use for Domestic Consumption

10.1.1 Availability of water is a determinant of development of the human culture. Human habitation could foster only there where drinking water had been available round the year. Where such perennial sources were not available, village tanks were constructed to meet the winter and summer requirement of drinking water of human beings and to have had water in an adequate measure to cope up with the drinking water requirement of livestock. Persisterit efforts appear to have been made to cater for adequate and clean drinking water supply to the increasing habitats. Especially, systems had been created in Maharashtra during the medieval period for catering on permanent basis drinking water supply round the year to military camps of permanent standing, civil colonies, forts which were crucial from political viewpoint by deploying engineering skill. An overview at length in this regard is already appearing in Chapter 2.1.

10.1.2A separate group had emerged in Maharashtra which used to provide drinking water to the urban population manually. This group was generally called as *"bhisti"*. People from the *Bhoyee*, *Koli* communities also used to supply drinking water to urban areas. The *kawad* and pakhal were the traditional means with which to convey water. A *"kawad"* was formed by hanging big pots of water (*kanda*) at both the ends of a bamboo stick, which could be carried by a person on his shoulders. Two leather bags, each of about 50 to 60 litres capaCity, also used to be loaded on the back of a buffalo on either sides to form a *"pakhal"*. The community which was used to supply water to the urban population through these means used to be called as *"bhisti."*

10.1.3 Even today water continues to be brought for their domestic drinking use from sources like rivers, village tanks, individual and community wells by the villagers on head load using, large pitchers and metal vessels. Besides the water wheels, buckets tied to a string were used to draw groundwater from wells. Now they are being gradually replaced on a large scale by hand pumps and power-driven pumps. Efforts are now being made to have pipe water supply schemes and to distribute drinking water to householders. In earlier days, water was brought through human or animal labour and so was used conservatively and carefully. Individual needs were thus comparatively smaller and confined to thinking, cooking and washing utensils only Quantity of wastewater generated also used to be small. Use of pumps and ipes has substantially increased per capita use of water.

10.1.4 An organisation named *"Maharashtra Jeevan Pradhikaran"* has been handling the works of the piped water supply and wastewater disposal in the State for more than 100 years and has thus acquired an extensive experience in design, execution, operation and maintenance of these schemes.

During the British rule, the pace of these developmental works was slower and was used to be handled by the "Consulting Public Health Engineer." From the year 1945, this activity was controlled at Pune by the "Public Health Engineer to the Government". Late Sir. M. Visvesvaraya, the world-renowned engineer worked on this post for some period. After independence, in the year 1958 this post was converted into a post of Superintending Engineer similar to that in the other Government departments.

After having carved out the Irrigation Department from the then Public Works Department by the year 1958, the Public Health Engineering Wing was transferred to this new department. After formation of the Maharashtra State in the year 1960, firstly a post of Superintending Engineer was created at Nagpur and subsequently similar offices were opened at Mumbai and Aurangabad.

The Maharashtra Public Health Engineering Organisation - a part of the Irrigation Department till the year 1975 - has been subsequently renamed as the "Environmental Engineering Organisation" and administratively transferred to the Urban. Development and Public Health Department of the Government.

The concept of a separate institution for the management of loans from the Life Insurance Corporation to finance the urban water supply and wastewater disposal schemes gave rise to the creation of the "Maharashtra Water Supply and Sewerage Board" in the year 1977. This board was entrusted with the responsibility of helping the local bodies (except the cantonments) in preparing long term plans and executing them.

In October 1979, the entire duties and functions, the assets and, the services of the trigineers of the Environmental Engineering Oraganisation were transferred to this Board.

10.1.5 In spite of efforts on the part of the Government and the local bodies, the water supply situation continued to become more and more acute. After having noticed it, the Government has accorded the highest priority to this problem and created the "Water Supply and Sanitation Department" in *Mantralaya* in 1995 to overcome this situation. A white paper analysing the problems and proposing remedial measures pertinent to water supply has been brought out in July 1995. On 11th October 1996, *Maharashtra Jeevan Pradhikaran* has been formed by amending the Maharashtra Water Supply and Sewerage Board Act of 1976 to look after the work of planning, designing and execution of proposed on turn key basis for carrying out water supply and sewerage works in the entire State except the Greater Mumbai. A master plan to provide satisfactory solution to water supply problems was formulated by the *Pradhikaran* for period from 1996 to 2000. The plan is being implemented by three organisations. The *Maharashtra Jeevan Pradhikaran* is responsible to implement all the urban water supply and sanitation schemes and the rural piped water supply schemes costing more than Rs. 15 lakh. The *Zilla Parishads* have been entrusted with the responsibility of implementation of piped water supply schemes for rural areas costing upto Rs. 15 lakh and drinking water supply programme through measures such as open dug wells, pans, etc., and also mini water supply schemes. The Groundwater Surveys and Development Agency is to shoulder the implementation of drinking water supply responsibility through hand pumps or power-driven pumps. To achieve coordination among all the three agencies, a post of the District Water Supply Officer has been created in every district and the Superintending Engineer of *Maharashira Jeevan Pradhikaran* in charge of the district is entrusted with the local responsibility of extending guidance.

Growing Demand

10.1.6 Population of Maharashtra had been 3.96 crore in the year 1991. The urban population formed about 28% of the total population. Barve Commission (1962) had allocated 1456.69 Mm^3 water for drinking purpose in urban and rural areas and had predicted that the demand would double in the following 25 years. Total population of Maharashtra has been estimated at about 8.81 crore by the year 1996 with about 3.52 crore residing in urban areas and 5.29 crore residing in rural areas. The domestic water demand has been estimated at 2767.52 Mm^3, 1705.46 Mm^3 is of urban area and 1062.06 Mm^3 is of rural area The population by the year 2030 is projected at 18.13 crore (8.45 crore urban and 9.68 crore rural). The water demand is estimated as 6187.57 Mm^3 out of which, 4240.47 Mm^3 is expected in case of urban areas whereas 1943.10 Mm^3 that in rural area (Statement 10.1.1). Share of drinking water on count of urban area is going to increase due to the increasing level of urbanisation.

10.1.7 The industrialisation is causing the rapidly increasing pace of urbanisation. Good job opportunities in urban area and scarcity prone condition in rural area have resulted in the migration of rural population to the towns and cities. The existing civic facilities in cities are, therefore, falling short and owing to expansion of cities the nearby available sources are proving inadequate compelling implementation of schemes involving long-distance water conveyance. Day-by-day it is becoming difficult to finance such schemes. Relentless exploitation of groundwater for irrigation has been one of the main reasons of water scarcity in villages. It has, therefore, become necessary to protect and conserve water sources in rural areas and regulate withdrawals therefrom for irrigation. Growing population, increased urbanisation as a result of industrialisation and uncontrolled draft of groundwater have made the need of planning afresh the water use on count of domestic, irrigation and industrial purposes and preparing a balanced water plan of the available surface as well as groundwater in river basins imperative.

10.1.8 The comparison between the amount of available water from the surface and subsurface (sources and the likely demand by the year 2030 shows a higher degree of imbalance. The following table shows that the potential use of water in the year 2030 will be 127 % more than the available water in Krishna Basin while in Godavari Basin, it will be more than 129%. The sub-basinwise analysis shows that the proposed use of water will be more than the availability in Manjra, Puma (Dudhana), Upper Godavari and Wardha Sub-basins.

Basinwise Availability and Demand of Water in the Year 2030

Sr. No.	Basin	Water available for use (Mm^3)*	Estimated demand in the year 2030		
			Irrigation	Other uses	Total
(1)	(2)	(3)	(4)	(5)	(6)
1	Godavari	38882 100%	46422 120%	3546 9%	49968 129%
2	Krishna	18356 100%	18713 102%	4748 25%	23461 127%
3	Tapi	9324 100%	8487 91%	1841 20%	10328 111%
4	Nannada	343 100%	364 106%	10 3%	374 109%
5	Konkan	72322 100%	9862 14%	3675 5%	13537 19%
	Total	**139227** **100%**	**83848** **60%**	**13820** **10%**	**97668** **70%**

* Including average surface water availability and groundwater.
Reference: Statement 10.1.2

However, water use envisaged in Central Wainganga, Painganga and. Indravati Basins (Statement 10.1.2) will be less than the water availability. In Konkan Basins, only 19% of the water will be utilised during the year 2030.

It will be necessary to consider beforehand the provision for drinking water while planning use of water for irrigation in sub-basins in which the expected water demands are likely to be more than the available water.

Drinking Water Problem

10.1.9 For improvement in quality of life of human beings, drinking water should have been available in requisite quantity and should be hygienically pure. The World Health Organisation has promulgated standards in this respect all over the world. The Government of Maharashtra has also prescribed a minimum per capita supply of 55 litres per day in rural areas and 70 litres to 150 litres in urban areas depending on the size of the town. (Master Plan, Government of Maharashtra, October 1996). At these rates, a provision of 20 m^3 of water per capita in rural areas and 30 to 60 m^3 per capita in urban areas will have to be made available every year. Compared to these figures, the available water ranges from the minimum of 103 m^3 per capita in Girna Sub-basin to the maximum of 15841 mi per capita in Terekhol-Tillari Sub-basin in Konkari (Statement 3.2.1). The standards and the supply management system for drinking water adopted by the Government are, however, the same all over the State. In view of doubling of the population during the forthcoming 30 years, the urgent issue of water supply system that is going to remain is that at nowhere shortage of drinking water in its totality be required to be experienced in the least; and thereafter comes the same of localised growth of population & industrial centres and decentralisation related thereto. In sub-basins, (e.g., Sina), where the availability of water is on an mierage short of 500 m^3 (i.e., hardly 362 m^3 per capita) it is essential to ensure that the growth in population, industrial centres and irrigation area does not outgrow limitlessly.

Comparative study of total available water and that is required for drinking purpose in Maharashtra State as a whole, reveal that the demand of drinking water is quite meagre. However, this demand is not uniformly distributed all over the geographical area A large proportion of this demand is‘ concentrated in regions of large towns and cities. As supply of water catered for domestic and industrial needs results in creating increasing shortgge of water required for irrigation in rural life, issues as to availability of water have cropped up, especially in sub-basins where capability of locally available sources is limited. For example, Nashik-and Aurangabad Corporations in Godavari Basin, Pune in Bhirna Basin, Solapaur, Ahmadnager in Sina Basin. A discordance is invoked between the requirement of water at theseplaces and the locally available water.

Hence while undertaking planning of these sub-basins, it is essential to analyse critically the water supply being catered-to urban area and the returns likely to be accrued therefrom. Normally, the aspect of returns from water so supplied does not receive the same degree of attention as-that of the supply of water and demand pertinent thereto. For example, the issues of collection, treatment and reuse of the wastewater have not received the attention which they deserve and thus have caused more stress in areas which are already deficit. To mitigate this, it will be essential to implement on priority the programmes of recycling and reuse of water in these deficit sub-basins during the forthcoming decade.

10.1.10 It is going to be absurd to apply the same standards in respect of supply of drinking water at uniform norm to deficit as well as abundant sub-basins while planning needs in human life in the context of natuial availability. In order not to adversely affect the public life and water that is required for means of livelihood in deficit basins, less water than that stipulated for normal basinS be provided by undertaking timely review of drinking water norms in such deficit sub-basins. In any basin, it may not be affordable to supply more than 10% of the available water for drinking needs in urban and rural areas, since the demand for industries and other human needs also need to be coped with. It is extremely important to maintain a good balance between these two needs in those sub-basins.

10.1.11 To improve the living standard in rural areas and reduce the gap between urban .and rural areas pertinent to that, it is essential to progressively increase the per capita supply of water in rural areas. Adequate facility for drinking water supply can be one of the measures to curb migration of rural population to urban areas. Hence, one of the suggestions is to supply water at the rate of 100 litres per capita per day, (i.e., 40 m^3 per capita per year) in rural areas, except in the small dispersed hamlets located at far-off, inaccessible locations. Nevertheless, this appears to be infeasible when its economic aspects are scrutinised.

Water Requirement of Livestock

10.1.12 Livestock is an integral part of rural life. Improving its capability and productivity is one of the important objectives of rural development. Accordingly, a separate estimate and provision of water supply to meet needs of livestock be made. The present practice is to make an additional provision of 5 litres per capita per day in supply rate to human population while planning rural water supply schemes. This is not proper since actual need of an animal is much more. Different animals like buffaloes, camels, cows, bulls, goats, poultry, etc., require different quantities of water for drinking and other cleaning works (like animal washing and place washing). The goat or sheep requires about 8 litres per head per day while a cqw or a buffalo requires about 80 litres per head per day. But considering the optimum yield of 40 litres of milk per day, a milching cow needs about 120-150 litres of water per day. The information on water requirement of domestic animals in each sub-basin in years 1996 and 2030 has been collected from the Animal Husbandry Department is presented (Statements 10.1.3 and 10.1.4). Total water requirement for animals has been estimated at 748.723 Mm^3 in the year 1996 and 1000 Mm^3 in the year 2030. The Commission feels that planning of rural water supply schemes should make a separate provision for water supply and its management thereof on count of live stock. The large scale migration of livestock population in drought and scarcity years due to insufficient provisions needs to be avoided. Dairy farming is goirig to occupy an important place in the rural economy and hence warrants a Careful consideration.

Problem Villages and Hamlets

10.1.13 Maharashtra experienced severe drinking water scarcity and the drought during the year 1972. Shortage of drinking water has not been fully made good since then. It recurs in every summer. In sixties, development of irrigation facilities was accorded priority to overcome scarcity of food crops. This resulted in large scale exploitation of groundwater by way of installing electric pumps on wells, culminating into lowering of the groundwater table in many areas. In the changed situation, the traditional sources like rivers, shallow and deep wells, village tanks, etc., dried up in many areas. Scarcity of drinking water became more and more acute. The supply of drinking water to villages and hamlets by tankers, which started as an emergent measure, later on became a regular practice. As per the Master Plan, about 27654 out of total 40785 villages and 25808 out of total 45896 hamlets face the problem of water shortage. The Government of Maharashtra has undertaken an ambitious programme of making the State tanker-free by supplying water to all the problem villages and hamlets from the dependable water sources by the year 2000. Investigation of the ground water sources and development of new sources have been undertaken through the Groundwater Surveys and Development Agency for small villages and hamlets.

10.1.14 However, the present trend is generally to supply water to bigger villages with population more than 2000 from the surface water sources. Since, construction of independent storage reservoirs exclusively for drinking water supply is mostly impractical, the reservoirs constructed for irrigation purpose are generally used for most of the drinking water supply schemes. This creates a shortfall in irrigation potential planned by the Irrigation Department. Use of part water for drinking which is going to cause proportionate shortfall in water that would have otherwise been available for agriculture in deficit basins calls for development of the concept of coordinated planning even at a village level. Presently, a clear system of ensuring planning of the coordinated water use at the village level does not appear to have been in existance. The lifting of groundwater for irrigation being at individual levels is uncontrolled and therefore takes place without limit. It causes harm to the public water supply facility. It is, therefore, essential to plan an integrated use of water sources available at the village level. This arrangement needs to be implemented desirably through medium of the *Panchayat Raj*. Several villages are benefited from the watershed area development units other than groundwater or they gain water from irrigation, canals or seepage therefrom. *Panchayat Samiti* needs to be entrusted with the responsibility of taking into consideration all available water sources at village level, identifying and reserving the sources and quantity of water for drinking purposes and undertaking planning for properly using these sources. The proposed watershed development committee shall provide the necessary guidance. It is doubtful as to how much extent the present district level water supply coordination committee can pay attention to the coordinated set-up at village level. Consistent with the decentralisation envisaged in the *Panchayat Raj* Act, it is desirable that this responsibility shall be entrusted with the *Taluka Panchayat Samiti.*

Urban Water Supply

10.1.15 Piped water supply schemes exist in all the towns and cities in Maharashtra except in Malayan. The actual supply is much less than that specified in the per capita supply norms at many places as is seen from the Annexes 10.1.1 and 10.1.2.

For successful operation of the underground sewerage schemes, a minimum water supply of 150 litres per capita per day is required in urban areas.

10.1.16 Supply to the towns and cities is usually catered from the surface water sources. Presently supply to many of them is being catered from the storage reservoirs built for irrigation purpose. Very few cities have their own water sources. The Government has resolved to reserve upto 15% of the live storage in irrigation storage reservoirs for drinking purpose. If such reservation exceeds 15%, then that proportionate cost of the construction of the storage reservoir is to be shared by that scheme as stipulated in the present policy. In drought prone areas, it is seen that good rainfall for 2-3 years is followed by less than average rainfall in next 1-2 years. This results in reduction of yield coming into the reservoir. Hence the surface water source, which is considered to be more dependable, is not so useful in drought period in absence of carry over of yield in good rainfall years. For example, in the year 1994 the water level in Dhanegaon Storage went below the minimum draw down level due to which Latur Town had to depend entirely on the groundwater. Before implementation of the piped water supply scheme, Amravati Town also largely depended on the groundwater sources. This shows that the groundwater can serve as a good supplementary source in bad years provided the recharging of aquifers is cautiously accomplished in times of good rainfall.

At present, shortage is experienced in the supply of water from the piped water Supply schemes in summer. As an emergent measure, the Government provides grants to the municipal councils for drilling bore wells. Manybore wells have thus come up in municipal areas since last so many years. This has resulted merely in lifting of groundwater. It will be necessary to take up measures for groundwater recharge in good rainfall seasons. Rainwater falling on roof tops of buildings which normally flows down is collected through rainwater pipes and allowed to soak into the ground instead of allowing to flow out in rainy season.

According to the estimates prepared by *Maharashtra Jeevan Pradhikaran,* an outlay of Rs. 10979 crore will be required to provide water supply to towns and cities as per the prescribed norms. Out of this 40 to 45% outlay will have to be provided by the Government as grant-in-aid. Knowing that the financial resources of the Government are limited, it is desirable to reduce as much as possible the burden on the public system. Hence evolving an integrated approach in providing water supply by pooling diverse sources including groundwater together has become obligatory.

10.1.17 Details in Annex 10.1.1 show that most of the municipal corporations are pot in a position to supply drinking water at the prescribed water supply rates to the population in their jurisdiction. They are also not in a position to bear the huge capital expenditure involved in bringing water to the city from distant water sources (like storage dams). In fact, it is equally necessary to take up the wastewater and sewage disposal schemes also alongwith those of water supply. But that could not be materialised.

Financial Implications of Drinking Water Supply and its Use

10.1.18 Following table shows the capital and recurring cost per cubic metre (cum) of water supplied to urban and rural areas from different sources and by way of various methods. The capital cost per cum of water supply from surface sources through piped water supply scheme is generally Rs. 20 in urban areas and Rs.10 in rural areas whereas recurring cost is Rs. 7 per cum in urban water supply and Rs. 5 per cum in rural water supply. The capital cost of water supply from groundwater sources in rural areas is Rs. 25, 15 and 5 per cum in case of wells, borewells with hand pumps and borewells with electric pumps respectively. Corresponding recurring costs are Rs. 5,5 and 2 per cum, respectively. Storage of rainwater falling on rooftops requires about Rs. 1500 per cum as capital investment and Rs. 220 per cum as recurring expenditure. Rs. 1000 and Rs. 50 per cum are required to meet the capital (private) and recurring costs of water supply through tankers. This arrangement is the most expensive of all.

Cost of Drinking Water Supply in the State

Cost in Rs. per m^3

Sr.No.	Particulars	Public capital investment	Recurring cost	Remarks
(1)	(2)	(3)	(4)	(5)
1	Urban water supply	20	7	Piped water supply
2	Rural water supply			
	(a) From surface sources	10	5	Piped water supply.
	(b) From groundwater sources			
	(i) Wells	25	5	Piped water supply.
	(ii) Hand pumps	15	4	
	(iii) Electrically operated pumps	5	2	
	(c) Storage of rainwater on roof tops	1500	220	
	(d)Through tankers	1000 (Private investment)	50	

Reference: Compilation of information received from concerned agencies.

Notes: (1) Foregoing figures indicate broadly an average situation.
(2) Recurring cost includes interest and depreciation.

10.1.19 Supply of drinking water from nearby groundwater sources using electric pumps is the cheapest. However, due to unreliable nature of the groundwater source, there is a tendency to supply water in rural areas from the surface water sources which, however, is not desirable. Schemes which do not observe the financial norms are entailing wastage of scarce resource. On the path of development all the systems will have to be formulated on the marginal cost principle so as not to render them untenable economically. Water rates being charged for drinking water supply appear to be smaller than half the cost of such water supply Water tax of only Rs. 3.45 per cum for domestic supply in urban areas has been fixed by the Government Resolution No. Gen 1096/2877/CR/198/96 PUDA - 14 dated 1.4.1997. Actual cost of supply is about Rs 10 per cum. Rates charged for non-domestic supply are higher, i.e., upto Rs. 9 per m^3. However, non-domestic supply represents just a small fraction of the domestic water supply. Moreover, the recovery of water tax, which is already subsidised, is also poor. Annex 10.1.3 shows the details of amount billed and recovery realised in respect of a few municipal councils. It gives some idea that the proportion of recovery realised is meagre.

10.1.20 Statement 2.6.3 presents per capita average income from agricultural produce. It gives a fair idea of the rural economy and social life. If only 20 cum of water per capita based on a cheaper groundwater source is supplied annually, the water charges of Rs. 40 per head will have to be paid whereas if 40 cum of water per head is supplied through piped water supply scheme, the maximum of Rs. 400 water charges will be required to be paid. How can this much water charges will be affordable to rural areas having the annual income of Rs. 5000 to 6000 per head? As grampanchayats will not be able to recover water charges at this rate, they will also go in arrears. It is essential to examine standing economic status. As it appears, the present water supply schemes do not incorporate a properly spelt out water rate structure. The financial affordability of people who are going to be the beneficiaries of water supply schemes is never assessed. Therefore, when a scheme is actually completed, it is not being handed over to the local government bodies and each new scheme becomes a permanent liability of expenditure to be incurred annually to the Government.

10.1.21 It is, therefore, felt that planning of such schemes should hereafter be resorted to after assessing the affordability of beneficiaries. As the financial health of the water supply schemes is dependent on the production system, employment avenues and permanent sources of income that are prevalent in rural life, it is desirable to link water supply schemes with Such systems.

10.1.22 The same principle applies more effectively to urban water supply also The economics of water supply should be given a fresh consideration from this viewpoint. How much water in the minimum is to be supplied as a part of public welfare scheme and in what manner is it to be accomplished? How much more water is to be supplied as a part of economic stability and higher standard of living and in what manner is it to be realised? It will be proper to handle both these aspects separately. Limiting the extent of expenditure of welfare schemes to that much quantum of water which can be manually lifted from well (40 litres per capita) and subjecting the feasibility of all uses beyond that entirely on economic criteria is necessary from the point of view of economic sustainability of agencies supplying water. Otherwise, existence of organisations which are set up on economic footings and implementing programmes by borrowing loans will be threatened.

10.1.23'Drinking water' is a social need and as well as an economic good. Therefore, minimum necessary water must be received by everyone and there should not be a considerable disparity in its distribution. As the Government has accepted the responsibility of ensuring at least guaranteed water to poors also, the assessment be carried out with the 'differential price' method and Government organisation should bear the cost of free water supply on account of that social group for which it is offered and grant financial aid to that much extent. However, care should have been taken so as not to upset the principle of water supply system. A system of supplying water for domestic use in measured quantities on cubic metre basis will have to be set up in order to inculcate the awareness in organisations supplying water, water users' organisations and the society that 'water' is scarce and is an 'economic good.' Presently, water charges are assessed according to the size of taps. Instead of that, it should be assessed on the basis of cubic metre of water supplied by installing independent metres for each customer. This inspires them to use water economically. The Commission feels that all water for urban use should be supplied by installing meters during the coming ten years in view of the scarcity value of water.

Strengthening of Water Sources

10.1.24A per capita supply norm of 55 litres of water per day is assumed while finalising rural water supply sources. It is experienced that the source of schemes predominantly dependent on groundwater falls short in course of time and the village again suffers from the problom in due course the water issue of winch was once resolved. Again, a scheme is formulated by adopting a new source. Schemes are framed in this manner by envisaging tapping of newer and newer sources and old schemes are abandoned. The very concept of sustainability of sources itself is required to be scrutinised from the scientific point of view. The nature's cycle is never stationary. It is always subjected to time-dependent and spatial changes. Therefore, it is difficult to regularly get water every year from a single source in accordance with the norm. It, therefore, becomes necessary to go in for an integrated planning of all existing sources and ensure their protection in order to achieve more and more supplementary uses therefrom. It is important for that also to strengthen the sources that are falling short in a conventional or non-conventional manner and make them more and more efficient. Such sources are to be used supplementarily. A number of schemes had here-tobefore been implemented for rural water supply. A special programme is to be undertaken to strengthen the sources to the extent possible by assessing reasons for failure of such schemes which are neglected and not in use. This will, therefore, facilitate to meet the requirement at majority of the places through local sources. Moreover, this therefore will ensure bringing into reuse those sources in which case Government has invested crores of rupees to create ati asset. The load on distant sources, will also be reduced owing to availing use of local sources. In the same manner, the recurring cost being incurred every year will also be on lower side to that much extent.

10.1.25 Availability of water being supplied to human population and livestock is arrived at on 95% dependability. Moreover, in view of the losses entailed through irrigation, seepage and conveyance, ordinarily twice the water storage is required to be reserved in a reservoir to enable supplying water to the actual beneficiary to satisfy his requirement. If use of local groundwater is made to the extent possible while accomplishing this, the aforementioned losses can be avoided by minimising the necessity of surface storages. Arrangement of water at every place, if managed to be jointly composed of three expedients, it will be more beneficial, economically as well as practically.

* Rooftop rainwater harvesting
* Groundwater supply through lift / pump
* Freshwater supply to be catered from reservoir, river, etc.

Groundwater Conservation and Drinking Water

10.1.26 As the water supply to'be catered from groundwater is cost-effective and it is also affordable to the rural population, groundwater planning and its management is necessarily to be accomplished in more details in the context of drinking water.

Statistical information about sub-basinwise groundwater availability in Maharashtra is presented in Statement 10.1.2. A detailed discussion on groundwater use has also been the subject matter of Topic 2.9. An act titled the 'Maharashtra Groundwater (Drinking Water Control) Act 1993' is already in existence to provide protection to drinking water sources. However, owing to lapse in its enforcement, relentless exploitation is continued causing the opinion to swing on the side of impracticability of groundwater dependent drinking water supply schemes. If a same kind of liberality persists in enforcement of the Act, the vicious circle of supplying water through tankers during the months of April-May to tiny villages, caravans and hamlets will be continued. It is economically not affordable to arrange drinking water supply through taps to small villages and hamlets from distant surface water sources. It is essential to obviate the uncalled-for burden on scarce financial resources. Lack of effective enforceinent of the Groundwater (Drinking Water Control) Act is forcing the rural public life to go in for the costly piped water supply schemes which are far from affordable.

10.1.27 Drinking water supply everywhere in urban areas is being managed exclusively through surface water. Treated purified water is being supplied to urban areas. This water is being used not only for drinking purpose but also for other domestic uses like washing clothes & utensils, floors, house surrounding, gardening, garages for washing & servicing two & four wheelers, etc. In fact, ample groundwater is available in urban areas also. Previously, the same had been in use through wells. The use of same be continued. It will be useful to promote catering the requirement's of water other than those for drinking through groundvvater. It will be proper on the part of cooperative housing societies and owners of private houses from this point of view to incorporate in the plan of houses a set-up of use of groundwater that is available in the locality. This will enable to obviate the necessity of reservation for drinking water through surface sources and preventing evaporation losses entailing therefrom.

Reservation Policy

10.1.28 The requirement of Maharashtra of water on count of drinking and livestock by the year 2030 is going to be 7181.36 Mm^3. If it is to be entirely met from reservoirs, a provision double that of, i.e., 14362.72 Mm^3 will have to be made. This will amount to 17.12 per cent of the water use entailed for irrigation (amounting to 14 per cent of the total water use: Annex 1.0.1.4). At the most 20 per cent reservation on.account of drinking water and the same for municipal use can be made in proportion to the total water availability in a sub-basin. Use of water other than that merely for drinking will have to be apportioned less water that is proportionate to the shortfall in rain than the average.

It appears the priority that has been lent to the drinking water in the National Water Policy is being misinterpreted at many places. Requirement of water merely for drinking is, in fact, very meagre, viz., upto 5 litres. More water than that is required mainly for sanitation and municipal activities there. Whereas there is a provision to curtail water being made available for agriculture during a year of water deficit, it is essential in a like manner to adopt to some extent a method of achieving saving in water by using more conservatively the water being supplied for municipal use also Though it is not possible to lay down uniform rules as to the quality and quantity in this respect for all basins and at all places, it is essential to curtail water supply during a deficit year according to the circumstances appreciating that per capita municipal distribUtion of water assumed in planning is merely for an average water year and it is necessary on the part of all not to be oblivious about this It will be desirable on the part of planning and regulation committee of respective sub-basins to institute changes in yearwise /seasonwise distribution on the basis of prevailing status of total water availability.

Reuse

10.1.29 Alongwith the quantitative aspect of requirement of water for domestic use, the consideration of quality is also equally necessary. Cost is entailed in attaining quality in water. It is essential to take timely cognizance of this aspect in the context of system of water reuse. A limited experience as regards to collection and treatment of sewage has so far been gained in Maharashtra. However, it appears that in general, a capital expenditure of Rs. 12 per m^3 will be entailed for obtaining water for reuse. This expenditure, too, is not expensive in comparison with new storage, new distribution system, etc. Therefore, it will be desirable to incorporate returns and reuse out of such water in planning while considering water requirements of municipal life.

In fact, 60 to 80 per cent of the water supplied for domestic and municipal use fors other than drinking purposes, can be obtainable for reuse. Nevertheless, it is today not obligatory on the part of organisations which are to supply water like *Maharashtra Jeevan Pradhikaran*, municipal corporations, municipal councils and *gram panchayats* to make available water in that manner. It is required to be made so. There should have been a set up so as to offer an incentive in the form of adjusting price of such water from the accounts of water so supplied to the concerned organisations. If that is accomplished, water charges can be halved in practice. Therefore, it is essential to strengthen the system of reusing used water by getting it back.

Transfer of Schemes

10.1.30 It is noticed that water charges are not at all recovered at many places or no enough hike is made in that respect. Reasons put forth by *Zilla*

Parishads are that it is not possible for them to undertake maintenance of schemes from their income nor is there proper technical staff required for carrying out maintenance and repairs therefor. In consequence, several regional water supply schemes are being operated by the Water Supply and Sewerage Board (today's *Maharashtra Jeevan Pradhikaran*) for the last 15to 20 years. As the said schemes in principle, belong to *Zilla Parishads*, the Board can not recover water charges. The expenditure, however, is required to be incurred from the outlays of the Board. The *Maharashtra Jeevan Pradhikaran* is mainly accomplishing the task of commissioning the schemes. As its means of income are limited, it diverts the outlays granted by the State Government, Central Government for capital investment of new schemes towards maintenance and repairs of such schemes. Consequently, new schemes linger for a long time owing to inadequate grants. Cost of these schemes also rises and the concerned population is deprived of the benefits accruable from these new schemes. The outstandings on account of maintenance and repairs due to the *Maharashtra Jeevan Pradhikaran* from *Zilla Parishads* run into crores of rupees. It is not possible for the *Maharashtra Jeevan Pradhikaran* to undertake eve_n the maintenance and repairs of such non-transferred schemes due to want of grants. Also, the beneficiary habitats are entailing water use over several years free of cost without paying any water charges. It is learnt that in all 104 such schemes are with the *Maharashtra Jeevan Pradhikaran* which are awaiting transfer. The state of minor irrigation projects transferred to *Zilla Parishads* also beset with almost the same fate. No system has yet been properly set up which will carry out inspection, management and recovery of irrigation water charges of these projects. To sum up, there is a considerable scope for bringing out improvement in planning of all water at rural level, its management and financial care-taking. It is necessary to go in for even the integrated consideration of irrigation water and that for drinking.

Planning of River Flows

10.1.31 The issue of water pertinent to villages situated along the river banks has newly emerged as a result of relentless groundwater draft, damming the rivers, absence of water in river courses during post-monsoon period. Wdter supply schemes of a number of towns, (e.g., Loha, Gangakhed, Kundalwadi) are taking from Godavari River. These towns are presently facing water shortage. Large dams are now constructed across big rivers and water supply schemes are being framed by taking pipelines from reservoirs to supply water to 'B' and 'C' class municipalities situated on river banks. Drinking water issue of villages, towns situated along river banks will be resolved if barrages are constructed across rivers or a series of K.T. weirs is created all along the rivers. Moreover, it will also facilitate irrigation. Planning and control of flows in river courses is going to be essential for this. However, instead of going in for independently different systems of uses on account of irrigation / urban - rural water Supply / industrial supply in small and big sub-basins / watersheds, it will be considerably cost-effective if a system is set up by undertaking an integrated consideration of all these. An increasing need of skills in planning and management for this is, however, called for.

There is a growing demand for *bandharas* constructed across river courses, catering drinking water to villages situated along river banks or supplying water for private or collective irrigation. It is, nevertheless, feared that if no proper system of regulating storage capacities" of the *bandharas*, urban / rural water supply to be catered therefrom, maintenance & repairs thereof and revenue collection therefrom is set up, it will upset the entire system in that river basin. A comprehensive programme of constructing barrages across river courses can be successful in the proportion of exercising control on draft from storages in rivers impounded by such *bandharas.* At least at present, no concrete system has yet been set up to undertake planning of and to exercise control over river flows. Some powers are conferred on the Irrigation Department in this context in areas of notified rivers. None the less, numerous technical and social difficulties are beset with its effective implementation. On how much administrative and social control can be established over the excessive or beyond -that-permitted use of water is going to depend the long-term prospects of water supply and irrigation development of villages situated along the river banks. No schemes based on *bandharas* can be successful unless action to be taken and rules to be framed in this respect *vis-à-vis* the statutory provision to support this are brought into being. In view of this, it is felt that the task of bringing out a suitable manual and vesting in it a statutory basis be undertaken early.

Village Tanks

10.1.32 Earlier, there used to be tanks in villages and responsibility of their protection used to rest with the respective villages. At most of the places religious sentiments were used to be associated with them. In course of time they, however, were neglected. They have now been silt up. They are being used for washing clothes, buffaloes, etc. They, therefore, are in a dilapidated state presently the water therein exhibiting an unhygienic and eutrophic look. The said village tanks are needed to be rehabilitated today. This work is to be undertaken through public awareness, public participation and employment guarantee schemes and a ban should be there for swimming, washing, etc., in order to prevent its water from getting polluted.

Where there are no village tanks, a programme of constructing village tanks anew be chalked out. However, water supply is required to be catered from a dug well taken at favourable site in vicinity instead of directly conveying water through a pipeline from tanks. The role of village tanks in today's rural water supply schemes does not appear to be overwhelmingly to that much extent. Its inclusion as an important component is, therefore, felt to be necessary.

Rainwater

10.1.33 Policies be framed which will inspire to incorporate an arrangement for storing incident rainwater in plans of permanently roofed-housing structures in urban and rural, parts. A policy be framed by the year 2030 which will, make it obligatoTy to go in for roof-top water harvesting in a basin. To begin with, a start to this undertaking be given by arranging forthwith for roof-top water harvesting in case of hundred per cent of the houses in earthquake-rehabilitated colonies in Latur and Osmanabad Districts.

Miscellaneous Measures of Water Saving

10.1.34 While considering water supply of Mumbai Metropolitan City, the Chitale Committee (December, 1994) has estimated that 40 % (1046 Mld) water can be saved everyday by resorting to measures such as preventing evaporation & percolation, public education, reuse and desalination. A similar kind of study will be desirable to be undertaken in respect of urban drinking water supply schemes of other parts also. Before undertaking new schemes for augmenting their water supply, the same will be required to be enhanced only for reasonable demands by switching over from demand-driven supply systems and by planning the demands too.

10.2 Drinking Water and People's Participation

10.2.1 In our today's social life, major water use is divided into the following three categories:

* Drinking water
* Water for industrial sector
* Water to be used for irrigating farms.

Since the participatory irrigation management has been separately dealt with elsewhere, people's participation in use of water for drinking and industrial purposes is et discussed here.

Drinking Water Use

10.2.2 In urban life, water used for drinking and other purposes is not supplied separately. Hence treated and disinfected water is used for all other purposes also. Only 25% of water purified to the fullest prescribed degree of purity is required for household consumption. The rest is used for toilets, sanitation, washing clothes & utensils, gardening and such other purposes.

There is a considerable difference in the quantity of water supplied to the urban and rural population taking into consideration the health standards and water use requirements. The rated water supply in urban areas is almost double that in rural areas. Narrowing down this gap is desirable. To achieve this, a close scrutiny of factors responsible for causing excessive use of water in urban life alongwith remedial actions is warranted. Shortage of potable water has also become a formidable problem in itself alongwith that of overall water scarcity. That is why, issues such as how to effect proper use of water; how to achieve this economically; how to ensure altogether avoidance of water wastage and how to safeguard purity and quality of water have come up. 'People's participation' assumes a very extraordinary importance on this front.

Though rates for urban water supply are higher than those for rural water supply and irrigation water, the very concept of economical use of water which is valuable commodity, has not found roots in the society so far. Therefore, use of excess water than necessary, (e.g., flushing of toilets), leaving taps flowing, leaking pipelines, etc., is the scene in every house. Yet the society does not regret this This work can not possibly be accomplished through the Governmental propaganda agency. Social organisations need to come forward to promote the concept of economical use of water. For this, the society is required to be oriented and awakened.

Water Literacy

10.2.3 (a) Urban Sector

It has been noticed that even the citizens in urban / local government bodies do not have an adequate knowledge of water supply schemes and prospective plans. Small booklets or brochures containing information about water supply schemes on which they have to depend alongwith sketches outlining them need to be liberally circulated for their orientation.

Through this booklet, information on technical and financial details (such as capital expenditure, 0 & M expenditure, recovery through water charges, financial deficit in O&M, cost per cubic metre of supplying water, etc.), be presented before citizens. Similar booklets will also have to be brought out which will offer instructions aimed at ensuring appropriate use of water to curb wastage and loss of water without which it will be difficult to accorriplish the objective of economic use of water. All water supply and sewerage schemes are going to be expensive in future. Hence it will also be necessary to apprise response of beneficiaries by disseminating amongst them information such as likely improvements in water distribution system, expected water rates, capital mobilisation for water supply schemes, loans to be raised for that and so on. A conducive atmosphere will have to be developed to increase participation of beneficiaries in mobilising funds for capital expenditure and sharing the responsibility of management. Seminars will have to be organised to hold discussions in regard to water supply and sewerage schemes amongst water experts, doctors, engineers, professors, environmentalists, institutions which will arrange for public education such as rotary clubs, colleges, voluntary organisations, etc., by arranging trips of school and college students to visit water supply and sewerage schemes. The coming generations will also have to be made alert about planning in regard to water. Presently, awakening in this regard is being carried out very minimally. It needs to be intensified.

Of late, a new and good concept of harvesting rainwater from roof-tops of buildings and using it for the whole year is gaining ground. In certain regions like Saurashtra and Rajasthan, it is traditional to store rainwater in underground tanks during monsoon and use it during the next 6-8 months. It is quite possible to use this very method everywhere in a newly-developed form. It is being popularised that every house in an urban area should practise rainwater harvesting. Some such programmes are being exhibited on T.V. This is a welcome sign. Such undertakings are required to be given more encouragement. Urban water supply schemes should also make provision for financial assistance on count of such schemes.

If collective storage of rainwater that is incident on houses in urban and rural areas in the country goes on increasing, evaporation loss of water will be minimised and, to that extent, water availability will be augmented.

Water supply to slums in cities and many villages is catered through public standposts. Once need of an individual is met from such a standpost, nobody bothers as to what happens to this water supply system. At such places, tap cocks are stolen or, if in place, are allowed to remain flowing and there is wastage of water even when the standpost is not in use People see taps running and water getting wasted but they do not bother to close it down. They need to be made aware. It is also necessary to identify a social faction which can be entrusted the definite responsibility of maintenance of these public standposts. In Murnbai City, the management of public standposts located in slums is being carried out by small groups of about 10-15 people. They also collect water charges from the water users. Keeping these examples in view, it is desirable to take a policy decision on the part of municipal councils of not supplying water at public standposts unless water users' associations are formed.

The measures to save water should not be limited only to domestic water supply but should be extended to dispensaries, lodging and boarding houses, theatres, small and large trading firms, cottage industries, public parks, etc., in order to avoid wastage and promote economical use of water. Voluntary organisations need to be formed to launch campaigns for popularising proper water management systems in villages and towns and thereby to help increase public awareness. Such organisations be honoured by inducting their representatives in water management committees of municipalities and village *panchayats.*

(b) *Rural Sector*

Water supply schemes in rural areas, which are based on the groundwater sources, are limited in its scope due to rainfall and geological formations. The rural population needs to have a scientific knowledge about these aspects. This will facilitate in preparing plans for recharge, planning withdrawal from sources and reservation of groundwater storage for use in summer. Involvement of villagers in balancing expenditure being incurred on maintenance I repairs in running rural water supply schemes and income accrued by *grampanchayats* through water charges is called for.

Water Supply to-Industrial Areas

10.2.4 Water being used by industries is also expensive like drinking water. But, in absence of any formal control on usage of water, 'price' of water is lost sight of and lot of water is wasted. In small garages, quantity of water used for washing of vehicles can be reduced by resorting to a small modification in size of nozzle of pressure pipe. If a smaller diameter nozzle suffices, the municipal council can enforce rules making it obligatory the use of smaller diameter nozzles and similar other water saving devices to check the relentless use of water. If the Maharashtra Industrial Development Corporation determines to supply only requisite quantum of water to Industries and introduces a system of periodical audit of water use per industry to avoid uncontrolled loss of water, a substantial saving in water can be effected.

After use, the wastewater from urban areas and industries is still being discharged into rivers and *nallas* without any treatment. The sources of drinking water in that river get contaminated as a result of releasing such a polluted water into it. A collective movement of all villages and towns on banks of rivers is required to be formed to prevent such contamination and increase awareness in this regard. Such vigilant organisations of people along each river have not still been developed in our part. Special efforts to develop such organisations in the coming decade are called for.

Even now sugar factories in Western Maharashtra without exception are still used to let the factory effluents in rivers and *nallas*. This results not only in killing germs, fishes in a river but also spreads a kind of an exceedingly bad smell over the surroundings. An agitation took place against this as a result of which factories have started releasing effluent into rivers treating it to some extent. Nevertheless, no satisfactory arrangement has ever been set up anywhere.

Participation of Women

10.2.5 Mainly, women are involved in domestic use of water for cooking, washing of clothes and utensils, spraying and smearing mud floors, etc. They decide how to make use of water. If they are made conscious about proper use of drinking water through the 'Water Awareness' campaign, it will help save mater to a large extent.

The proposals of training women in villages in the sphere of operation and maintenance of piped water supply schemes, forming their organisations and entrusting them the management of these schemes are of worth consideration. Sdcial workers should come forward to motivate the women's organisations in this respect.

Besides this, having created an awareness through various media regafding public health and sanitation, women's organisations can be inspired to use water that is being wasted through open *guttars* in a village by collecting it together outside its precincts, undertaking conservation of trees / setting up gardens.

10.3 Water for Industries

10.3.1 Maharashtra State has persistently remained in the forefront as far as industrial sector is concerned. Achieving industrial expansion in the developing part of the State also by retaining this position is the basic principle the Government has practised. Ambitious programmes such as framing a new industrial development policy and to enforce that to create a Maharashtra entrepreneurs' development centre to establish estates of the Maharashtra Industrial Development Corporation in developing parts has been undertaken. It is, necessary to provide a dependable source of water for all this.

Present Use of Water in Industrial Sectors and Probable Requirement

10.3.2 Presently (1996) 1512.8 Mm^3 (Annex 10.3.1) of water is being used in the industrial sector. The number of workers occupied in household industries and factories were 4096 lakh in the year 1991 and accounted for about 5.2% of the total population of that year which is 789.29

lakh (Annex 10.3.2). Taking into account this percentage, number of workers in the year 1996 in household industries and factories may be 45.70 lakh. It shows that broadly 33.10 Mm^3 of water is being consumed every year per lakh workers in industries. Total population in the year 2030 is estimated to be 1813.15 lakh. If the present pace of development in irrigation and industries persists, the number of workers occupied in industries will be (1813.15 x 5.2)/100 = 94.28 lakh and estimated use of water in industries will be around 94.28 x 33.10 = 3120.67 Mm^3/year.

Taking into consideration the growth of industries, an independent assessment of demand for water required by industries in the year 2030 has been made by the Commission. According to this, total water demand of industrial areas of M.I.D.C., private and cooperative industrial estates together has been estimated at 3753.60 Mm^3 per year in the year 2030. Considering total available water in Maharashtra, it will not be difficult to supply entire quantum of water required by industries, However, industries need to be sited at proper places & in proper sub-basins suitable from water availability point of view.

Industrial Water Use in Deficit Basins

10.3.3(1) Different types of industries require water in different proportions. Thermal stations consume a large quantum of water for generation of electricity. Chemical and paper industries[1] are highermost in water requirement while the electronic industries which are coming up in recent years require least quantity of water. A similar kind of extreme disparity prevails as that exists in sub-basinwise natural availability of water in Maharashtra. Hence less water-intensive industries will be required to set up in deficit basins whereas in Konkan and Wainganga Basins, water-intensive industries may be encouraged.

(2) As the practice goes, the industrial sector is being catered water that is available with 90% dependability. If available natural water resources are considered, the industrial need can be met with only there where average availability of water is nearly double of that More caution will, therefore, be required to be exercised in planning industrial water use in coming time Criteria of selection of industrial sites will have to be a function of the dependability with which water availability is being worked out.

(3) *Mumbai* is the capital of the State and a key port. Besides the availability of necessary infrastructure of air & rail services, financial institutions, etc., the availability of water also is more as a result of which the *Mumbai* Metropolitan City has grown industrially. Further development is now taking place in the *Mumbai* Metropolitan Region. The North Konkan Basin is undergoing a fast industrialisation. Similarly, the industrial growth in Middle Konkan Basin is also taking place as the chemical industrial areas have been set up there by the M.I.D.C. The Vashishthi, South Konkan and Tillari-Terekhol Basins in the rest of Konkan are also bestowed with abundant water due to which there is a great scope in these basins for developing water-intensive industries. Similar situation exists in Narmada and Wainganga Basins also Ample water can be made available for industries in Painganga, Middle Wainganga and Puma (Tapi) Basins also These basins are comparatively backward as far as industrial developthent is concerned and special boost up is required to ensure its development. Water-intensive industries are required to be given an injpetus in these basins. On the other hand, industrial areas have been established at Nashik and Sinnar in Upper Godavari Basin and are growing day by day. Water-intensive industries can no now be given scope there. It will rather have to be contemplated whether water use .cail be gradually reduced where such industries are already existing or such industries can be shifted

1. United Nation's Report - October 1973.

elsewhere at alternative sites in due course. Similar situation exists in deficit basins of Yerala, Sina, Lower Godavari, etc. It makes necessary to promote less water-intensive industries such as electronics, textile, engineering or mechanical production enterprises involving steel structures, etc.

Reuse of Water once Used for Industries

10.3.4 (1) Water is a scarce natural resource and is going to be more and more so in proportion to the needs of future. The industrial sector is wholly well- organised. Where returns against the capital investment are more in comparison with the primary sector (especially the agricultural sector). Therefore, the foremost responsibility of using water more economically rests with this sector. The water disputes tribunals have taken for granted reavailability of most of the water (97.5 per cent water) for reuse. The system to facilitate that in practice is required to be set up. If at least 75 per cent water once used for industries could be obtained for reuse, the water supply meant for industrial sector can be reduced to 75 per cent. Else, water obtained after use from industrial sector can be used for other purposes (for example, agro-forestry). Requirements of water on that count will diminish. It will have to be made obligatory in deficit basins for that to make water available which is supplied to them for reuse after recycling the ,same by setting up water recycling plants either collectively or industrywise.

(2) The polluted water from industries is posing a grave danger to the natural water regime and as a result of that human life is getting adversely affected. In order to obviate this, it will be proper to recycle this water so as to bring its reuse atleast to the level of 75 per cent. In order to instigate industries to go in for making reuse of water, it will be desirable to consider extending special concessions in water charges, grants in token of special incentives, etc., as per the circumstances prevailing in respective sub-basins to those industries which will embark on more and more reuse. Timely consideration be given to keep a provision of taking penal action in case of those industries in deficit basins which hesitate to instill recycling system for water. Besides, charges for water being supplied to in respective basin's will have to be assessed in such a way as to maintain a balance between rates of water supply to industries and the cost entailed in recycling polluted water which will inspire industrial undertakings to install treatment plants. It is essential to determine water rates, taking into consideration the fact that no reuse will be encouraged if water supply is catered at cheaper rate. Recycling and reuse of water has been discussed later at:length in Topics 10,6 wad 10.9.

Balance Sheet of Industrial Water Use

10.3.5 (1) The water requirement and supply of organised indmstrial complexes such as estates of the Maharashtra Industrial Development Corporation and those of CAXIMatifte industries are determined on the basis of the nature of industries and:extent of industrial area. For example, the norms[2] of water use per hectare are stipulated thus: engineering industries - 25 m^3, chemical industries - 50 m^3 and textile / paper industries - 100 m^3. Norms for water use should be stipulated industry specific and per unit of production in lieu of that It should be made binding to maintain an industrial organisationwise balance sheet of water use in industrial sector by keeping annual account of water use entailed.

(2) A large scale industrial proliferation is taking place in areas outside the organised industrial sector as well. As they are posing a burden on the total available water resources, a system will have to be established to maintain an account of water use entailed by them. It is necessary to make obligatory setting up a system

2. Information obtained from the Maharashtra Industrial Development Corporation, Mumbai.

which facilitates all supply of water in measured quantities to industries. The Industries Department should make a practice of maintaining an account of annual water use in respect of the organised industrial complex and all industries falling within private undertakings. It will be desirable to publish sub-basinwise balance sheets of industrial water use in accordance with the type of industries. On that basis promotional, regulatory or penal actions in different sub-basins can be properly thought of in the context of respective sub-basins. Framing uniform rules in this respect will prove difficult as availability of water in Maharashtra is not of the same kind everywhere.

10.4 Water Requirement for Thermal Power Generation

10.4.1 A total power generation installed capacity of 12238 MW has been created in Maharashtra by 1998 through private undertakings and the State Electricity Board.[3] Out of this, 1758 MW share goes to hydro-electricity whereas that of thermally generated electricity which makes use of fuel such as coal, gas, etc., and nuclear means amounts to 10480 MW.

The electricity demand in Maharashtra is mainly met from thermal power stations. Presently existing and completed thermal power stations in Maharashtra alongwith their installed capacities are indicated in what follows:

Name of the thermal power station	Installed capacity (MW)
(a) Within the purview of M.S.E.B.	
1) Koradi	1100
2) Nashik	910
3) Bhusaval	482.5
4) Paras	62.5
5) Parali	690
6) Chandrapur	2340
7) khaparkheda	420
Sub-total	**6005**
(b) Belonging to Tata Turbhe	1150
(c) Belonging to B.S.E.S.	500
Total	**7655**

Existing Water Requirement for Thermal Power Generation

10.4.2 Thermal power stations usually require water for following counts:

* Power generation process
* Cooling of generators
* Carrying away fly ash
* Colony, domestic use, fire fighting, etc.
* Sprinkling on coal transport track and coal yard.

Chandrapur Super Thermal Power Station

10.4.3 The Chandrapur Super Thermal Power Station is recognised as the foremost (2340 MW) among thermal power stations in India as far as generating capacity is concerned. This station fulfills almost 30 per cent power requirement of the State. The details of water requirements on different counts as stated in the foregoing are presented in what follows as an example in case of this super thermal power station to which the Commission had paid visit.

The daily consumption of coal entailed in this station is 38000 tons and water requirement for this is nearly 0.28 Mm^3. Fly ash left behind after burning the coal is around 40-45 per cent. It means daily 15000 to 17000 ton fly ash is formed. A slurry is formed by mixing water with the fly ash so obtained so as not to get the atmosphere polluted and conveyed the same to ash bunds by pumping. Daily consumption of 112000 m^3 water is entailed on account of this. After having settled down in the bunds, water on the surface in the stilling basin is drained through internal drains with the help of a pumping station to convey it to the power generation station. It is again brought into use to dispose off the ash. In some thermal power stations ash is used to be stored in the tailings and the water is released into *nallas.* This

3. Administrative Report of the Maharashtra State Electricity Board: 1997-98.

water so released controls pollution and can be used for irrigation as well by the farmers in vicinity.

Water which is specially processed, free of metals and salts is required to be used to form steam in this thermal power station. Daily 5300 m^3 water is required for this. Also, about 121000 m^3 water is used daily for cooling hot water. For the thermal power station and domestic use, daily requirement of water is 17500 m^3. Fire fighting, cooling down the refractory and catering to gardens and construction activities in colonies combinedly consume daily total 23560 m^3 of water.

As such, 280000 m^3 water is daily required to generate 2340 MW electricity. This means daily watet requirement of 1 MW electricity generation is 120 m^3. Hardly 13% water out of this can be returned for reuse. Balance water can not be obtained back owing to evaporation. Water supply to this thermal power station is being managed from the nearby 'Erai' Reservoir. The capacity of this reservoir is 193 Mm^3 and the present water use also is hardly at par with it Difficulty in regard to availability of water is going to be encountered in further development of this thermal power station.

No provision of carryover storage has been made in the 'Erai' Reservoir. Therefore, if storage in the reservoir happens to be less during water short years, the thermal power station faces difficulty in generating electricity owing to want of water. Availability in respect of water is going to remain a priority in case of this thermal power station. For this, accomplishing a study as to the status of groundwater in catchment of this reservoir is, also called for. The present capacity of other thermal power stations in Maharashtra and their present annual water requirement are indicated in the Statement 10.4.1.

Future Expansion and Projected Water Requirement of Thermal Power Stations

10.4.4 An overview of increasing industrialisation and increased demand for power to run the farm pumps reveals that the peak demand of power every year is increasing by 500-600 MW. It is meant that daily (500 x 120) = 60000 m^3 additional quantum of water will have to be supplied for thermal power generation.

It is learnt that the peak demand of the State by the year 2011-12 will be upto 25087 MW. In order to meet this peak demand, 33450 MW power generation (according to the 75 per cent availability) will have to be achieved. Bu deducting the present pace of generation, i.e., 12238 MW., it is necessary to generate additional electricity of (33450 - 12238) = 21212 MW. If this entire electricity is, proposed to be generated through thermal means, approximately 1000 Mm^3 of additional water will be required every year, it appears.

Details as regards to capacity of following proposed power stations posed to the Central Electricity Authority, New Delhi for according approval and expected annual water requirement are as follows:[4]

Sr. No.	Station	Generation capacity (MW)	Annual water requirement (Mm^3)
(1)	(2)	(3)	(4)
1	Parali Thermal Power Station Phase - I: Extension	250	10
2	Paras Thermal Power Station Extension	250	10
3	Uran Thermal Power Station Extension	400	2
4	Fluidised Bed Boiler, Chandrapur	60	3
5	Bhusaval Thermal Power Station	1000	45
6	Bhusaval - B Thermal Power Station	2000	90

4. Infermation obtained from the Maharashtra State Electricity Board.

In addition, following schemes are planned for future to augment the presently installed power generation capacity:

Sr. No.	Station	Capacity (MW)	Annual water requirement (Mm^3)
(1)	(2)	(3)	(4)
1	Parali Thermal Power Station Phase - II: Extension	250	10
2	Khaperkheda Extension	500	22
3	Nashik Extension	500	22

Not a single project out of this has so far been undertaken for commissioning.

It is given to understand that by employing atomic and gaseous fuels 1 MW generation of electricity consumes daily 0.1 m^3 and 2 m^3 water respectively.[5]

Setting up of Future Thermal Power Stations

10.4.5 The Maharashtra State Electricity Board appears to be inclined to thermal power generation which is almost 4 times costly when compared to hydro-electricity. The electricity problem of the State is not going to be resolved merely by enhancing thermal power generation. Taking into consideration the huge demand for water required by thermal power stations, availability of coal and basinwise water availability, the thermal power stations should be set up mainly in the Wainganga Basin where abundant water is available. It is going to be necessary to stress the setting up of hydropower stations (conventional or pumped-storage) elsewhere as they are less water-intensive. Similarly, it is necessary to incorporate in time the requiremcnt of thermal power stations in planning of respective sub-basins as they are highly water-intensive. For this, water will have to be reserved from reservoirs. Therefore, it will be desirable on the part of the Maharashtra State Electricity Board to identify in time the prospective thermal power station sites in different sub-basins by undertaking a far-fetched consideration of ensuing 50 years.

10.5 Hydropower-Generation

10.5.1 In Maharashtra, prior to independence the Tata Electric Company installed three hydro-power stations in private sector generating total 276 MW power. After independence, Radhanagari and Koyna hydropower projects were completed in 1954 and 1966-67, respectively.

Later through implementation of different five year plans, the installed capacity has been substantially increased and by March 1998 the same reached to the order of 12238 MW. This includes hydropower projects (Annex 10.5.1), thermal power projects, atomic power projects and the share of Maharashtra from projects commissioned by the aovernment of India as shown in the following:

		MW
1	Hydro	1758
2	Thermal	7655
3	Gas and waste heat recovery	1092
4	Atomic power (share of Maharashtra)	190
5	Owned by the Government of India (share of Maharashtra)	1543
	Total	12238

Out of total demand of 12238 MW of the State, about 9770 MW is the peak load and about 6300 MW is the base load (Reference: Graph 10.5.1: Power demand in the State as on 26.2.99). As per this graph the demand varies substantially in

5. Information obtained from the Nuclear Power Corporation, Tarapur.

different periods of a day. The difference between peak demand and the lowest demand is about 20 to 30 per cent. In order to maintain an efficient and smooth supply of power it is necessary to vary generation to suit the changing demand. Thermal power stations have to generate power continuously and hence they are used as base load stations. Hydropower is generated in conformity with the demand at the time of peak load. The difference between the peak demand and base load is economically more beneficial if generated through hydel schemes. Serious technical problems may arise during periods of low demand if even after closing down hydropower units it becomes necessary to operate thermal power units at capacity lesser than 70% of their installed capacity. Hydropower units on the contrary can be switched on one by one in the period of peak hours to fulfill the peak load requirement and also can be closed down one by one in case demand falls down and in this way power generation can be appropriately matched with the demand. In view of the flexibility inherent in hydropower generation to meet, daily peak load, the ratio of generation of hydropower and thermal power has to be kept at least 40:60 which enables the supply of electric power to be managed efficiently, smoothly and economically.

Role of Hydropower Generation in the Installed Power Potential

10.5.2 In 1968 the proportion of generation of hydropower and thermal power had been 54:46. Later on it went on diminishing continuously and by March 1998 it has reduced tol 4:86. As the ratio goes, presently the hydropower generation capacity is already short by 3137 MW. The effect of this shortfall is already manifested in inefficient running of thermal power stations and at the time of low demand they are underutilised. Therefore, it is necessary to increase, as much as possible, the hydropower generation in our power generation system which is at present dominated by the thermal power. The Commission is of the opinion That in order to improve this ratio over a period of a decade or so, there is no option other than installing additional pumped storage hydro schemes and mini-hydropower stations by providing funds and completing them expeditiously. Even Barve commission (1962) had recommended that efforts should be made wherever possible to generate hydropower along with irrigation as a general practice.

Future Requirement

10.5.3 In view of the rapidly taking place industrialisation and increasing demand being placed for agricultural pumps in the State, the generation of electricity has almost doubled, that is, it has increased from 27647 million units to the order of 51338 million units[6] during the last decade. Power use in industrial- sector has, however, dropped down from 49 per cent of the total demand to 39 per cent during the last 10 years whereas the same for agriculture, it appears, has increased from 16 per cent to 30 per cent.[7] As the increased use in agriculture is basically taking place for irrigation, overall it appears that it has become necessary to consider the issue of power generation and irrigation development conjointly. The peak power demand is being on an increase every year by about 500 to 600 MW. During the Eighth Year Plan, it rose from 6796 MW to 8800 MW. As of February 1999 end, it is of the order of 9770 MW. Presently it appears that no definite long-term planning in respect of expansion of power generation potential till the year 2030 has ever been accomplished. Nevertheless, the expected expahsion in power generation capacity (according to the planning of M.S.E.B.) at the end of Tenth Five Year Plan (2000-2007) is, it is learnt, to be as per the

6. Information obtained from the Maharashtra State Electricity Board.
7. Information obtained from the Maharashtra State Electricity Board.

Capacity: MW

Year	Generation capacity	As per 40:60 ratio	
		Hydropower generation capacity	Thermal power generation capacity
(1)	(2)	(3)	(4)
2001	18067	7227	10840
2007	27182	10873	16309

Source: Information obtained from the MSEB.

As per the report of All-India Fifteenth Power Survey brought out by the Central Electricity Authority-New Delhi, the peak power demand of Maharashtra by the year 2011-2012 is anticipated to be 25087 MW. In order to cope with this anticipated demand, the 33% more installed capacity than the peak demand that is (25087 x 1.33) = 33450 MW is called for. This survey report does not take into account the large scale lift irrigation projects being undertaken by corporations in various basins. It appears that by March 1998 end the shortfall of 3137 MW in hydropower generation can be made good by raising it to 1402 MW by completing the following projects which are under construction. Notwithstanding this, as per the planning of the Maharashtra State Electricity Board, this shortfall is going to be 1402 + 7227 = 8629 MW by the year 2001 and 12275 MW by the year 2007:-

Sr.No.	Name of project	No. of units	Capacity (MW)
(1)	(2)	(3)	(4)
1	Ghatghar (Pumped storage scheme)	2x125	250
2	Karanjwan	1x3	
3	Bhandardara Power House No.2	1x34	34
4	Surya Dam (Dam foot power house)	1x6	6
5	Surya Right Bank Canal fall	1x0.75	0.75
6	Dolvvahal	2x1	2
7	Dimbhe	1x5	5
8	Warna (Dam foot power house)	2x8	16
9	Dudhaganga (Dam foot power house)	2x12	24
10	Shahanur	1x0.75	0.75
11	Majalgaon	3x0.75	2.25
12	Koyana Stage IV	4x250	1000
13	Sardar Sarovar Interstate Project		
	a) Canal power house (share of Maharashtra)		67.50
	b) River bed power house (share of Maharashtra)		324
	Total		1735.25 say 1735

Source: Ninth Five Year Plan (1997-2002). Report of theStudy Group on Irrigation and CAD - December 1996, P- 61.

This capacity can be augmented by total 10331 MW with 9000 MW through possible schemes to be taken up in future [Annex 10.5.2(a) & 10.5.2 (b)] and 1331 MW share of Maharashtra from the interstate projects. Planning therefor, however, is essentially be taken up on top priority. In spite of this addition, there is going to be a shortfall of 1944 MW by the year 2007 in the installed hydropower generation capacity.

Overviewing the planning of use of available water resources and as there is no possibility of commissioning exclusive hydel projects of large capacity, owing to the overall geographical setting of the State, it is necessary to undertake an independent study as to how the shortfall in installed hydropower generation capacity is made good by increasing hereafter power producing capability of all irrigation-related major, medium and minor projects. It is felt necessary to formulate the ensuing long-term planning report by raising the water storage column behind dams wherever necessary.

It is possible to generate electricity on a large scale through pumped storage schemes without wasting water by taking advantage of the high drop present in the Western *ghats.* About 15400 MW power generation is possible according to the list [Annex 10.5.2 (c)] List of pump storage projects for which preliminary investigations are carried out with the assistance of Japan. They are also required to be considered on top priority. A similar kind of suggestion has been put forth by the Barve Commission (1962) and the National Irrigation Commission (1972) through their reports.

The inclination so far evinced by the Maharashtra Electricity Board appears to be siding 'mainly with the thermal power generation. This has adversely affected the development of hydropower generation. The power issue of the State is not going to be resolved merely by increasing thermal power generation but it is necessary to boost up hydropower generation alongwith that. Thermally generated electricity costs considerably more as indicated in the following:-[8]

		Production
1	Hydro rates	35 Paise per unit
2	Thermal	125 Paise per unit
3	Gas	100 Paise per unit
4	Atomic	84 Paise per unit.

Moreover, the technology, machinery & equipment needed to generate thermal power is required to be imported. On the contrary, their counterparts needed to generate hydroelectricity are available even today in India itself All the European countries, USA, China have become self-reliant in power sector by accomplishing development with the hydropower as the topmost concern. The Commission is, therefore, recommending that the same policy should necessarily adopted as far as power development is concerned by India and by the State of Maharashtra consequently.

Interstate Projects

10.5.4 It is possible for Maharashtra to accrue substantial power from interstate projects.

(a) Sardar Sarowar Project:- The multipurpose Sardar Sarovar Project is an interstate project among the states of Maharashtra, Gujarat and Madhya Pradesh. Presently, construction of this project has been suspended owing to the 'Save Narmada' Movement. The underground power house and canals of this project are going to cater to 1450 MW power generation. Maharashtra's share in this is 27 per cent, i.e., of the order of 391.5 MW.

(b) Bhopalpattnam Project:- This project belongs to Madhya Pradesh and Maharashtra. The apportionment as regards the costs and benefits of this project between Madhya Pradesh and Maharashtra will be in the ratio 55:45. The underground powerhouse of this project is going to generate 1000 MW power. The Maharashtra's share in this is 450 MW. The preliminary works falling in Maharashtra in respect of this project had been undertaken in December 1982, but have been suspended since 1986. Clearance from the Central Government to this project is still awaited in view of difficulties pertinent to environment and forest land.

Apart from this, other interstate projects between Maharashtra and Madhya Pradesh, viz., Kodur (150 MW), Markanar (150 MW) and Nugur (150 MW) also have not yet been cleared by the Central Government.

(c) Inchampalli Project:- This is an interstate project between Maharashtra and AndhraPradesh. Generation of 975 MW of power is envisaged through this project. Stare of Maharashtra therein is 431 MW. Even this project has still not received clearance from the Government of India.

The Wainganga Basin is favourable from the hydropower potential point of view. The large interstate projects, viz., Bhopalpattanam and Inchampalli could not be commissioned owing to the want of clearance from forest and environmental point of view. For want of these two projects, the State of Maharashtra and the nation (including share of other states) are annually being deprived of 881 and 1975 MW power respectively. The State of Kharia Gutighat Project in Tapi Basin is also equally dismal. The State is also being deprived of 30 MW power to be geneiated from the project. This means the State and the nation are being deprived of Rs. 3000 and Rs. 6000 crores annual income, respectively. In order to meet demand of burgeoning population

8. Information obtained from the Maharashtra State Electricity Board.

in respect of foodgrains, it is going to be essential to make available power for agriculture (for lift irrigation). In the State, the share of power for agriculture has presently crossed 30 per cent mark. Undeniably it may reach to 50 per cent. The Forest Conservation Act of 1980 has prevented the development of hydropower projects and this is far from affordable to the State / nation. The Commission has visited all the three project sites in 1998. Enormous water wealth in this part is being flown down the rivers devoid of any use The Commission has arrived at the conclusion that unless the Forest Conservation Act is reconsidered with open eyes, no development of this part is possible. An elaborate discussion pertinent to the Forest Act forms the subject matter of Topic 5.2.

How much is it beneficial from the social, economic and environmental counts to give impetus to power generation projects which are attractive, amenable to commissioning in a short duration, cost-effective and pollution-free instead of those which are prohibitive in costs, highly time consuming and posing serious pollution hazards (coal, ash, etc.), in order to fulfill the power demand should be considered in all its seriousness. A multifold environmental loss is required to be sustained due to thermal power plants than that is being thrusted due to projects which are prone to reduce forest area leading to loss of forest wealth. This is a fact. To consider thoroughly all these aspects is an utmost necessity.

With this premise, the Commission feels that it is necessary to give momentum forthwith to all such projects by appreciating the multi-faceted favourable aspects of hydroelectric projects from an environmental point of view.

Minor and Mini Hydel Power Schemes

10.5.5 The Western *ghats* of Maharashtra, especially the Konkan. region, is bestowed with abundant rains during monsoon. There is a considerable scope to install mini hydel stations of capacity 50 kW to 1 MW in that region where 3 to 15 m head is available owing to the geography there. A list of minor / mini projects as enlisted in the Master Plan upto the year 2004-2005 by the Chief Engineer (Electrical), Hydropower Projects and proposed on the basis of the information presented by the concerned Irrigation Projects Investigation Circles is indicated in Annex 10.5.2 (b). Besides this an estimate to the effect that 957 MW power can be produced through 132 exclusive hydropower projects, 37150 MW through pumped storage schemes and 165 MW through powerhouses at dam foot of major and minor projects is presented by the Superintending Engineer, Hydropower Investigation Circle, Pen through the survey report brought out by them in 1984. It is learnt that a few of these schemes are already included in the Master Plan of schemes planned for future. The study group of Dr. Swaminathan has also stated that China has produced 5200 MW power through minor / mini hydroelectric projects invoking public participation. The Commission is of the opinion that in Maharashtra too, it is possible to create a series of minor / mini power generation schemes in the Western ghats through public participation like those of minor irrigation projects by adopting the principle of ‘local generation - local supply’:

In order to set up mini projects in Konkan through farmers of installed capacity generally between 100 to 300 kW, the Government should provide grant-in-aid and en-courage the same. Sets which can be used in combination of pump and waterwheel by inducing minor changes in the conventional pumps, be developed for power production. The waterwheel be used for producing power during monsoon and the same set be used as a pump in post-monsoon period. It is suggested to encourage manufacturers of such sets and to offer facilities to farmers deploying the same. The Commission feels that it will pave way in making'power available to farmerg at a cheaper rate.

Funding Needs of Hydropower Generation

10.5.6 Capital investments needed on account of conventional and pumped storage hydropower projects are broadly Rs. 1.25 and Rs. 2.5 crores[9] per megawatt, respectively whereas the smile amounts to Rs. 5 crores[10] in case of thermal power generation.

Capacity: MW, Cost: Rs. crore

Sr. No.	Unit	Koyana Hydro- electric Project Stage-IV	Ghatghar Pumped Storage Hydr oelectric Project
(1)	(2)	(3)	(4)
1	Capacity	1000	250
2	Cost as per revised estimate (1994 rates)	1114	554.26
3	Cost per MW	1.11	2.22

Source :- Information obtained from the Chief Engineer (Electrical) Hydropower Projects Irrigation Department, Mumbai.

In order to have an improvement over the present ratio between thermal and hydropower generation so as to make good the deficit to date (by end of March 1998) in installed capacity of hydropower generation, it is necessary to enhance it forthwith by 3137 MW and for that roughly Rs. 6275 crore will have to be invested. An overview of investments made in hydroelectric projects undertaken during different Five Year Plans reveal that extremely scant grants have been made available to the hydropower sector in comparison with the State's total developmental works. As the aforementioned outlay of Rs. 6275 crores is not possible for the Government to make available, it is felt by the Commission that framing a proper policy so as to attract private investors is necessary. It is learnt that the State Government has offered 700 hydroelectric projects for private investment and alongwith that the two big pumpedstorage projects, viz., Chikhaldara and Malshej *Ghat* too are being proposed to be developed through privatisation. The Commission is of the opinion that the private entrepreneurs will only be attracted if they are offered some facilities if construction work of hydroelectric projects is to be got carried out through them as per the present policy. The flat power tariff made applicable by the Maharashtra State Electricity Board does not make distinction among peak demand period, normal period and off-peak demand period. This distinction is required to be made in order to make clear the true price of power in financial planning. The Commission feels that it will be desirable to make applicable forthwith such rates accordingly.

Organisational Changes

10.5.7 Presently the work of evolving designs for civil works of hydropower projects (excluding Koyana Hydro Electric Project) are dealt with under the control of the Superintending Engineer (Power House), Central Designs Organisation - Nashik, whereas the same in respect of the Koyna Hydroelectric Project is being dealt with under the control of the Superintending Engineer, Koyna Designs Circle, Pune. The electric and mechanical works pertinent to hydroelectric projects are being accomplished through 5 Superintending Engineers under the control of the Chief Engineer (Electrical).

As such, electrical and mechanical works (including the work of designs) of hydroelectric projects, design works of civil components, construction of civil works and works pertinent to the Koyna Hydroelectric Project are presently being handled through 4 different organisations. It is the contention of the Commission that it will

9. Information obtained from the. Chief Engineer (Hydropower), Hydropower Projects, I.D., Mumbai.
10) Information stained from the Chief Engineer(Generation P&P), MSEB, Mumbai.

be desirable to constitute an independent organisation for large hydroelectric projects in this State so as to bring the works thereof being handled through these four organisations under the jurisdiction of one hydropower organistion on the lines of the Central Government (the National Hydropower Corporation or the National Thermal Power Corporation). Capital investment in hydropower generation will increase if such an independent corporation is constituted to pursue hydropower development at the State level and to give impetus to the State's stalled hydropower development. Similarly, efficiency will increase through technology development as is felt by the Commission.

Organisational Set-up of Basin Development Corporations

10.5.8 The works as regards planning, designs and execution thereof in respect of hydropower projects are being got carried out through the Irrigation Department. Once these projects are commissioned they are entrusted to the Maharashtra State Electricity Board for operation and maintenance. As is informed, no difficulty is encountered of whatsoever kind in this system at present.

Since the setting up of various basin development corporations in the State, the works pertaining to hydroelectric projects have, however, been withdrawn from them, it is learnt. Corporation is an economic set-up and is founded on commercial principle. Under such circumstances, if the means of income being accrued through hydropower generation itself is got withdrawn, how the corporations are going to mobilise funds is a matter of reconsideration. The Commission feels that works of medium, minor and mini hydel development should again be entrusted to the corporations.

Similarly, the power of deciding the power tariff structure and royalty to be accrued out of hydropower generation if restored to a corporation, it will be helpful to its economic stability. The foundation of water management can be strengthened economically only through interlinking multiple uses of water. Therefore, transactions be so structured as to make the hydropower generation a great economic support to a basin development corporation.

10.6 Reuse of Water

10.6.1 In view of the largely increasing need in respect of demand and use of water resulting from growing urbanisation, industrialisation, population growth, etc., it is obligatory to employ techniques which involve reuse of wastewater for irrigation and other uses as an 'alternative source. Rather it is a dire need of time.

10.6.2 The concept of 'reuse of-wastewater' is not that way new in India. It is used to be realised from thcconcept of kitchen garden which is familiar to all of us. None the less, usage of this technique has remained limited as it has not been sufficiently developed. It appears that the method of reusing wastewater for agricultural purposes has been in practice in India since nearly 100 years, The, practice of this method has been in vogue in Mumbai City since 1897, in Delhi City since 1913 and also in Hadapsar and Manjri parts of Pune City since 1916 in Nagpur also treated water used to be utilised. A method involving conjunctive use of wastewater and canal water had been prevalent till 1988 on the Mutha Right Bank Canal. The said method has, thereafter; ceased to exist owing ta impairment of plant & machinery there. Nowhere in the State such attempts of reuse ofwatenhad twerbempraotised later.

Earlier Recommendations

10.6.3 The Barve Commission (1962) had recommended in this respect to the effect that canal water and sewage water should be used conjunctively and a provision to that effeCt should be made in formulation of irrigation schemes wherever canals are passing in vicinity of towns and sewerage system is in existence there.

The National Water Policy of ours as framed by the Central Government has accorded priority to the concept of reusing wastewater for irrigation. As there are natural limitations on availability of water, it is possible to overcome the problem by adopting measures such as using available water economically, ensuring recharge of water and practising use of water in order to meet our increasing demand in respect of that.

Domestic Use

10.6.4 1) Estimation of wastewater generated through domestic consumption:

Total population of Maharashtra as per the 1991 Census had been about 7,89,38,000. It is expected to reach about 18,13,15,000 by year 2030. (Statement 10.1.1) The demand of water in urban and rural areas in the year 2030 will be as indicated in the following table:

Sr. No.	Area	Population ('000')		Water requirement in 2030 (Mm^3)
		1991	2030	
(1)	(2)	(3)	(4)	(5)
1	Urban	30542	84517	4240
2	Rural	48396	96792	1943
	Total	78938	181315	6183

Source: Information provided by Task Consultants, Pune.

A large part of water used for domestic purpose in urban areas is received back through surface streams. However, in rural areas the same is not obtained to that much extent through surface streams as water used for domestic puiposes there is being allowed to infiltrate into trenches or else is being used for growing kitchen garden.

The quantum of wastewater being generated is as shown in the following table:

Part	Quantum of water being supplied (Mm^3)		Wastewater being generated	
	Total	Net (80%)	Percentage water supply	Generated quantum (Mm^3)
(1)	(2)	(3)	(4)	(5)
Urban	4240	3392	60-80 per cent	upto 2713
Rural	1943	1554	50 per cent	777
Total	6183	4946		3490*

Source: Information provided by Task Consultants, Pune

* 1 Mm^3 of water caters to irrigation to 140 ha land. With this rate, area likely to be brought under irrigation through this much water quantum is about 490000 ha. In cities like Mumbai, Thane etc. almost no irrigated agricultural areas are available for practising wastewater irrigation. There also, special efforts will have to be put in to achieve such water use for gardens and sanitation needs.

2) Alternative schemes for ensuring wastewater release.

Treated domestic wastewater can be used either for irrigated farming or for watering parks and gardens in towns / villages. Alternatively, it can be used either for groundwater recharging where deep cuts in soils are present and where underlying strata are water-bearing or for creating artificial storage of water in regions of water shortage for entertainment.

3) Quality of wastewater

If treated wastewater is used for irrigation, traces of elements present in it prove beneficial for the crop growth. The tolerance limits expected of the treated wastewater being used for agriculture are far less stringent than their counterparts in respect of that being'used for releasing water for public use after treatment. Therefore, this entails appreciable saving in capital and operational costs of treatments being applied to such wastewater.

There are three types of concerns to be exercised while ensuring quality of water being used for irrigated farming.

Salinity: If concentration of salts dissolved in wastewater happens to be more, the Productivity of soils is adversely affected (Topic 10.8 discussed in Water Quality undertakes a detailed discussion in this regard).

Sodicity: Contents of soluble sodium which affect the two characteristics of infiltration and permeability of soils; andcsodicity rendered to water thereby.

Toxicity: Concentration of elements such as sodium, chloride and that of boron present in the domestic wastewater which are harmful to plants; and toxicity rendered to water thereby.

4) Aspects related to public health

Presence of micro organisms, (e.g., nematodes, ficle, colifonns, etc.), that are present in wastewater can render harm to various crops in various prOportions. More vigilant measures are required to combat this.

5) Indian standards

The Central Pollution Control Board has stipulated the contents of various components in wastewater which is being used for irrigation. The same are presented in Annex 10.6.3.

Estimation of Wasteivater Generated from Urban and Rural Areas

10.6.5 The Annex 10.6.4 indicates distribution of urban and rural areas in Maharashtra (as on February 1997).

There are 72 towns having population more than 1 lakh or over These towns are being supplied water ordinarily at the rate of 135 litres per capita. Out of this, nearly 80% water is returned as wastewater. That means around 11 million litres wastewater is generated everyday. This can cater irrigation to 400 to 500 ha area As such, 4000 to 5000 ha area can be brought under irrigation through wastewater, generated from a city having 10 lakh population. To sum up, use of treated wastewater generated from towns / villages having population more than 1 lakh or over can be beneficial for irrigation. Its use in case of towns having population less than this can be decided considering its economic viability as the quantum of wastewater generation is lower on one hand and dependency of its use on land available for irrigation and a definite site for practising its use on the other.

Collection of Wastewater

10.6.6 If the policy of straightly collecting domestic wastewater through a sewerage network is to be adopted, the cost will be prohibitive. Following alternatives can be employed for this:

1. To provide a sewerage network in towns or villages having population 5 lakh or over during the period 2001-2025 (75 to 80 percent portion of water provided through this is returned back in the form of wastewater).
2. To provide a sewerage system for towns having population between 2 to 5 lakh during the period 2015-2030.
3. To impound wastewater; to recycle it and to treat the same in other towns (50 to 60 per cent portion provided through that is returned back in the form of wastewater). This system can be used in towns referred to above in (1) and (2) till the sewerage network is completed.

4. To set up in villages a system which is least cost-intensive, amenable to use for local irrigation and facilitating conveying surface sewerage.

When no system is at hand near the wastewater source which can cater to irrigation to farms and irrigation is badly needed at such times, treated wastewater can straightly be used for farming. Else, canal water is being used for irrigation nearby and wastewater is available in abundance, the same can be mixed in canal water and can be catered to farms. Alternatively, a separate project can be implemented which will enable to grow a special type of crop, (e.g., wet fodder). Else, a three-tier process involving chemical processing and sand filter can be employed for groundwater recharging.

Various types of pathogenic bacteria present in wastewater forbid the use of crops which are eaten raw. As the possibility of contracting infectious diseases by those who work on farms where sewage farming is practised is revealed, preventive measures such as going in for mechanised farming and wearing protective clothes / foot wears are required to be resorted to Efforts to practise the same are called for.

As the *sara* irrigation method adversely affects saving in water and health of labourers working on farms, it is not suitable for reuse of wastewater.

The *sari* irrigation method is comparatively better though hazard to health of labourers is unavoidable in this method too. In case, proportion of salts is not sizeable in treated wastewater, sprinkler irrigation method proves advantageous.

Drip irrigation method is good. However, an excellent filtering facility for this is a must.

10.6.7 Treated wastewater can be used for certain crops in accordance with its quality (Annex 10.6.5).

Responsibility of Local Government Bodies

10.6.8 As the present practice goes, the responsibility of implementing wastewater disposal projects and maintenance & repairs thereof rests with the local government bodies, (e.g., municipal corporations, municipalities and *gram panchayats.* However, experience in this regard is far from satisfactory. Financial handicaps, overall working modality of bodies and absence of uniformity therein, indifference to the concerned project and such other negative traits have been preventing practising the use of treated sewage for irrigation.

This will have to be kept in view here-in-after that this is needed as an alternative source for undertaking water resources development instead of implementing it merely for pollution control by appreciating the fact that the use of treated sewage water is a need of time The local government bodies should not treat the collection of sewage and conveying it to the final water treatment plant as their only responsibility. The Irrigation Department too should regard the work of treatment plant and reuse of sewage as if it is a project one that like irrigation project and commission it as a source of supplying water for irrigation. Pertinent to that, the responsibility of operating treatment plant & implementing further works and also that of maintenance and repairs be assumed by it As a first step to begin with in this respect, survey should forthwith be undertaken to assess the possibility of reusing the sewage for irrigation in areas of municipalities having population 1 lakh or over.

However, sewage treatment projects can become technically and economically feasible only if the modality for such plants in big towns is adopted the same as that being adopted for raising the regular irrigation projects. At least from this count, it will be useful if their formulation and commissioning be accomplished hereafter.

Financial Provision

10.6.9 A provision based on presently gathered experience for estimating the cost being incurred for reusing domestic sewage for irrigation to be phased as 2001 to 2015 as the first phase and 2015 to 2030 as the second phase is suggested as per the following in the Annex 10.6.1 : -

* for regular municipal sewage network: Rs. 800 per capita
* for collecting sewage, treating it and practising its reuse: Rs. 500 per capita and
* for surface gutters Rs. 300 per capita.

Reuse of Industrial Effluent

10.6.10 A substantial quantity of water supplied to industries comes out as wastewater. The quality of this effluent is much inferior to that of the water supplied. None the less, this effluent once it has been treated to regain it need not in any way be generally inferior in quality to that of the water supplied earlier. No difficulty should, therefore, be encountered in using it river / drinking water source or for irrigation, industrial use or other alternative. Had this untreated water otherwise been discharged into river as it is, it would have inflicted an irreparable damage to the river water or drinking water source. Use of wastewater irrespective of whether it is for reuse or for releasing it into a river is dependent on the overall water status of respective basin. Therefore, system of reuse of respective sub-basin will have to be set up in conformity with water availability therein.

After treatment, the effluent from industries can be used for different purposes in accordance with its quality by dividing it into four types.

1) Irrigating agricultural lands or
2) Letting into river or water source or
3) Cooling plants in industrial units or
4) Cleansing requirements such as floor washing, sprinkling on roads, gardening or similar lesser purposes.

a) Conveying wastewater after treatment thereon: Cattle in Maharashtra used to wander in search of fodder here and there. They are prone to drink water from whatever *nallas* they come across. These *nallas* are dry for almost 9 months in a year whereas they keep flowing for the remaining 3 months. In case these dry *nallas* are to be used as wastewater carriers, the same to be let into them after treatment should be of the standard at par with that of drinking water though its ultimate use is destined for agriculture. Alternatively, treating this wastewater to bring it upto the standard of water that is being used for irrigation (BOD - 100 and suspended solids - 200), it can be conveyed through a closed pipeline instead of an open one to the point where it is to be disposed off in a controlled manner. Obviously, the final decision in respect of both these alternatives will depend upon the outcome of schemes being proposed basing them on economic status, alertness and safety, management and public acceptability.

b) Financial provision: Information submitted by the Project Manager, Maharashtra Industrial Development Corporation, Mumbai pertaining to the effluent generated daily in industrial area of Mumbai and capital expenditure required for setting up treatment plants in accordance with the standards stipulated by the Pollution Control Board is presented in Annex 10.6.2. Accordingly, 228.5 million litres of wastewater is going to be generated in this industrial area daily involving capital investment of the order of Rs. 288 crores for that. In order to ensure reuse of this effluent in accordance with the Indian Standard - 2296, the total capital cost of the order of Rs. 447 crores is required. This means approximately Rs. 2,crores will be required in order to undergo 1 million litre effluent through a modern treatment. Pilot projects implemented on this tine have revealed that 1 m^3 of effluent will ordinarily cost Rs. 30 to Rs. 50[11] to meet the expenditure on count of energy, chemicals, maintenance and so forth so as to ensure regular operation of these treatment plants. It appears that this cost will come down to Rs. 25 to Rs. 30 per m^3 if capital expenditure and discounted interest thereon is recovered within 5 to 6 years. Therefore, the degree of shortage of water will govern the level of water purification and the uses for which reuse of water is to be realised.

As on today, there are 4000 major, medium and registered small scale industries in Maharashtra. Industrial centres numbering 267 of various grades have been set up through the Maharashtra Industrial Development Corporation. Factories belonging to 17 types have been categorised by the Maharashtra Pollution Board as instrumental in causing high degree of pollution. The Maharashtra Pollution Control Board seems to have not yet completely mastered the necessary technology of effecting treatment to the effluent emerging from this and various types of industries such as distilleries, paper and pulp mills, paint industries, industrial units manufacturing insecticides. The Maharashtra Industrial Development Corporation has accomplished a study as to the manner in which the use of effluent can be made in respect of 11 selected factories with the cooperation of private sector industries. An increasing trend as regards making reuse of effluent will be set in if such efforts are technically and legislatively supported and received encouragement and proper guidance. Involved technical studies and experiments, however, are required for this. At least 75 percent water that is supplied be made available for reuse. Condition to that effect will have to be laid down in accordance with the type of respective industry and provision to that effect will have to be made in the very agreement of water supply thereto.

10.7 Effect of Non-irrigation Use of Water on Irrigation

10.7.1 Alongwith irrigation, water is essential for various purposes such as drinking, domestic use, power generation, etc. Although water is required for meeting different needs, it is obtainable from only one source, viz., rains. (Maharashtra does not get benefit of snow melting taking place in Himalayas). Population is ever-increasing and so is the demand. Quantity of water obtainable from rains is, however, constant. Water is needed during the entire year against which the rainy season is of four months' duration only. It means unless water available during rainy season is, not stored, it is not made available during the whole year. Rainwater is required to be stored either in lakes or will have to be infiltrated info the ground. Water thus infiltrated can be made available through wells. For non-irrigation use of water one has to depend either on wells or water stored in lakes as rivers in the State are not perennial.

Many reservoirs have so far been built up in the State by constructing minor, medium and major dams. At the time of construction of these dams, people residing in respective parts or their representatives have not at all thought over that they will require more water in future for drinking, domestic needs, industries. It has not dawned upon even on the Water Supply as well as the Irrigation Department Water requirement for non-irrigation uses has, therefore, been either underestimated or not counted at all. Irrigable area is determined and all structures necessary for facilitating water distribution have been constructed anticipating use of all water for irrigation. A demand is being put forth to the Irrigation Department to reserve water storage owing to increase in water requirement on count of non-irrigation uses in those parts now.

11. Information obtained from the Maharashtra Industrial Development Corporation.

To lend foremost priority to drinking water is the policy of the Government. Demands as to reserving water on a large scale have been put-forth by the *Maharashtra Jeevan Pradhikaran* in the context of accomplishing completion of drinking water supply schemes in the State by the year 2000 and are to be met mainly from completed or under construction projects of the Irrigation Department taking into consideration the prospective population by the year 2030. Similarly, Department of Industries is also placing such demands with the Irrigation Department for five star industrial estates and other industrial complexes. After complying all such demands together for long-term reservation, it is noticed that on an average 21% of net storage out of present total storages from different parts of the State will have to be kept reserved for non-irrigation uses. Though by the year 2030 there will be a substantial increase in the use of water for non-irrigation purposes, it is possible to increase the quantity of water storage and hence about 14% of net storage will have to be kept reserved.

Effect on Irrigation

10.7.2 Water required for domestic and industrial purposes has an overriding priority and it is, therefore, necessary to reserve water on this count. This will adversely affect the quantum of water planned for irrigation. If 21% of water available from storages is diverted for non-irrigation uses, there will be reduction in already declared 6.72[12] lakh ha of irrigable command area (irrigation potential) and the expenditure incurred on development of this area will be uncalled for. Irrigation projects are approved by the Government. If, therefore, there is a need to carry out substantial changes in water planning of a project, seeking approval from the Government is obligatory. The reduction in command area and the amount of uncalled for expenditure incurred on the development of such area due to usage of irrigated water for non-irrigation purposes will have to be brought to the notice of the cabinet and approval is sought. In order to reestablish irrigation in such areas roughly Rs. 3360 crores expenditure will be required to accomplish modernisation of irrigation system at the rate of Rs. 50000/ ha. In some cases it may not be possible to recoup shortfall even after modernisaton. In such cases it will be necessary to review scope and extent of command area and a suitable reduction will have to be proposed. It is expected that drinking water supply schemes will be completed by the year 2000. Thereafter, shortage of water for irrigation in case of the project will start experiencing and taking this into consideration, the work of modernisation of irrigation system will also have to he taken up on priority forthwith.

Measures to Combat Effects of Non-irrigation Uses of Water

10.7.3 Water supplied to municipal population for domestic and industrial uses is available for reuse in the form of an effluent. Taking this and the scarcity of water into consideration, the *Maharashtra Jeevan Pradhikaran* and the Maharashtra Pollution Control Board should implement schemes which undertake treatment to effluent and facilitate its reuse for irrigation. It is estimated that about 60% to 80% of water supplied to domestic and industrial uses is made available for reuse as effluent. After necessary treatment the same can be used for plantation of crops such as cotton, sugarcane, fruit crops, plantations of eucalyptus, teak, bamboo, etc., or for gardens and to that much extent it is possible to make good the shortfall in irrigation area.

In past, the demand for domestic water supply in case of some towns and villages might have been satisfied through wells and natural lakes prior to proposing of water supply schemes from large reservoirs therefor. Perhaps water supply

12. Information received from the Irrigation Department, Government of Maharashtra.

being catered to through these earlier schemes was falling short. Therefore, water demand to be catered from reservoirs is being put forth afresh now and water supply schemes are undertaken. But instead of putting *demand for water to the extent t was used to fall short before, meeting demand of the entire - requirement of a city is envisaged in a new scheme. Once a new water supply scheme is implemented, no use of water in the existing wells, small domestic wells (*aad*) or natural lakes is being made. Use of such water can be made for other purposes other than that of drinking. The groundwater being supplied earlier happens to be cost-effective in comparison with a new scheme. Moreover, runoff resulting from rainfall in urban areas is also more when compared to that from other parts. This water goes on flowing down the *nallas*, rivers alongwith effluent during monsoon and contaminates the fresh water in a reservoir down further. For this, all this water (wastewater and rainwater) should be treated near every city by impounding it and be made available for irrigation. Only after having undertaken such 'water returning schemes', atleast' 75% water catered to domestic and industrial uses in municipal area can be reobtained for irrigation after being duly treated.

10.8 Water Quality

10.8.1 Water available in nature is basically not in pure form. The vapour in atmosphere solidifies around dust particles and raindrops while descending down to earth; absorbs oxygen carbon dioxide and other gases in atmosphere. Soil particles present on ground and other inorganic ingredients get mixed with this water. As water flows down over the ground, microorganisms, biodegradable organic ingredients, nitrogenous compounds, ammonia, minerals also get mixed with it. These contaminants can remain in surface water indefinitely; but in respect of water that gets infiltrated into the ground, silt and micro-organisms present in it are arrested in upper layer due to the infiltration and the filtered water finds access in underlying layers. The organic materials in water get degraded and react chemically with the chemicals present in ground. Plants absorb useful ingredients therefrom as food and remaining organic compounds remain confined in upper layers of ground. This filtration process in upper layers of ground does reduce the afore-mentioned impurities. The salts present in ground dissolve in water during infiltration deeper down in the ground. The concentration of salts depends on the nature of the underlying natural rock and chemical Composition thereof. Millions of types of micro-organisms are present in the ground. However, only a few cause diseases. Presence of algae impart foul odour to water. Some salts render water had in taste and make it hard. Corrosiveness of water increases because of some salts. Some dissolved gases impart odour to water and increase corrosiveness.

Pollutants in Reservoirs

10.8.2 (a) Suspended contaminants

* Micro-organisms: Some micro-organisms among numerous ones cause diseases.
* Micro plants: Cause odour, colour and turbidity (algae).
  (algae)
* Protozoa: Some cause diseases.
* Virus: Some cause diseases.
* Fine clay: Causes turbidity.
* Collidals: Render colour and turbidity.

(b) Dissolved contaminants

Salts	positive-charged	calcium	hardness
		magnesium	hardness
		ferrous	hardness and colour
		manganese	hardness and colour
		others	dissolved solids
	negative-charged	bicarbonates	Alkali
		carbonates	Alkali
		sulphates	purgative
		fluorides	teeth decay
		chlorides	taste
		organic	colour, smell, taste, toxicity
Gases			oxygen, corrosiveness, inflammable
			carbon dioxide - acid
			hydrogen sulphide - acid
			Nitrogen
			ammonia - caustic

Water is said to be potable if it is safe for drinking, palatable and fit for domestic use.

Waterborne Diseases

10.8.3 1. Bacteria: typhoid, prolonged fever, diarrhoea, cholera.

2. Virus:
3. Protozoa: amibyosis,- dysentery.

There is a possibility of getting well water or river, *nallas*, reservoirs, etc. contaminated if excreted wastes of persons who have contracted typhoid, prolonged fever, diarrhoea, gastro, cholera, etc., are allowed carelessly to find access as it is into them instead of disposing them off in a proper manner. It is, therefore, necessary to treat the excreted human wastes before it is disposed off. It has been observed by those who undertake study of epidemic diseases that gastro is followed by typhoid epidemic. Reservoir water contains numerous types of bacteria. Barring a few pathogenic organisms, existence of others, is of little importance from the health point of view. They are not harmful. The pathogenic organisms cause diseases like typhoid, diarrhoea, gastro, cholera, etc. Bacteria of coliform group are indicators of pollution. Bacteria of E coli group among them dwell in human and animal intestines and come out during waste excretions. Their existence is visible in water as excreted wastes get mixed with water. In water, they are not prone to grow and die out with exponential speed. They survive a few weeks or whole month in fresh water when they are thinly populated. Therefore, existence in large numbers of coliform bacteria proves indicators of contamination of human and animal wastes. Coliforms are by no means pathogenic but they can possibly infect urinary tract. The proportion of E coli bacteria is enormous when compared to that of pathogens. Fresh human excreta contains 5 to 500 million E coli bacteria per gram. Average human excreta weighs 82 gram per person. This proportion happens to be 25 to 50 thousand per millimetre. Ordinarily 10 lakh E coli bacteria exist with 1 bacteria of typhoid. Therefore, water is Tendered safe for drinking-if number of E coli bacteria is reduced considerably (Annex 10.8.2). Pathogenic bacteria die out naturally in presence of sunlight, extreme temperature, other bacteria etc. Pathogenic bacteria and E coli micro-organisms are killed in water purification plants by applying a chlorine dose.

Viruses are still more micro in nature than bacteria. Their cells comprise of pure proteins and they grow with the support of special cell's. Therefore, technique of their counting has not developed as that in case of bacteria. Chlorine and ozone treatment kills 95-99 per cent viruses. However, a single cell of a virus can even become harmful. That is why it can not definitely be said whether viruses are fully eradicated or not due to conventionally carried out water purification.

Microscopic Organisms

10.8.4 Besides bacteria, some other micro-plants and micro-organisms are present in water.

1) Algae - This is an unicellular, chlorophyllic plant. It manifests in several spacies. It is fibrous in nature and at times develops a dense carpet over water surface. Water is thereby rendered turbid and green in colour. Similarly, water is smelt bad and its taste also gets, altered. There are 3 main types of algae. (1) Green algae (2) Blue algae (3) Diatom. Secondary types such as yellow-green, grey, red also exist. Algae is grown in sunlight. They secure their food from salts present in water, nitrogen compounds and carbon dioxide. Their life process involves release of oxygen in water which gets dissolved. The life process, of algae is prone to secretion of a special kind of oil in water which renders a peculiar taste and odour to water.

2) Protyst - These are unicellular living beings because of which other advanced living beings of complex constitution and life processes are developed in water. Among these unicellular protozoa only Endomoeba hystolytica causes diarrhoea. The filtration process in water purification enables to filter them down from water. Chlorination doesn't have any - effect on them. However, break point chlorination in which if free chlorine is 2 mg / litre and contact time of chlorine happens to be 30 minutes certainly kills them.

3) Fungi - Fungi are plants which are devoid of chlorophyll. They therefore grow in absence of sunlight. When this plant dies out, water is rendered unpleasant in odour. This is prevented if chlorination process is applied to water.

4) Actinomycetes - They are related both to the bacteria and fungi and impart earthy odour to water.

Standards for Measurement of Characteristics of Drinking Water

10.8.5 Standards prevalent for measurement of characteristics of drinking water are indicated in Annex 10.8.1.

1) Turbidity: Water is rendered turbid due to suspended micro particles of soil in waters silt & clay and live or dead algae plants and also due to other organisms. When water becomes still, heavy soil particles quickly settle at the bottom and micro particles remain suspended in water for months together. Inorganic particles quickly settle down at bottom in reservoir water; but the algae grows because of presence of sunlight and water is rendered turbid.

2) Colour: Suspended colloidal particles lend a colour to water. This colour is caused because of colour substances released basically through decomposition of plants. Effluent released from factories is also lent a colour because of chemical processes.

3) Odour: Decomposition of biotic constituents or decomposition of sulphates present in water lend an odour to it Drinking water should be devoid of odour.

4) Acidity and alkalinity of water: Compounds of calcium, magensium arid sodium impart 'alkalinity to water. Alkalinity is essential for the process of water purification. Presence of dissolved carbon dioxide renders water acidic. Acidity and alkalinity of water are measured in terms of pH value which ranges between 0 to 14. Water with pH as 7 is inert Water is termed as acidic if pH happens to be less than 7 whereas pH exceeding 7 indicates that water is alkaline.

5) Dissolved minerals: Dissolved minerals of more than 200 mg/litre concentration impart a taste to water. Water with concentration exceeding 3000 mg/litre can not be consumed. According to the Indian Standards, water is forbidden for drinking if concentration of dissolved minerals exceeds 500 mg/litre. Combined concentration of magnesium sulphates and sodium sulphates if exceeds 500 mg/litre makes water purgative. If total dissolved minerals exceed 2000 mg/litre, water is of no use to industry though it may not be hard.

6) Hardness: Natural water contains minerals in more or less different proportions and a human being is habituated to it presence. Water in originally pure form is devoid of any taste and unsatisfactory. Carbonates of calcium and magnesium and bicarbonates render hardness to water. Those react on a soap making it inert. If water is boiled, carbonates are formed and settle down at bottom after getting separated from water. Hard water is converted into soft one for using in boilers. Mere presence of carbonates in hard water is called as temporary hardness. Sulphates of calcium and magnesium and chlorides render water permanently hard. Because of them, encrustations are deposited along the inner side of boilers.

7) Chlorides: Salt is being used in cooking and the same is being discharged. Therefore, sewage contains salts in more proportion than that in natural water. A primary conclusion can be drawn that water is polluted due to sewage in case water from a well or a source happens to be more in salt contents. Of course, testing for existence of micro-organisms is necessary to ascertain pollution.

8) Sulphates: Compounds of sulphates are converted into hydrogen sulphide gas after <their decomposition which lends water an obnoxious smell and water is rendered unpalatable.

9) Fluorides: Concentration of fluorides in water between 0.6 to 1.05 mg/litre is beneficial for growth of teeth. However, if water with fluoride concentration exceeding 1.05 and mainly beyond 3.0 mg/litre is given to children to drink at the time of outgrowth of permanent teeth they contract Peoria and suffer permanently from tooth decay. Obviously, adults do not get adversely affected, because of this water. Groundwater in districts of Sindhudurg, Solapur, Dhule, Aurangabad, Yavatmal, Chandrapur, Wardha, Nagpur, etc. appears to be infected with this.

10) Nitrates: Concentration of nitrates in water exceeding 75 mg/litre adversely affects brain of an infant.

11) Ferrous and manganese: Ferrous minerals lend hardness to water. Ferrous contents exceeding 0.3 mg/litre lend a peculiar taste to water. Similarly, colour of clothes also fades out because of that. Water with ferrous is replete with crenothrics bacteria and clothes are stained because of their action. Groundwater in districts of Sindhudurg, Kolhapur, Ratnagiri, Chandrapur, Gadchiroli, Bhandara appears to be affected with them. Manganese contents exceeding 0.05 mg/litre fade out colour of cloth and also growth of organic plants takes place.

12) Gases: Gases present in atmosphere like nitrogen, methane, hydrogen sulphide, oxygen

and carbon dioxide mix in water. Among those, hydrogen sulphide, oxygen and carbon dioxide are of importance.

(a) Hydrogen Sulphide: This gas is formed as a result of decomposition of organic matter and also because of sulphates, ferrous sulphates etc. This gas gets mixed with lignite and water oozing out from organic substances. Its presence in atmosphere in 0.06 to 0.08 per cent proportion causes toxicity. Dissolved gas is extracted through water by aeration method.

(b) Dissolved Oxygen: Concentration of oxygen in pure water is in the range of 8.6 to 7.9 mg/litre. It is, however, used up by bacteria to stabilise unstable organic compounds by decomposing them due to which its concentration decreases. Rather oxygen is supplied for treatment of sewage by entraining air into it. As demand of dissolved oxygen goes on increasing, its concentration decreases. Dissolved oxygen renders water pipelines corrosive.

(c) Carbon dioxide: Its presence increases corrosive potential of water. Dissolved carbon dioxide is required for the growth of algae in water.

13) Toxic elements: Contents of arsenic, cadmium, chromium, cyanide, lead, selenium, mercury, etc. present in water should be minute. Indian Standards have already specified the tolerance limits for the same.

Quality of Wastewater for Irrigation Use

10.8.6 Domestic sewage contains 99.9 per cent water and 0.1 per cent other organic and inorganic matter. They contain nitrogenous compounds such as urea, proteins, amines, amino acids, etc., salts of phosphate, sodium, potassium, calcium, magnesium, etc., fats, carbohydrates, metals and other elements in very minute quantities.

The quality of effluent being released from factories changes with the nature of factory. For example, the effluent from a fertiliser factory contains salts of ammonia, acids, alkalis, arsenic, nitrates, chromates, cyanides, sulphides, fluorides and phosphates. Effluent from paint industries contains predominantly zinc and colour. Tanneries release effluent containing sodium chloride, chromium and tanin. Effluent released from industries situated n districts of Ratnagiri, Raigad, Thane, Pune, Satara, Kolhapur, Nagar, Sangli, Nashik, Aurangabad, Nagpur, Chandrapur pose a considerable danger of groundwater pollution.

It is necessary to exercise care so as not to affect adversely land, plants and human health while going in for use of domestic sewage and industrial effluent for irrigation. From this viewpoint, ascertaining quality of wastewater for suitability as to irrigation appears necessary.

(1) Salinity: Concentration of dissolved salts in water, being used for irrigation is termed as salinity. Continued use of such wastewater in which concentration of salts is high favours deposition of salts over the ground. Plants of course use up some portion out of that. Use of water containing sodium alters the composition of soil after some time and it becomes prone to stickiness while it is wet and shrinks after drying. Plants find it difficult to suck water through such soils. Moreover, aeration in soils is hampered. Fear as to land becoming partially infertile looms large. Tolerance of soil to salinity alters in accordance with the crops. Range of variation is tenfold. The problem of salinity is felt more often in coastal districts like Thane, Ratnagiri. Factors which are instrumental in increasing salinity of soil are (i) type of soil (ii) climate (iii) quality of irrigation water (iv) soil moisture. There is a direct relationship between dissolved salts in water, osmotic pressure of soil and electric conductivity. Concentration of salts can be determined through electric conductivity of a soil solution, Salinity of water for irrigation should range between 1.0 to 2.3 milli mho / cm and it should not drop down below 0.2 milli mho / cm as sodium salts present in soil get dissolved in saline water. This adversely affects drainability of soil and the crop growth too.

(2) Sodicity: Capability of irrigation water to influence exchangeable sodium in a soil is sodicity. The sodium salts in soil get dissolved in water used for irrigation and segregate soil particles as a result of which fluid conductivity of soil decreases. The plants do not get adequate oxygen thereby and their growth is adversely affected.

Six standards for measuring sodicity of irrigation water are evolved. (i) percentage of exchangeable sodium (ii) sodium absorption ratio (iii) residual sodium carbonate (iv) calculated pH (v) adjusted sodium absorption ratio (vi) sodium absorption ratio existing An root environment, (i.e., rhizosphere).

(3) Toxicity: If concentration of sodium, chloride and boron in domestic wastewater increases it inflicts harm to plants, Similarly the industrial effluents are found to contain sulphides, heavy metals, phenols, oil and grease beyond a certain concentration of which they are harmful to the plants.

(4) Sodium: High concentration of liquid sodium not only alters the soil composition, but owing continuous absorption of sodium it gets deposited in plants and the leaves get overburnt also Orchards are sensitive to a slightly higher concentration of sodium unlike .conventional crops which, however, are not so sensitive. Concentration of sodium in leaves of trees should be 0.25 to 0.5 per cent (based on dry weight). Concentration exceeding beyond this leads to overburning of leaves.

(5) Chlorides: These remained in dissolved state in water without getting adhered to soil particles because of which roots of plants absorb it In case concentration of chloride in plant leaves exceeds 0.3 to 0.5 per cent (based on dry weight) leaves of fruit crops get overburnt. None the less, conventional crops are not so sensitive.

(6) Boron: Boron is essential for growth of plants if present in minute concentration. However, crops like lemon get affected with water having concentration of boron exceeding 1 mg / litre. Tolerance capacity in respect of boron is different in case of different crops / trees.

(7) Heavy Metals: Very minute concentration, i.e., 0.5 to 20 mg /litre present in industrial effluent inflicts harm to plants. Mining works in districts of Sindhudurg, Ratnagiri, Nagpur, Chandrapur, Bhandara, etc., has given rise to the problem of groundwater pollution.

(8) Sulphides: Sulphides are obtained from effluent let out through fertiliser factories. It poses no harm to plants if its concentration is within 1 mg/litre.

(9) Phenol: It poses no harm to plants if concentration is within 10 mg/litre. However, it is not tolerable even if present in very minute traces in drinking water.

10) Oil and grease: It is not detrimental to plants if concentration is within 10 mg/litre.

11) B.O.D.: If the biochemical oxygen demand happens to be of the order of 100 mg/litre it is tolerable for irrigation.

12) Fluorides: These do not affect if present in minute traces but they get deposited in some kinds of lucerns. If such lucern is consumed by animals, it is detrimental.

13) Suspended particles: Pores in soils get chocked up because of these. How much should be its concentration in irrigation water is determined on the basis of composition of soil.

14) From hygienic point of view quality of irrigation water is indicated in accordance with effects it entails on plants and composition of soils.

(a) Presence of excessive salts in irrigation water makes it difficult for plants to assimilate water.

(b) Presence of toxic elements in irrigation water hampers metabolism of plants.

(c) Presence of various contaminants in irrigation water modify the composition of soils reducing its permeability thereby.

Nevertheless, it is necessary to stipulate some additional criteria in this respect in order that irrigation being accomplished through wastewater should pose no danger to health. Such criteria are not laid down in the Indian Standards as there are several types of bacteria present u wastewater. It is necessary to lay down criteria in respect of water being used for irrigation so that vegetables, tomatos, brinjals, etc., being grown through such irrigation should not come into contact with bacteria and should not spread diseases.

If chlorination dose is applied to wastewater, 95 per cent bacteria are prevented from surviving. Therefore, it is very much necessary to supply such disinfected wastewater to irrigation; otherwise pollution likely to take place/will be diverted to farms by discharging wastewater into rivers. Indicative concentration pertinent to quality of irrigation water as per the Indian Standards are produced in Annex 10.8.3(1),

15) Norms in respect of use of wastewater for irrigation as stipulated by the Central Pollution Control Board are reproduced in Annex 10.8.3(2). Considering that a few toxic substances are detrimental to plants and animals, a criterion to the effect that 90 per cent fish will survive in 100 per cent wastewater after 96 hours is laid down therein. In spite of that, it is necessary to ensure eradication of pathogenic bacteria and incorporating consideration of that in the Standards, criteria should be laid down.

Groundwater Quality

10.8.7 In most parts of the country, groundwater reserve is suitable and fair for drinking, domestic use and agriculture. However, through overuse and other ways it is getting polluted at some places. Instead of clean and clear, turbid and brackish groundwater has now been found on a large scale in Rajasthan, coastal areas of Saurashtra and Katchha. Similarly, overuse of groundwater present in the form of small water courses in vicinity of coastal strip has rendered the groundwater far from palatable owing to ingress of sea water in this part. In the strip near Chennai also water has not remained fit for drinking owing to ingress of sea water into fresh water courses as a result of continued overuse thereof. Concentration of arsenic has increased fourfold than necessary in the groundwater present in regions of Malda, Naida, Murshidabad, North 24 Pargana, South 24 Pargana, Hoogali, Howrah, etc., in West Bengal. It has come to the notice that proportion of skin and bone diseases has increased due to consuming such water. Concentration of fluorides has been observed to be considerably increased in groundwater reserves of Andhra Pradesh, Haryana, Rajasthan, Punjab, Uttar Pradesh, Karnatak, and some specific areas in Tamilnadu. It has been come across that concentration of chromium is increased in groundwater reserves rendering them polluted in areas of Faridabad (Haryana), Ludhiana (Punjab), Udaipur, Khegi, Jodhpur, Kanpur (Uttar Pradesh), Warangal (Andhra Pradesh) and North Akot District of Tamilnadu. This detrimental effect is being manifested due to omission of treatment on industrial effluent which is replete with chemicals. This is a matter of grave concern.

As indicated in the foregoing, groundwater reserve in several areas has proved to be contaminated, unsuitable / unfit for drinking / domestic use due to intermixing after infiltration with manmade sewage and chemicals-mixed polluted water.

Once groundwater storage is polluted, it takes years to improve its quality. The proportion of polluting groundwater reserves has now been increased considerably than it had been earlier. However, there is no provision in groundwater act or rules which helps prevent this pollution. It is extremely necessary on the part of Government to take stringent steps for this by making provision in the act and enforcing the same.

The total dissolved solids (TDS) is the only parameter which has been incorporated in the map (Map 10.8.1) depicting groundwater quality in the State as obtained by the Commission from the Groundwater Surveys & Development Agency. By basing on this parameter alone, it is difficult to infer about defunct area for drinking water or irrigation from groundwater quality point of view. It is essential to accrue data regarding other parameters also for this.

If quality of groundwater is hereafter examined for fluorine, arsenic and other toxic elements alongwith TDS, and in the light of microbiological analysis, matter which is of no use will exhibit an increase only For this, groundwater quality maps should be prepared every year and published alongwith statistics by considering all factors together. Accordingly, use of sources that are polluted should be forbidden forthwith by publishing details thereof.

Classification pf Groundwater in the State Based on TDS

Part unsuitable for drinking water (500 mg/1) use		Part unsuitable for irrigation (500- 10 00 mg/1) use	
(1)	(2)	(3)	(4)
1) Dhule	Eastern	1) Ahmadnagar	Northern
2) Jalgaon	North-Western	2) Pune	South-Western
3) Nashik	Central	3) Kolhapur	Eastern corner
4) Aurangabad	South-Western	4) Amravati	Central
5) Jalna	Central & Eastern parts	5) Akola	Northern & North-Eastern
6) Parbhani	Northern, Western & South-Eastern	6) Thane	Part along the Western coast
7) Nanded	Central		
8) Latur	South-Eastern		
9) Pune	Northern		
10) Ahmadnagar	North-Eastern		
11) Satara	South-Eastern		
12) Sangli	Central & Eastern		
13) Solapur	Central & Eastern		
14) Thane	Part along the Western coast		
15) Raigad	Part along the Western coast		
16) Ratnagari	Part along the Western coast		
17) Sindhudurg	North-Western		
18) Buldana	Central & Eastern		
19) Akola	All parts-except that on South		
20) Amravati	All parts-except that on North		
21) Yavatmal	Central & Northern		
22) Wardha	North-Eastern		
23) Nagpur	Northern & North-Eastern		
24) Bhandara	Central		
25) Chandrapur	South-Eastern		
26) Gadchiroli	South-Western		

Source:- Information received from the Groundwater Surveys and Development Agency, Pune.

10.9 Water Pollution and Purification

10.9.1 Industrial development was provided an impetus after independence with a view to increase pace of the economic development. The Maharashtra Industrial Development Corporation is formed with a view to facilitate entrepreneurs to set up factories; and basic facilities such as land, electricity, water, etc., are provided. Similarly, in-backward regions the industrial development took place rapidly due to extension of facilities such as tax concessions up to 5 years, financial assistance for raising capital, facilities in the form of financial institutions for raising loans, etc., in establishing industries. No adequate attention has however, been paid to the likely adverse effects of this development on the environment. In many places, the industrial effluent is being discharged into rivers and *nallas* without making it undergo any treatment even now Many rivers have therefore been polluted and their water has been rendered unportable. Rather, in most of the places it is not even fit for agriculture. Most of the rivers have now become mere gutters carrying wastewater from industrial and urban areas. There is an urgent need to bring out change in this scenario.

10.9.2 Construction of dams across rivers and diversion of water in canals- not only in monsoon but also in dry weather compounded with excessive lifting of groundwater- has led the flows incoming into rivers to vanish. No flows of their own are left in many rivers and their condition turned from bad to worse. Big towns are situated in catchments of large dams. Municipal sewage from these towns is being accumulated alongwith rainwater in the impoundments formed by these dams and water therein is heading towards pollution, (e.g., Lower Pus, Ujjani, Jayakwadi, Sukhana).

10.9.3 Water available in nature is limited. Increasing reuse of all available water is inevitable to meet the needs as regards to foodgrains, municipal and industrial needs of growing population. Hence the used up water needs to be treated again and brought back to the quality which is suitable for its reuse. To some extent, self-cleansing capability of rivers can come to help. Nevertheless, industrial or domestic wastewater is basically required to be treated to make it pure. Barring the 30 per cent use of water obtained from reservoirs for municipal and industrial use and losses arising out of that, schemes envisaging making available atleast the rest 70 per cent water in river, canal, etc., will have to be completed during the forthcoming decade.

Restoring the food cycle, of aquatic animals by restoring flow of rivers with freshwater should have been the principal objective of ecological balance of any river regime. The management of river basin and that of river will have to be streamlined from that viewpoint.

10.9.4 The city sewage contains unstable organic compounds and they need oxygen for their stabilisation. This itself is termed as oxygen demand. The very objective of sewage treatment process is to make available sufficient oxygen for stabilisation of organic compounds. In spite of fulfilling the oxygen demand, various kinds of microorganisms still survive in water that is released through the processes such as sludge digestion, oxidation pond, aerated lagoons etc. Pathogenic bacteria too are present in it Chloripation of this water kills these bacteria and the resulting water no longer remains harmful to the health.

10.9.5 Heavy metals present in the industrial effluent adversely affect the animal life. The process enabling removal of inorganic matter present in effluent in excess of the norms is now possible in respect of many contaminants. It is essential to purify water by adopting those.

Pollution Control Board

10.9.6 The Central Government has proclaimed in 1992 the policy in regard to pollution. It emphasises conservation of natural resources. As spelt out in para 0.2 of it, the industrial organisations and municipalities should realise that controlling pollution should be the responsibility of theirs. A system is required to be set up to ensure implementation of environmental norms and reuse. The statutory responsibility of not allowing the pollution to result lies on industries and local government bodies. The State Government owns an independent department looking after environment. Moreover, an independent pollution control board is also there. A separate pollution control act has also been enacted by the State Government in 1974. Permission from the Pollution Control Board is required to be sought while establishing factories. The pollution Control Board boasts to have laboratories at numerous places in the State in which mainly polluted water, industrial effluent, etc., are tested. The rules, pursuant to that, provide for taking action on the concerned organisations (penal if necessary). The Board is empowered to severe water supply and electric connection of factories which are causing excessive pollution.

Besides this, the Pollution Control Board in pursuance to the clause 17 of 1974 Act is entrusted with the responsibilities of gathering information pertinent to wastewater, disseminating the same, conducting the research and promoting the same, evolving methods which undertake processing on wastewater, evolving methods for making possible sewage farming evolving methods of wastewater disposal, etc. However, the annual reports of the Board reveal that no worthwhile work involving technology in this regard has so far been accomplished by the Pollution Control Board. No concrete steps in regard to bringing under control the mitigation of pollution appear to have been taken by the Board other than the routine regulatory works such as how many organisations were given permission to release effluent in natural systems on certain conditions, to what extent treatment on wastewater is being accomplished and how many organisations have been brought within the ambit of legal action.

10.9.7 If the overall state of affairs in regard to water pollution in the State is overviewed, it reveals that by most of the municipalities municipal wastewater, sewage are being released in nallas and ultimately to rivers without making it to undergo any kind of treatment. The largermost share of pollution is caused by the prevailing municipal system. Similarly sugar factories, distilleries - also appear to have neglected to establish any kind of set-up for treatment.

Smaller industries do not afford their own treatment plants nor has there been evolved any collective system to gather their effluent at one place for making it undergo any treatment. The Maharashtra Industrial Development Corporation provides land, electricity and water to industries; but no explicit responsibility is put on them to undertake disposal of wastewater in its Act nor have they knowingly assumed any. The *Maharashtra Jeevan Pradhikaran* too is in the forefront in formulating newer and newer schemes of water supply. However, it seems that it is not taking any lead in conceiving sewage disposal schemes. No set up appears to be with it which conducts some sort of research experiments to evolve less capital intensive treatment or techniques requiring minimum maintenance and repairs. In addition to this, lack of any kind of system ensuring regulation of flowing water in rivers, the self-cleansing capacity of rivers has altogether vanished at numerous places. While suffering from pollution, the habitats along the rivers are at a loss as to precisely who is to be approached for redressal of this situation. Therefore, a few public interest litigations also appear to be filed in the courts of law. It is very much essential to go in for an urgent remediation of this state of affairs to obviate the further havoc by forthwith taking a serious cognizance of such a neglected scenario of water quality.

Studies Conducted as Regards to Water Pollution in Maharashtra

10.9.8 The inferences of the pollution studies conducted by the Maharashtra Pollution Control Board in respect of Tapi, Krishna and Godavari rivers are depicted in the Graphs 10.9.1 (A,B,C). It is seen from that the proportion of dissolved oxygen is diminished in areas downstream of Deepnagar Part because of letting sewage of Bhusawal City to join Tapi as a result of which BOD thereof has increased. As the sewage from Nashik City is being let into the Godavari, the BOD has increased further down Nashik. Similarly, the river is polluted in the stretch from Paithan to Shahagad. At Nanded, the gutters in the city have joined to the river causing pollution of river water. It has been observed that pollution has occurred at seven places in Krishna and its tributaries. The Panchaganga River has been polluted due to wastewater released from factories near the Kolhapur City and municipal sewage whereas the very water of Krishna at Sangli is polluted.

The Annex 10.9.1 contains a list of 15 corporations and 15 municipalities at least in areas of which local government bodies sewage disposal schemes have been executed. No regard as regards to this responsibility appears to be paid by 1 corporation and 213 municipalities among the rest. Among those who have partially taken cognisance of, action of none has proved effectual in controlling pollution barring those at Pimpri-Chinchwad, Solapur and Pandharpur.

All sewage - either treated or untreated - from towns along the sea, coast is being released into the sea as it is Out of total water supply to Mumbai city, hardly 534 Mld sewage is being treated and the rest of it is being let into the sea as it is The study conducted to assess the effect of wastewater of Mumbai City on the sea environment clearly reveals that no fish flourish there where wastewater is allowed to drain into the sea as the water there is 730 devoid of dissolved oxygen. The sewage from Thane, Kalyan, Dombivali and Ulhasnagar joins to the Ulhas Creek where also considerable pollution has occurred.

Sewage farming is being practised on the wastewater of Solapur, Pimpri-Chinchwad and Pandhapur as the existing sewage disposal schemes there are properly functioning. Also, part of the sewage of the Pune City is being released into the Khadakwasla Canal from the Bahiroba Pumping Station. After getting mixed with the canal water (Statement 10.9.1) it is being used for farming at Hadapsar. Though there are such schemes for cities of Nanded and Latur, they are doomed to be fully inoperative.

Wherever sewage disposal schemes exist those are not for the entire area of the city and hardly cover at the most 30 to 40 per cent of the area Rest of the part is devoid of such a systematic sewage disposal.

The last 35 years saw 2.2 times increase in urban population of Maharashtra and urban water use is increased 2.34 fold. It means 2.34 times more sewage is being generated as compared to that in 1960. No capability has, however, been acquired to handle the same in that much proportion. Atleast a some sort of system manages to cater for only 20 per cent of the wastewater of gross municipal sewage. Water supply augmentation schemes are being taken up that way on priority to cater water supply to the increasing population. The sewage - disposal schemes, being cost-prohibitive from the capital investment and maintenance & repairs point of view are however, been neglected by the municipalities.

10.9.9 Treatment of sewage entails employing a series of some processes among various alternatives such as removal of solids floating over the sewage sheets by screening, removing grit present in sewage by reducing velocity by allowing it to settle into pits, lending aerobic treatment by means of biologically active sediments, settling ponds or aerated lagoons or trickling filters and rotating biological discs; or provoking anaerobic process with the help of anaerobic filter, rotating biological discs and anaerobic filters. Therefore, sewage treatment plants are prohibitive in, costs from the capital investment point of view, are technically complex and involve intensive use of power. No adequate technical staff seems to be at hand even now who is capable of running such treatment plants. This entails difficulties in operating these treatment plants. This results in either their running down in course of time or rendering them prone to throw out the sewage in a polluted state only as a result of incompletely taken place process.

As sewage disposal schemes are highly cost-intensive, they have been implemented with foreign aid or loan from the World Bank. The influence of foreign consultants, local manufacturers of equipment for treatment plants is, therefore, apparent in dictating the layout of such plants. All this set up is conspicuously found to be wanting in indigenous technology and self-reliance.

It is urgently necessary to develop a technique of handling sewage which is least cost-intensive as far as capital investment is concerned, cost-effective as far as expenditure on count of power and maintenance is concerned and convenient from the point of view of maintenance & repairs. Barring the one owned by-the Mumbai Municipal Corporation, all sewage disposal schemes in the State are being undertaken through the *Maharashtra Jeevan Pradhikaran.* However, constructions of sewage treatment plants are also being accomplished basically with the help of consultants. No organisation or any set-up which conducts such research exists within the *Maharashtra Jeevan Pradhikaran* of its own. Therefore, a tendency of disposing off this work in accordance with either the orthodox way or the foreign technology, is evident. It has, therefore, become necessary to, formulate a special programme and push it further meticulously during the coming decade so as to build up a capable system within the State of handling sewage by instituting a radical change in this It is seldom going to be achieved without exclusive grants of sizable proportion from the Maharashtra Government.

It is called for on the part of the Maharashtra Engineering Research Institute, Nashik to undertake an extensive research pertinent to processes necessary for making use of effluent for irrigation especially by paying special attention to this A momentum can be given to treatment of sewage by setting up a separate a cell in the Engineering Complex at Nashik.

10.9.10 One important component of pollution control is to minimise the quantum of wastewater in the first place. A considerable difference appears in per ton water use of two factories manufacturing the same kind of production. This is due to the fact that no heed is critically used to be paid towards the actual needs and its polluted state in respect of water that is being used for various processes in factories. It becomes easier to undertake purification of water by treating after every use instead of collecting the same and treating once after its all kinds of uses in a factory. Moreover, recycling of Water can easily be achieved in a factory. The requirement for fresh water for that factory therefore reduces and so also the quantum of wastewater ultimately. As the price of water for industrial supply has already been increased basically, recycling and reuse of water are promoted. Such a kind of reuse is presently being realised in a very small proportion. There is a scope for reuse of water in industrial cooling, cooling of processed steam, water used for washing filters in water purification plants, water being used for transporting goods in a factory and at many such places. From this viewpoint it is necessary on the part of the Maharashtra Industrial Development Corporation to evolve a system which will undertake periodical scrutiny of water use being entailed in factories. After having carried out such a scrutiny, a provision will have to be made in the rules to cater to that much supplementary water supply which is just necessary for a factory. Moreover, new techniques can be evolved which will entail reduction in water in various uses in factories. It will be useful to undertake the work of developing such a technology by the Maharashtra Industrial Development Corporation. The Maharashtra State Government should provide special grants to such undertakings so as to promote such programmes and the findings be disseminated among the public. The loading on the various measures required to be adopted by the Government for increasing availability of water will thereby reduce progressively.

New Technology for Sewage Treatment

10.9.11 The developed countries had encountered a similar kind of pollution problem which we are experiencing now in today's developing phase of India. To find solutions for this is far from easier. For that, they vigilantly launched a pollution mitigation campaign and developed newer and newer techniques. Considerable amount of money and time is required for this. It is beneficial to Make them available in time. To some extent, the solutions for mitigating pollution are found even in natural and biological methods instead of confining them to chemical and mechanical processes. Some such methods entail lesser capital and maintenance costs. For example, developing the technique of Engineering Wetland Management. If a peculiar kind of vegetation is planted in manmade wetland, the slowly flowing wastewater gets purified while passing through it with the help of physical, chemical and biological processes. Especially heavy metals present in contaminated water get settled at the bottom of such wetland. The dense growth of plant roots manages to filter the water and helps accumulate the suspended matter present in wastewater at the roots of plants. Ferrous present in wastewater gets converted into ferrous oxide by means of oxidation and gets accumulated to the roots of aquatic plants. This process is achieved with the help of micro-organisms and heavy metals like lead, arsenic, copper, zinc, etc., get deposited on the ferrous oxide. Some kind of bacteria cause reduction in sulphates of heavy metals owing to the anaerobic environment prevailing there. The excess sulphur is released in atmosphere in the form of a (decaying odour) which is known as marsh gas. For this to happen, the flow passing through the wetland should be of extremely slow velocity. The wetland area should, however, be of sufficiently extensive extent for that. Moreover, some time is required to be elapsed even before the wetland gets stabilised - biologically as well as chemically. This balance is required to be continuously kept under observation and some changes are also required to be brought about on this wetland for this from time to time. Extensive research and experiments in this direction are required to be undertaken at different places in Maharashtra. A system of tanks incorporating waste stabilisation in such a manner, being least capital-intensive, would be possible to develop.

Various techniques are required to be evolved which will prove favourable for the climatic conditions prevailing in the State. It will be proper to undertake an extensive programme in this regard during the ensuing decade. It will be proper on the part of the Maharashtra Pollution Control Board to pursue all such research activities by forming a joint action/ group of the Maharashtra Industrial Development Corporation, *Maharashtra Jeevan Pradhikaran*, Maharashtra Engineering Research Institute, Pollution Control Board and the Directorate of Irrigation Research & Development. Earmarking atleast 1 per cent of the outlays expended on water supply for conducting such a kind of research is called for.

10.10 Fisheries

The fisheries can prove to be supplementary from the viewpoint of increasing financial returns accruable from reservoir being created as a part of an irrigation project. From this viewpoint, it has become very much necessary to achieve proper use of irrigation reservoir at proper time. Therefore, instead of entailing use of available irrigation water resource merely for irrigation, if fish production is practised at reservoirs every year, the Government can amass a sure and sizable income as that is being accrued from interest on bank deposits. Moreover, employment opportunities can also be extended to fishermen. In this respect the Barve Commission (1962) in its report has made a mention to this effect:

> 'Development of pisciculture and tourism are two ancillary activities which can be undertaken alongwith storage works. The reservoirs should be stocked at an adequate rate for a number of years so that they may then yield quantities of carp fry (baby fish) large enough to make fishing worthwhile. Nurseries for growing baby fish can be provided without much extra cost by converting excavations below the dam site into regular pits of suitable dimensions to serve as nursery tanks.'

Nevertheless, the fisheries along irrigation reservoirs in Maharashtra has remained neglected even today. No scientific extension and development in that respect has ever been taken place. Therefore, it is desirable to arrange for fish production at all irrigation, reservoirs where it is economically viable to go in for fish production by undertaking an overview of all irrigation tanks in the State on behalf of the Government.

Current State-of-art of Fresh Water Fishery

10.10.1 Fish production is being practiced mainly in three ways: 1) Coastal fish production, 2) Fish production in partially saline water and 3) Fresh water fish production. Out of fisheries being practised through three different types of water resources, only the fresh water fishery is of concern with the overall water planning and reservoir management of irrigation projects.

Fish production being managed through rivers, streams, canals, lakes, ponds and reservoirs is termed as 'fresh water fishery. Districtwise and submergence extentwise, there are 8771 perennial tanks in Maharashtra encompassing submergence of the order of 312052 ha. Tanks encompassing submergence 200 ha or less number 8608, the total submergence being 109366 ha (Statement 10.10.3). Perennial tanks numbering 163 and having submergence more than 200 ha encompass submergence of the order of 202686 ha. A perennial tank from the view point of fishery is one which impounds water throughout the year and where in atleast 1.5 m water column is extant even at the end of summer. As stated in the publication titled 'The Concept of Fisheries in the State of Maharashtra : 1995-96' brought out by the Commissioner of Fisheries - Mumbai, there are 1387 perennial' tanks belonging to the Irrigation Department which have been given on lease for a period of 5 years to cooperative societies of fishermen on behalf of the Fisheries Department. In case of few of the reservoirs, fishery is being successfully practised on a large scale amongst which Jayakwadi (Aurangabad), Pench (Nagpur) and Bor (Wardha) are the noteworthy examples. On this count, the modus operandi of fisheries being practised at Jayakwadi (Aurangabad) is briefly presented in what follows.

Jayakwadi Reservoir is the largest in Maharashtra encompassing submergence of the order of 27500 ha. One fish seed farm is established in a gross area of 44 ha at the foot of this dam. Though construction of this farm was completed in 1986-87, the Jayakwadi Reservoir and fish seed farm were handed over for management from 1 st July 1983 to the Maharashtra Fishery Industries Development Corporation. However, as the maintenance works in, the fish seed farm were not managed properly by the Corporation, the Government withdrawn the fish seed farm with effect from 1 st March 1991 leaving the maintenance of Jayakwadi Reservoir with the Corporation itself.

Jayakwadi Fish Seed Farm: The year 1991-92 saw the construction of latest type of circular hatchery on the lines of that of Chinese in the fish seed farm. The spawn production through Chinese hatchery commenced thereafter. To facilitate this, a stock of breeding fish aggregately weighing 2500 kg is maintained at the farm and is being looked after with especial care. Though the fish seed farm boasts of about 22 ha submergence encompassed by small or big 408 tanks, hardly 35 tanks with only 5 ha submergence expanse have been utilised during the last 3 years for annual fish seed production. The population of spawns, fish seeds and income accrued therefrom during-the last 3 years at this farm is presented below:

Year	Spawn production (lakh)	Fish seeds production (lakh)	Sale of fish seeds (lakh)	Income accrued (Rs. lakh)
(1)	(2)	(3)	(4)	(5)
94-95	375	35	19	1.07
95-96	432	40	13	2.98
96-97	405	32	13	5.63

Source:- Information with the District Fisheries Development Officer, Aurangabad.

The information presented in the foregoing table reveals that the spawns from here are used to be sold every year This had resulted fish seeds production of the order of 35 lakh during 1994-95 and 32 lakh during 1996-97. Income accrued through the sale of spawns and fish seeds had been of the order of Rs. 1.07 lakh during the year 1994-95. It has increased to Rs. 5.63 lakh during 1996-97 which includes income accrued from sale of 154 lakh spawns, 9.76 lakh fingerlings and 3.24 lakh carp fry. That means income accrued during 1996-97 appears to be three times than that accrued during 1994-95 owing to surpassed sale. Spawns and fish seeds from this place are being supplied mainly to fisheries cooperative societies and to some farms in the district for rearing through 5 litre capacity plastic / tin cans mixed with a little oxygen and spawns (around 25000) in water contained therein. Before releasing the spawns into reservoir, they do survive during journey for about 35 hours due to oxygen impregnated, into water in cans.

Fish production and sale in Jayakwadi:

The fish production reaped through this reservoir during the last three years and income earned therefrom are indicated in the following:

Year	Fish Production (MT)	Income earned (Rs. lakh)
(1)	(2)	(3)
1994-95	535	145
1995-96	550	150
1996-97	600	160

As the information gathered from the District Fisheries Development. Officer goes, the price fetched by the fish production in the Marathwada Region used to be upto Rs. 25000 to Rs. 30000 per metric ton. As the fish production at Jayakwadi reached upto 535 tons in 1994-95, 550 tons in 1995-96 and 600 tons in 1996-97, the annual income it fetched appeared to be around Rs. 1-1.5 crores. The average per hectare yield of fish in respect of Jayakwadi Reservoir is expected to be 50 kg. All types of fish obtained from this reservoir are, being sold out at a wholesale price at the nine centres enlisted in what follows: (1) Paithan (2) Shevta (3) Sawkheda (4) Kaygaon (5) Pravarasangam (6) Jalanimba (7) Ramadoh (8) Dahegaon (9) Erandgaon.

Natural Resource Conducive to Fresh Water Fishery

10.10.2 The districtwise seasonal and perennial freshwater reservoirs in Maharashtra admeasuring submergence of the order of 355267 ha number in all 26050. Out of that, the seasonal tanks number 17279 with about 43215 ha submergence. As the ownership in the State goes, 1777 tanks belong to the Irrigation Department, 12861 to *Zilla Parishads* and 11412 combinedly to *gram panchayats* / municipalities, private and public undertakings (Statement 10.10.1). Submergence encompassed by them is 263881 ha (74 per cent), 64492 ha (18 per cent) and 26894 ha (8 per cent) respectively.

A) Water sheet area of tanks: From the viewpoint of fishery, the gross storage in a reservoir is not of special importance. In the presence of sunlight algae formation is being taking place in water with the help of photosynthesis. This is the very food of fish. This thereby helps protect water quality / purity of tank water as well As the sunrays do not reach beyond 2 meter depth in water, the deep parts of reservoir are as good as useless from the viewpoint of fisheries. Therefore, average of the largest water spread of a reservoir during rainy season and the least one during winter is treated as natural wealth on the basis of which fishery is being practised. The tanks are categorised as belonging to minor, medium and major projects in accordance with the extant of command as far irrigation is concerned. However, such type of categorisation being of little use from the viewpoint of fisheries, the reservoirs are classified in accordance with their water sheet area as indicated in the following:

Sr. No.	Class of tank (ha)	Number of perennial tanks	Total water sheet area(ha)
(1)	(2)	(3)	(4)
1	0 to 20	7020	35039
2	21 to 60	1229	41122
3	61 to 200	359	33205
4	201 to 1000	116	48203
5	Above 1000	47	154483
	Total	8771	312052

Source :- Information with the Regional Fisheries Development Officer.

The foregoing table reveals that 80 per cent of the total 8771 tanks in the State have water sheet area upto 20 ha. The proportion of tanks with water sheet area between 21 to 60 ha is 14 per cent; hardly 4 per cent tanks have a water sheet area between 61 to 200 ha whereas tanks whose water sheet area exceed 201 ha are 2 per cent in proportion. The proportion of water sheet area of tanks belonging to water sheet area extent class of 0 to 20, 21 to 60 and 61 to 200 ha happens to be between 11 to 13 per cent of the total water sheet area The same in case of tanks with water sheet area between 201 to 1000 ha would be 15 per cent. However, it appears, the percentage of tanks having water sheet area exceeding 1000 ha is 50.

In Maharashtra State, tanks are owned by the Irrigation Department, *Zilla Parishads*, municipalities, *gram panchayats* and other bodies. Out of this, the contract of tanks belonging to the Irrigation Department is being given to Fisheries Cooperative Societies through the Fisheries Department. Half of the contract amount is being diverted to the Irrigation Department. The policy as to giving on lease-basis the tanks of fresh water is revised with effect from 29.6.1995 according to which tanks with water spread 200 ha or over are being lent out through public auction. The responsibility of mixing fish seeds rests with concerned ones. As the tanks are lent out with a competitive auction, it is expected to realise fish seed stock to its fullest capacity and the State could earn an increase in revenue through it The irrigation tanks encompass 202686 ha whose water sheet areas exceed 200 ha. It means they occupy about 65 per cent of the total perennial water sheet area of. 312052 ha the State possesses. The tanks with the *Zilla Parishads* are being lent out on auction to agencies amongst which fisheries cooperative societies are given priority. Tanks with municipalities, *gram panchayats* and other bodies are lent out through public auction.

The total number of tanks and their water sheet areas in accordance with their ownershiplights can be presented like this:

Sr. No.	Ownership rights	Total Number of lakes	Total water sheet area (ha)
(1)	(2)	(3)	(4)
1	Irrigation Department	1777	263881
2	Zilla Parishads	12861	64492
3	Municipal corporations/ municipal councils	46	988
4	Malgujari/ village tanks, private fishery occupationals	10796	14125
5	Gram panchayats, Railways, MSEB, Forest Department, autonomous bodies	570	11781
	Total	26050	355267

Source:- Information with the Regional Fisheries Development Office.

The foregoing information reveals that average water sheet area (seasonal and perennial) of tanks happens to be 14 ha. The irrigation tanks average 148 ha in water sheet area whereas tanks with the *Zilla Parishads* are having water sheet area hardly of 5 ha.

As the tanks owned by the Irrigation Department now belong to the various basin corporations, e.g., Maharashtra Krishna Valley Development Corporation, Vidarbha Irrigation Development Corporation, Konkan Irrigation Development Corporation, Tapi Irrigation Development Corporation and Godavari - Marathwada Irrigation Development Corporation or process to that effect is on, ownership rights now belong to corporations.

In order to achieve an all-out development of pisciculture through small or big farm ponds, the centrally-sponsored pisciculture development set-up has since been functioning in selected 26 districts of Maharashtra since 1994-95. This set-up receives 50 per cent subsidy in expenditure on developmental count from the Central Government. It instigates the farmers to go in for pisciculture by constructing new ponds in waste and water-logged land of farmers. The fisheries being practised in fresh water is a kind of pisciculture. By removing fish - unwanted and carnivorous - and weeds as well, seeds of excellently and speedily growing fish or prawns are released in a reservoir every year By providing natural as well as supplementary food to them, the prawns are allowed to grow more and more till they are fit for sale (at least 1 kg and 5 kg at the most) and used to be sold beneficially through a proper management. The farmers whose farms are water-logged / marshy or salt-affected, can practise prawn / pisciculture by constructing ponds in their farms.

B) Prawn/ pisciculture in waste or salt-affected land: Shrimps / Prawns can be grown in any pond. The cost of constructing a pond in one's own land which is marshy or waterlogged. is about Rs. 1.6 lakh per ha. For this purpose, a subsidy of Rs. 40000 from the Government is extended, the remaining amount can be raised through bank loans. Similarly, it is possible to obtain on lease for a year small ponds or tanks belonging to the Irrigation Department, *Zilla Parishads*, municipalities, *gram panchayats*, etc., and practise prawns farming / pisciculture.

Approximate cost required for husbanding shrimps / prawns released in a pond of average 1 ha area by collecting or purchasing seeds thereof grown in a partially saline water and income being accrued therefrom are indicated in what follows:

Sr. No.	Details	Cost (Rs.)
(1)	(2)	(3)
(A)	**Expenditure likely to be incurred**	
1	Lease amount / rent (tank of 1 ha area)	2000
2	Prawn / shrimp seeds (baby fish) stocking capacity of 20,000 per ha @ Rs. 800 per thousand	16000
3	Use of lime in tanks at 400 kg per ha @ Rs. 4/kg	1600
4	Fertilisers	
	1) *Inorganic fertilisers* i) Super phosphate 200 kg/ha @ Rs. 3/ kg ii) Nitrogen (Urea) 200 kg/ ha @ Rs. 4 per kg	600 800
	2) Organic fertilisers Manures 5 ton/ha @ Rs. 500/ton	2500
5	Food: Prawn food 1000 kg/ha @ Rs. 20/kg	20000
6	Watch & ward and maintenance (for the last 3 months)	3000
7	Collection of prawns and transport	3000
	Total expenditure	49500
(B)	**Income**	
1	*Weight:* Anticipating 5Q per cent mortality rate and average growth of each carp fry to be of 50 gm, the surviving 10000 carp fry will weigh in all 500 kg.	
2	*Income*:- @ Rs. 150/kg, i.e., (500 x 150)	75000
3	*Net profit:-* (Income accrued - expenditure incurred), i.e., 75000 - 49500 = 25500/ha is the net profit over a period of 6 months	25000

Source:- A published booklet of the workshop "Land Improvement of Saline Tract through Ponds" held at Kolhapur.

As the foregoing reveals, income generated in a period of mere 6 months through prawns is higher than that being accrued from agriculture over an equally extensive area. Moreover, by, excavating fishponds in saline land, drainage of excess salts and water is effected leading to bringing the land near the pond for cultivation of crops. Crops like Soyabean can also be grown in such land as has been exhibited by a farmer from Bhadole, *Taluka* Hatkanangale, District Kolhapur in a farm of his own. Therefore, practising of prawns / pisciculture by constructing small tanks-in basins of rivers, also commands of irrigation projects, saline lands, water-logged or wastelands can be a boon to farmers.

(C) *Fishery in rivers and canals:* Fishery can be practised by taking advantage of flowing water in large canals. Fish production which may sustain a family can be reaped if barrow pits admeasuring 0.2 ha at most in the vicinity of canals are given to the family of fishery occupationals on lease.

Rivers are recognised to be a free fishing zone as far as river fishery is concerned. Giving on contract the fishery rights over rivers is in vogue only in Kolhapur and Nanded Districts (being erstwhile princely states). Conducting hydro-biological survey of river gorge so as to boost up river fishery is called for Lengths of major rivers in the State are indicated in what follows:

Sr. No.	Region	Length (km)
(1)	(2)	(3)
1	Konkan	1781
2	Nashik	2407
3	Pune	2254
4	Aurangabad	4410
5	Amravati	3240
6	Nagpur	3008
	Total length:	17100

Source :- Information with the Regional Fisheries Office.

Fish Seed Production in Fresh Water

10.10.3 Fish seed is an exceedingly important input in this occupation. A female fish weighing one kilogram breeds almost 1 lakh eggs. The proportion of laying eggs increases with the weight gaining pace of the female fish till it assumes 5 kilogram mark. (A female fish weighing 5 kilogram breads 5 lakh eggs). Further on, this proportion declines. It is also necessary on the part of male fish to be of about equal weight. The growing seed resulting from eggs released by a female fish is termed as a fish seed'. However, seeds of different lengths have different connotations in practice. Notwithstanding this, the carp fry can rightfully be referred to be of 50, 70, 90 and 120 mm sizes without adhering to those connotation. The expected mortality rates in case of fish seeds growing till the period froth the fry seed phase to baby fish (of size 50 mm) is 50 per cent in about 30 days and 20 per cent further on till it grows to 50 to 120 mm size. That means about 20 to 25 per cent mortality is expected once 50 mm size baby fish are released into a tank till it grows into a fish.

In all, 36 fish seed production centres are there in Maharashtra spread over all the districts. Out of that, 29 centres are equipped with circular hatcheries which are producing seeds. At rest of the centres, construction of hatcheries is underway. The spawn production potential of all those 36 fish seed centres is expected to be of the order of 159 crores whereas their fish seed production potential is about 55 crores. Other methods of fish production such as wet bund, dry bund and *mogra* bund methods are also being practised in the State. The fish are prone to lay eggs in tanks in a peculiar natural environment. The seed production in such an environment is called as 'bund method fish production. Such a method has fetched 30 crores spawns in the year 1995-96 which accrued an income of Rs. 80 crores in spite of the fact that the targeted fish production had been of 55 and 60 crores for the years 1995-96 and 1996-97 respectively. In actual, however, the production of the order of 79 and 98 crores during the years 1995-96 and 1996-97 has been realised (Statement 10.10.2) fetching therefrom about 26 and 34 crores fish seeds during the corresponding years. In order to achieve a substantial growth in fish seed production, the deposition of fish seed according to the various categories of tanks be achieved as indicated in the following table:

Sr. No.	Tank category (ha)	Size of fish seed (mm)	Per ha deposition (Nos.)
(1)	(2)	(3)	(4)
1	0 to 20	50	5000
2	21 to 60	70	2000
3	61 to 200	90	1000
4	201 to 1000	90	500
5	exceeding 1000	120	500

The per hectare fish deposition will have to be reduced in the same proportion as it goes on enlarging. Therefore, expected yield in reservoir and productivity potential can be realised only when the three facts namely generation of fish seed in a proper number, their growth up to a proper length in tanks and deposition in accordance with the tank category are scrupulously paid attention to. Therefore, it is felt that districtwise planning aimed at setting up fish seed production centres and rearing space near the large reservoirs (water spread exceeding 200 ha) should form a part of reservoir planning.

Preservation, Transport and Marketing of Fish Produce

10.10.4 Fish contribute largely in fetching a diet with animal food, full of proteins and nourishing. However, fish being a perishable commodity, it is utmost necessary to bring it to wholesale or retail market in a shortest possible time once it is drawn out of water. As soon as it is taken out of water, decomposition of chemical constituents present in its body commences. Also, as the bacteria present in the environ have an effect upon it, It remains in a relishable state ordinarily within 5 to 6 hours. However, it is extremely necessary to preserve it into an ice in a shortest possible span from the time it is drawn out of water so as to not to get deteriorated, the consumers to get the same in a good condition and to fetch a proper return to the cultivator who catches it The period of fish sale ordinarily extends over 8 months from September to April whereas the fishery year is counted from 1 st July to 30th June. As the fish commerce is largely being handled in private sector, it is apparently controlled by private traders. Therefore, the cultivating fisherman who catches fish will have, by and large, to depend on private traders to manage its sale. Considering this and to ensure a maximum possible sale of fish caught by the members of cooperative organisations through that organisation only a subsidy is granted by the National Cooperative Development Corporation (NCDC). Similarly, a scheme has also been launched on behalf of the Government extending 100 per cent aid to cooperative organisations for purchase of vehicles, diesel tankers and, if necessary, cold transport vans.

Fish production accrued. from fresh water during the last two years is indicated in the following:

Sr. No.	Year	Production of fish seed (lakh)	Fish production (metric ton)	Income accrued (Rs. lakh)
1	1995-96	2595	91562	20740
2	1996-97	3379	112912	32520

Source:- Information with the Regional Fisheries Office.

The foregoing table reveals that in case the projected demand of 80 crores fish seeds is met with, the income accrued to the State every year solely from the fish production being practised in fresh water gets doubled. It means about Rs. 300 crores can be additionally amassed thereby. Efforts in that direction are called for, it is felt.

Cooperative Fishery in Fresh Water

10.10.5 After the formation of the Maharashtra State, a liberal and top priority policy as regards to the cooperative undertakings had been adopted according to which rights of, fishing were used to confer on cooperative societies of fishermen on priority. The Government Resolution of June 1995 has stipulated to bestow fishing rights in case of tanks-having water sheet area 200 ha or more by 'sealed' quotation method. This has led to a decline in obtaining works for the cooperative societies of fishermen. Similarly, local fishermen are also being deprived of the works owing to conferring the fishing rights by auction method. Traders. who originally do not practise actual fishing are managing the same with the help of fishermen of other states, causing thereby on a large scale injustice to the local fishery.

The total population of fishermen practising fishery in fresh water spread over all the districts of Maharashtra is of the order of 223100 and operative professional fisheries cooperative organisations number in all 1926. They comprise 117710 members out of which active fishermen (Annex 10.10.1) number 109369. This reveals that average number of members per organisation is 61 of which almost all (93 per cent) are active ones. Presently, these organisations have been sanctioned 1/3 capital share from the Government. As this proportion has been quite obsolete, it is necessary on the part of the Government to increase the limit of this share it capital in case of fishermen organisations so as to make them economically stable.

Presently, the fishermen organisations are functioning in a three-tier set-up in the State: (1) State Level Apex Body, (2) Divisional / district level bodies and (3) Primary cooperative societies. All divisional and district level bodies and also majority of the primary cooperative societies are members-of the State Level Apex Body. However, their functions / responsibilities / powers at various levels are overlapping with the corresponding ambits of others. Compounded with akin functional character, their working lacks in smoothness. Cooperative bodies, primary cooperative societies and Maharashtra Fisheries Development Corporation are also operational in this sector, their roles have proved to be of conflicting rather than of complimentary. Therefore, the hierarchy at different level organisations should necessarily be of pyramidal in nature (not only in composition but also taking into consideration various modalities of working of individual ones and functional ambits and jurisdictions) which will foster relations of goodwill and harmony amongst all For this to accomplish, revised bye-laws will have to be framed, it is felt.

Existing Programme of Fishery through Irrigation Reservoirs

10.10.6 Fish commodity is one of the most important food components which makes amenable animal proteins - a day-to-day diet of human beings. Socio-economically the fishery is becoming one of the most important occupations. Efforts on the part of the State and Central Government are continuously going on to increase productivity under various schemes. In Maharashtra, over Rs. 200 crores have so far been spent on various schemes of fishery from the first Five Year Plan period enhancing thereby productivity doubly.

In Maharashtra about 80 crores of fish seeds are needed every year to develop fishery in fresh water. The presently functioning 36 fish seed centres are not adequate to meet this requirement of fish seeds of the State in its totality. Additional fish seed centres during the ensuing ten years and additional 10 centres by the year 2030 should be set up. The fish seed centres shall be constructed only at those places which are fully equipped with all necessary amenities. The aforementioned 36 fish seed centres have been shown on the Map No. 20 of Maharashtra in Volume W. Besides this, the work of setting up of other 5 fish centres is underway.

With the grants from National Cooperative Development Corporation, an integrated reservoir development project is being implemented in the two districts of Akola and Bhandara. This scheme envisages development of 10775 ha water spread area encompassed by 140 small / big 140 reservoirs in Akola and Bhandara districts. An outlay of Rs. 5.65 crores[13] has been sanctioned for this The scheme is being implemented through the cooperative organisations of fishermen who are going to reap direct benefits therefrom. A similar kind of scheme is proposed to be implemented for 20 to 1200 ha capacity reservoirs by employing latest technology and resorting to proper use of fish production potential in other 10 districts also This undertaking envisages development of small / big 487 tanks which are likely to fetch about 12000 ton fish production every year.

An action plan is framed which brings within its ambit 1214 ha area belonging to 1200 farmers in the State. This scheme is going to require a subsidy of the order of 2 crores 87 lakh and financial outlay of 12 crores and 21 lakh.[14] This scheme has been launched in the State through 26 pisciculture agencies from this year with the assistance of banks and District, Planning & Development Councils.

As the prawn / *zinga* culture in fresh water has been practised and disseminated in the State in a better way, demand for prawn seeds is continually on an increase. Therefore, the Government proposed to set up 3 fresh water prawn seeds production centres in the State.

Besides this, construction of centres with capacity of 6 crores fish seed production each is underway at Amravati and Yavatmal.

13. The Concept of Fisheries in the State of Maharashtra: 1995-96.
14. The Concept of Fisheries in the State of Maharashtra: 1995-96

Improvements in the Working of Fisheries in Irrigation Reservoirs

10.10.7 The entire programme of fishery in Maharashtra is being conducted under the guidance of the Commissioner (Fisheries). Deputy Directors, Fisheries are there at headquarter of the former to assist him whereas Regional Deputy Directors, Fisheries are stationed at divisional levels and Fisheries Development Officers are functioning at district levels. All schemes pertinent to fisheries are been implemented through the Department of Fisheries.

The following modality be adopted, it is felt, so as to increase fish production in irrigation reservoirs:

1) While acquiring land for an irrigation project, land required for fish seed centre and tourism should be included in the land acquisition notice, alongwith that required for the submergence, canals and dam so as to ensure legal protection in case the land is used for purposes other than irrigation. Provisions to that effect should accordingly be made in the act.

2) A proper study of the biodiversity without and with the reservoir should be conducted. A proper place at the foot of dam or nearby should be reserved for setting up an independent fish seed centre at the time of commencement of construction for a large reservoir. Planned efforts should be taken so as to cater a permanent natural water supply by gravity to this centre through the dam wall (just like that of garden outlet) and, for that, provision for water and land should be arranged through the reservoir management in its vicinity.

3) The reservoir water should be tested for physical, chemical and biological constituents once in a quarter. Contamination of water can be avoided if precaution to prevent ingress of polluted / toxic effluent from factories into the reservoir is exercised. This will help fish production.

4) Water capacity in every fish tank is expressed in cubic metre. In lieu of that maximum & minimum submergence area and corresponding water levels should be reported.

5) The Government should make it obligatory on the part of Irrigation Department to maintain permanently a 3 metre depth in major and medium reservoirs so as to facilitate practising fishery around irrigation reservoirs in a proper manner. This is necessitated due to the fact that presence of at least 3 metre water column (1.5 metre to account of evaporation and 1.5 metre for survival) is essentially be present in the irrigation reservoirs for practising pisciculture.

6) By assessing the possibility of accomplishing development of fisheries from tail channels of all tanks, the trenches existing on d/s of the dam should be converted into suitable nursery ponds without incurring much expenditure. By constructing saucer-like smaller and smaller storage tanks of 3 metre depth and 1 ha area on d/s of dams having no command, the fry should be husbanded till they are raised to fingerlings.

7) There should be a facility for installing trash rack against the gates and waste weirs. so as not to allow the fish to flush out through reservoirs gates. Similarly, as and when reservoir water recedes, the area wherefrom trees are not removed, should be got cleaned from time to time by cutting down the trees, shrubs, etc. Also, the waste weir of a dam and submergence should be improved from the viewpoint of fisheries.

8) The nutrient status of soil and water availability based pisciculture and zinga farming should be encouraged in the command area development.

9) Instead of letting the tanks under the control of Maharashtra Krishna Valley Development Corporation directly to other private organisations for fishery, they should be kept with the Department of Fisheries only for management on 50 per cent share basis as per the earlier policy. The 50 per cent share of the contract amount on count of these tanks should be kept at the disposal of MKVDC instead of allowing it to be with the Irrigation Department as is in vogue. The same policy should be applied to other basin development corporations also .

10) The irrigation reservoirs will be owned by the Irrigation Department. However, maintenance and repairs of assets required for increasing fish production-and development of fisheries, plant & machinery, materials etc. should be carried out through the Department of Fisheries.

11) While letting reservoirs for fisheries on contract, it be done by determining per hectare harvesting of fish seed and the lowest acceptable productivity. The rights for fisheries should be withdrawn for a period of one year from a person or an organisation who/which harvests lesser production than stipulated.

12) A fisheries advisory board at the divisional level should be constituted. The Regional Deputy Director (Fisheries) be made to act as secretary of this Board. The chairman should be the Divisional Commissioner and members should include officers from the Irrigation Department who own the reservoirs, officials from *Zilla Parishads*, and office bearers of cooperative fisheries organisations. They should hold board meeting every six months. Advice offered by the said board on any fact pertinent to the development of fisheries should be made binding on all the concerned.

It is felt that fish production from irrigation reservoirs will be enhanced considerably if foregoing improvements are effected in the working modality of fisheries.

10.11 Tourism Development

As soon as the name of tourism is uttered, the immortal caves like Ajantha, Ellora and pilgrimage centres like Pandharpur, Shirdi, Tuljapur come before eyes. However, along with them, numerous famous holy places, historical sites, cultural centres, garden points, hill stations and picturesque spots in Maharashtra which can not even be forgotten, to which thousands of devotees / tourists I pilgrims / visitors used to visit. Therefore, tourism development can be achieved around possible irrigation projects for the sake of such and other visitors / tourists.

The Barve Commission (1962)(in its report has stated regarding this: "By assessing the possibility of development of sites near reservoirs so as to attract tourists and with the intention of encouraging tourism, necessary provision should be made for tourism facilities on all possible major works." Nevertheless, no tourism development has taken place on tanks in Maharashtra to the extent desired. Therefore, hardly on five irrigation projects (Statement 10.10.3) out of total 47 prominent reservoirs (water spread over 1000 hectares) tourist places appear to be developed today. The Irrigation Department boasts to have 1777 completed tanks (Statement 10.10.3) out of which 163 tanks admeasure water spread over 200 hectares individually. In order to accomplish economic development and overall prosperity of such completed tank areas, those irrigation projects which are amenable for tourism or whose projcct areas are bestowed with natural and geographical features (like - hills, mountains, valleys, etc.) which readily attract tourists, should be inspected from the possibility of tourism development. If, tourism facilities like resorts, lighting, terrace gardens, access roads, transport means, boating and water sports are made available at places wherever possible, these sites can possibly be brought into use as tourist centres. It can even fetch income thereby to the Government by enabling the use of vacant space around the projects.

Selection and Approval to the Tourist Places

10.11.1 After having conducted survey of places in the State which are proposed to be developed as tourist places, the Maharashtra Tourism Development Corporation carries out classification thereof in the following manner:

1) Grade 'A': This grade is meant for nationally and internationally reputed tourist spots and they inherit world and cultural heritage. For example, financial aid from the Central Government and foreign countries is received for the development of tourist places like Elephanta Island, Ajantha, Ellora.

2) Grade 'B': Important tourist places at the State level such as Jayakwadi, Ganpatipule fall in this grade. These tourist places are being developed through the budgetary provisions of the Government of Maharashtra or financial aid from the statutory development boards.

3) Grade 'C': Places of local importance at district level. All other local places, barring those which belong to grades A or B, fall in grade C tourist places. These places are developed through the provisions made available by the District Planning & Development Councils.

The Maharashtra Tourism Development Corporation used to prepare 3 lists corresponding to the grades A, B and C after conducting tourism survey.

The plans of places Stated under grades A and B among that are prepared and sent to the Home Department (Tourism) for further action. The works stated under grade C are sent to the Collectors for approval of the District Planning & Development Council. The selection of grade C tourist places in a district is done by the District Planning & Development Council. Approval and funds are also being made available to them. To facilitate undertaking of works on count of tourist places for which approval is given, the Collector accords technical sanction.

Present Position of Tourism Development around Irrigation Projects

10.11.2 As the available information goes, tourists places hardly on five irrigation projects have beep developed (Statement 10.10.3). These are: (1) Panshet (Pune), (2) Koyna (Satara), (3) Bhandardara (Ahmadnagar), (4) Jayakwadi (Aurangabad) & (5) Khindshi (Nagpur). Out of these, tourism undertakings in project areas of Khindshi (Nagpur), Panshet (Pune) and also Jayakwadi (Aurangabad) have become centres of attraction for tourists. Information about the *Sant Dyneshwar Udyan* - a tourism undertaking in the project area of Jayakwadi (Aurangabad) Project is briefly presented in what follows:

Jayakwadi (Sant Dnyaneshwar Udyan) Tourism Undertaking

The Government of Maharashtra has developed the *Dnyaneshwar Udyan* as a tourist spot in the Jayakwadi Irrigation Project area. This place has been included in the tourist map of the country whereat presently about 2500 tourists used to visit everyday. This garden has 'been planned on an area admeasuring 125 hectares on the lines of the famous Vrindavan Garden in India.

A beautiful orchard comprising multi-coloured flower trees of various kinds grown over the lawn admeasuring about 28 hectares is there in this garden. About 26 hectares is bearing different kinds of fruit trees forming an orchard. There is also an informal garden holding in it about 350 species spread over 28 hectares area. A spiritual garden containing about 2000 holy trees of 110 different kinds is there on 15 hectares area to provide for a quite place to students/tourists for practicing meditation. Similarly, 600 electric lamps and musical fountains of varied kinds are installed in the garden from place to place.

At the toe of Jayakawadi Dam in Godavari River a facility of boating for the tourists has also been provided through a private agency. A water sport facility is also proposed to be made available shortly.

The following table indicates expenditure incurred during the last four years on the development of garden, the number of visiting tourists and income accrued:

Year	Total expenditure including capital & other expenses (Rs.lakh)	Expenditure incurred excluding that on capital (Rs. lakh)	Income accrued (Rs. lakh)	No. of visiting tourists
(1)	(2)	(3)	(4)	(5)
93-94	100.90	5.60	17.52	356530
94-95	101.40	10.03	23.00	478400
95-96	126.34	14.39	30.23	602213
96-97	63.38	20.25	30.37	608925

Source: Information with the Environmental Development Division, Aurangabad.

The foregoing information reveals that the number of tourists who visited during the year 1993-94 was 356530. This number went on increasing to 608925 during the year 1996-97. Also gross income during the year 93-94 was Rs. 17.52 lakh while the same during 96-97 was of the order of Rs. 30.37 lakh. As the annual expenditure being incurred on maintenance is being met up through the annual income so accrued, it has become a source of income to the Maharashtra Government.

Works Required to be undertaken for Raising a Tourist Place on an Irrigation Project

10.11.3 In order to develop a tourist place, a few important requirements are spelt out in the following:

1) Flower garden:- Various kinds of flower trees and lawn should be grown in a flower garden. Permanent internal roads should be constructed for facilitating strolling by the tourists as per necessity. To enhance beauty of gardens, small and big falls be provided from place to place.

2) Orchard:- In order to meet up the expenditure on maintenance of the garden to some extent, various types of fruit trees be planted. Similarly there should be a nursery of various fruits and flowers in the garden with a facility of sale thereof. This could, therefore, inspire tourists to plan new fruit and flower trees.

3) Informal garden:- An informal garden be developed by planting various kinds of medicinal plants so as to be of use as the botanical guide to tourists / students.

4) Children's park:- A children's park be developed in the garden where different items of slides, swings, and newer and latest types of toy games are installed. This could, therefore, be a grand entertaining avenue to boys and girls and also to the tourists.

5) Electrification:- Electric lamps and various kinds of coloured fountains be installed at various places in the garden.

6) Restaurant, stalls and drinking water:- Drinking water facility and restaurant be there in the garden at appropriate locations for the tourists.

7) Rest houses:- There be an excellent facility of accommodation and rest houses for the tourists.

8) Toilets and dustbins:- There be constructed toilets at appropriate places in the garden. Also modern types of dustbins be there at several places in order to maintain the garden clean.

9) Water sports:- For the sake of young and amateur tourists, a facility of water sports be there.

10) Aquarium:- A small aquarium be maintained at the tourist spot which should house various kinds of and coloured fish.

11) Bird and wildlife zoo:- A zoo housing various kinds of rare birds and animals be there at the tourist spot. This, therefore, can pose attraction to the people about wild life.

12) Boating facilities:- Boating facility be there for enjoyment and entertainment of the. tourists.

If the foregoing types of attempts are provided at tourist places, the project complex will be made panoramic to please the minds of tourists so that they will be attracted towards it for visiting time and again.

Privatisation of Tourism Management on Irrigation Projects

10.11.4 The tourist places of the Indian people are no longer confined to merely religious centres as, had been in the past. They have now turned into cultural tourists places where classical dance, music, folk arts and other such festivals are being arranged. Alternatively, thrilling tourist places such as fort trekking, mountaineering, hiking, etc., where adventurous facilities are available or hill stations are also being crowded as tourist places. People's view with which to live life is changed and to undertake touring during leisure time / holidays has now become a part of life. The servants numbering over a lakh from the Central Government, state governments and the pubic undertakings used to visit various tourist places alongwith their families as they are eligible to get leave travel concession. Therefore, the Tourism Development in Maharashtra State has assumed an outstanding importance.

With this aspect in mind, the State Government has kept its role limited to development of basic amenities, information, dissemination and achieving coordination with field undertakings so as to attract private investors in the Tourism Sector. The Annual Plan: 1995-96, Part-I of the Planning Department, Government of Maharashtra has even stated further that the tourists organisations, voluntary institutions & hotel professionals and travel services if participate actively in tourism industry will beget financial incentive on behalf of the Government. The State Government will set up training institutes and appropriate machinery in order to verify the evaluation of quality of service rendered and the same of all these amenities / facilities, and extend assistance so that a good kind of treatment to the tourists is ensured.

In order to accomplish speedy development of tourism in the State, the Maharashtra Tourism Development Corporation has embarked upon the policy of privatisation. From this viewpoint only, the tourism undertakings at Panshet (Pune), Khindshi (Nagpur) and a few others have been lent to the private contractors on management basis. In order to lend in future other few probable tourists places in the State to private organisations in phases and on management basis, information pertinent to tourism undertakings at Khindshi Project is presented in brief in what follows:

Khindshi (Nagpur) Tourist Undertaking

The tourism management on Khindshi Project has been given on 5 years' lease to a contractor on a private basis. Information of this tourist place is as follows.

Year	Total expenditure incurred (including capital & other expenses) (Rs. lakh)	Total expenditure incurred (excluding capital expenses) (Rs. lakh)	Income earned (Rs. lakh)	No. of tourists visited
(1)	(2)	(3)	(4)	(5)
92-93	8.28	3.98	4.03	30000
93-94	11.25	8.75	9.02	40000
94-95	10.36	8.86	9.15	50000
95-96	13.67	12.47	12.79	60000

Source: Information with the Director, Khindshi Tourist Centre, Nagpur.

The information presented in the foregoing table reveals that the number of tourists who visited the privately-managed tourist place had been 30,000 during the year 1993. It went on 'increasing further to 60,000 during 1996. Similarly, the total income accrued during the year 1993 was Rs. 4.03 lakh. It is increased during 1996 to Rs. 12.79 (lakh. It means income has increased three-folds during four years. The annual expenditure being incurred on maintenance has been met from it and the net income has also been increased. This tourist place has provided employment to total 60 people directly and 300 people indirectly. A proper use of vacant land there has been accomplished and has resulted in creating means of income to tourism enterprisers as well as to the Government.

The undertaking at Khindshi has proved to be very much successful. The resultant effect of means of water sports, restaurant and other means of entertainment, as also the facilities created at this tourist place for tourists to spend leisure at this undertaking is continually increasing the number of tourists there. This brings to the focus the increasing attraction of privately -managed tourist places.

Methodology of Tourism Development on Irrigation Projects

10.11.5 Government of Maharashtra has established the !Maharashtra Tourism Development Corporation' in 1975 with an authorised capital share of the order of Rs. 15 crores so as to accomplish tourism development in a commercial manner. Works pertinent to tourism are entrusted with this Corporation. This Corporation has to accomplish various works such as formulating proposals of tourism projects, acquiring land therefor, constructing tourist complexes, making available to tourists the facility of shelter and reservation therefor, providing maximum possible facilities in the existing tourism resorts, also post information boards in railway stations / bus stands in order to attract travelers, bringing out the information brochures, publishing them, etc.

We feel that the following methodology be adopted in order. to accomplish tourism development in irrigation project areas:

1) Planning development of a tourist place at the very commencement of creation of reservoir minimum water spread of which is over 200 ha and reserving place for tourist spot well above the highest flood level of the project be undertaken.

2) The surplus rest houses and resorts extant in irrigation project areas be lent on annual lease on a long-term basis at nominal rates to the Tourism Development Corporation to house sports material, also running restaurants or holiday resorts.

3) A system be set up to offer the reservoir in tourist area on lease for water sports.

4) Viewing the trained human resources, means of water sports end the experience gained, in this sector with the Maharashtra Tourism Development Corporation, the same be appointed as a central body so as to accomplish development of water sports undertakings in existence in various parts and those planned in future in Maharashtra from the tourism point of view. The private entreprenuers should be given permission on behalf of the Corporation to run water sport undertakings wherever necessary on the conditions being put forth by the Irrigation Department, e.g., safety of reservoirs, keeping unaffected all the rights such as lease etc. All administrative aspects related thereto be looked after by the Corporation only. A provision to this effect should be there in the rules of water management.

5) All kinds of revenue being accrued through resorts at tourist places, profit being gained from restaurants, fees being collected from tourists, boating, charges being levied from amateur tourists for enjoying water sports and spot fishing, amount being amassed from the sale of fruits, flowers and plantings should be got distributed between the Tourism Development Corporation and the Irrigation Department in the proportion 75:25.

6) The basic amenities such, as permanent project roads upto tourist places, electricity, water etc should be provided. Facilities as to the advertisement and transportation should be available which will enable attracting travelers at least 100 days in a year.

7) The tourist complex of an irrigation project will be owned by the Irrigation Department. However, maintenance & repairs on counts of assets required for tourism development, for example, means of water sports, means of sports for boys and girls, boats meant for tourists, etc., should be carried out by the Tourism Development Corporation only.

Future Programme of Tourist Centres on Irrigation Projects

10.11.6 There is a large group of tourists which is desirous of comforts and rest. Tourism development will be accomplished if resorts, means of entertainment and also facilities such as water sports are made available to the tourists at some irrigation projects in the State. Existing 5 and proposed 16 tourists centres on irrigation projects of such kind are depicted on the. Map No. 20 (of Maharashtra).

The Maharashtra Tourism Development Corporation has, in 1989, embarked upon the first water sports and tourism complex at Panshet (Pune) Project with the cooperation of Irrigation Department. Thereafter, the Corporation has set up water sports centres at Ganpatipule (Ratnagiri), Wadali (Amravati), Khindshi Lake (Nagpur), Karla (Pune) and Sanjay Gandhi National Garden (Mumbai Suburb).

The following tourism and water sports centres which are amenable for development as such are revealed through the reservoirs survey conducted by M/s. Radia Water Sports - a private agency - in various parts of Maharashtra:

Proposed Tourist Centres on Irrigation Projects

Sr.No.	Name of lake	District	Taluka
(1)	(2)	(3)	(4)
1	Bhatsa	Thane	Shahapur
2	Dhamapur	Sindhudurg	Malvan
3	Ozarkhed	Nashik	Dindori
4	Karanjwan	Nashik	Dindori
5	Darna	Nashik	Igatpuri
6	Toranmal	Dhule	Dhule
7	Manyad	Jalgaon	Chalisgaon
8	Katraj	Pune	Pune
9	Tawarja	Latur	Latur
10	Mandva	Buldana	Lonar
11	Chikhaldara	Amravati	Chikhaldara
12	Bor Dam	Wardha	Selu
13	Mahakali(Dham)	Wardha	Arni
14	Khekarnala	Nagpur	Savner
15	Navegaon (Khairi)	Nagpur	Parsoli
16	Itiadoh	Bhandara	Morgaon Arjuni

Source:- Information with the Maharashtra Tourism Development Corporation Ltd., Mumbai.

The Irrigation Department should make available at least one project area in the aforementioned 12 districts with the space and reservoir necessary for creating water sports and tourist centre equipped with latest facilities during the forthcoming 10 years. Amongst those, possible places should be lent to the private organisations on management basis so as to become an attraction for tourists. The further 10-years' second phase will see the accomplishment of tourism development on irrigation projects in 10 more districts in case of 163 reservoirs in the State where tourism can possibly be achieved and are of water spread over 200 ha. In this manner, the State Government should further undertake assessment of feasibility of tourism development in irrigation project areas and set up tourist centres in all die districts of Maharashtra with at least one in rest of the districts by the year 2030, it is felt.

Chapter 10
Non-irrigation Uses of Water
List of Annexes, Graphs & Maps

Annex: 10.1.1
Position of Urban Water Supply

Sr. No.	Population	No of cities	Norms of water supply (Li-tres/day /Head)	No. of cities receiving water supply as per norms	No. of cities receiving water supply below norms
(1)	(2)	(3)	(4)	(5)	(6)
1	Up to 20000	25	70	17	8
2	More than 20000 but less than 60000	98	100	23	75
3	More than 60000 but less than 100000	48	125	6	42
4	More than 100000	72	150	8	64
	Total	243	--	54	189

Source: White paper on Drinking Water Supply Programme - July-1995.
Reference Paragraph: 10.1.15

Annex: 10.1.2
Position of Actual Water supply as compared to norms

Sr.No	Present water supply as compared to Norms	No. of Corporations	No. Of Municipal Councils			Total No.
			A-Class	B-Class	C-Class	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Less than 50 percent	1	11	17	51	80
	50 to 75 percent	4	4	11	55	74
	More than 75 percent but less than 100 percent	4	5	11	23	43
	More than norms	3	1	8	35	47
	Total	12+*	21-*	47	164-*	244

Note: *Indicates the break up of these figures as per Sr.No. 1 to 4 was not made available with the commission.
Source: Ninth Five Year plan (1997-2002) - A report of water supply and Sanitation study Group.
Reference Paragraph : 10.1.15

Annex 10.1.3 Financial Statement of Urban Water Supply for 1994-95

Amount: Rs. in laths

Sr.No.	Municipal Council	Total No. Of Water Supply Connections	Total Income from Water Tax	Actual Recovery	Expenditure on M & R (including establishment) of water supply scheme	Annual repayment Water Supply scheme	Recovery as % of gross water charges
1	2	3	4	5	6	7	8
	A-Class						
1	Akola	27388	46.53	49.00	156.00	577.00	105
2	Dhule	20820	66.03	52.00	94.87	67.01	79
3	Wardha	10642	25.54	19.47	66.84	1.54	76
4	Bhivandi	31995	828.00	150.00	533.00	110.00	18
	B-Class						
5	Nandurbar	6852	18.20	13.86	32.43	2.46	76
6	Karanja	3350	28.13	28.49	33.79	0	101
7	Basmatnagar	2200	5.27	2.07	8.60	0.32	39
8	Vani	4116	11.54	11.62	34.60	0	101
9	Shrirampur	7691	20.15	16.53	36.53	21.43	82
10	Manmad	4802	17.18	9.69	39.65	37.96	56
11	Satara	8555	30.35	23.03	40.00	0	76
12	Udgir	4612	11.45	8.85	41.39	7.82	77
	C-Class						
13	Dharangaon	3431	6.03	4.62	15.03	10.63	77
14	Khapa	1000	1.46	1.12	2.08	N.A.	77
15	Trimbak	164	1.75	1.67	3.78	Nil	95
16	Navapur	2664	7.19	6.29	8.98	N.A.	87
17	Bramhapuri	2088	2.61	2.11	5.44	N.A.	81
18	Mangloorpeer	1617	4.87	4.00	7.62	N.A.	82
19	Vita	3113	9.00	1.13	2.87	0.83	13
20	Loha	681	0.95	0.72	5.95	N.A.	76
21	Gadhinglaj	2580	5.78	5.16	21.11	4.20	89
22	Ghatanji	1334	5.45	4.32	7.37	N.A.	79
23	Jejuri	1376	2.86	2.62	6.20	N.A.	92
24	Pandhar Kavda	1955	8.74	9.39	11.94	N.A.	107
25	Georai	2000	6.86	2.41	17.03	N.A.	35
26	Jintur	2020	5.72	4.47	12.20	N.A.	78
27	Raver	2545	7.14	4.90	11.38	0.10	69
28	Karjat	1295	1.40	0.65	7.35	N.A.	46
29	Satana	3606	6.84	6.41	5.26	1.24	94
30	Murtizapur	2261	13.14	10.71	40.32	11.25	82
31	Sillod	2110	3.78	0.66	11.48	N.A.	17

Source: Information as received from concerned municipal councils.
Inference: The actual recovery is found to be less than total income accrued from Water Tax in respect of some Municipal councils.
Reference Paragraph: 10.1.19

Annex: 10.1.4
Utilisation of Water Various purposes

Purpose	Year 1996	% of Total Utilisation	% of Total Availability	Year 2030	% of Total utilisation	% of Total Availability
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1) Drinking Water						
A) Urban	1705.46	4%	1%	4240	4%	3%
B) Rural	1062.06	3%	1%	1943	2%	1%
Total	2767.52	7%	2%	6184	6%	4%
2) Live Stock	746.33	2%	1%	998	1%	1%
3) Irrigation						
A) Surface Water	24093	61%	16%	69161	67%	47%
B) Ground Water	7252	18%	5%	20501	20%	14%
Total	31345	79% ı	21%	89662	86%	60%
4) Hydro Electric	3112	8%	2%	3112	3%	2%
5) Thermal	271.5	1%	0%	495	0%	0%
6) Industry	1241.3	3%	1%	3254	3%	2%
Total Utilisation	**39483.7**	**100%**	**27%**	**103705**	**100%**	**70%**
Total Availability	**148208**		**100%**	**148208**		**100%**

Notes:

1) The information on the use of surface water for Irrigation & Hydro Electric generation is adopted from the sub-basin wise notes submitted by field officers.

2) The utilisation of drinking water for Urban & Rural sector is as per the norms fixed by Maharashtra Jeevan Pradhikaran. (See Chapter 10.1)

3) The requirement of water for Livestock is taken as per the norms of water required for cattle units.

4) The water required for Industry is adopted from the information submitted by the concerned Departments. Reference Paragraph: 10.1.28

Annex: 10.3.1 Requirement of water for Industrial Use

Water Demand: Mm^3

Sub Basin No.	Sub-Basin	MIDC (including 5 star Industrial Area)		Other than MIDC		Co-operative Industries and Sugar Industries		Thermal Power Stations		Total	
		1996	2030	1996	2030	1996	2030	1996	2030	1996	2030
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	Upper Godavari (Upto Paithan Dam) a) Godavari (Except Mula and Pravara)	18.9	202.7	7.5	7.5	7.7	9.6	40.0	62.0	74.1	281.8
	b) Mula and Pravara	0.0	4.4	0.8	0.8	5.2	7.3			6.0	12.5
2	Lower. Godavari (D/s of Paithan Dam	2.1	31.5	4.8	4.8	3.1	3.1	30.4	52.5	40.3	91.8
3	Purna (Including Dudhana)	0.7	89.3	0.0	0.0	2.3	3.8			3.0	93.1
4	Manjra	0.1	20.0	0.1	0.1	2.8	4.7			3.0	24.8
5	Godavari-Sudha-Swarna					0.2	0.2			0.2	0.2
6	Painganga	1.2	15.5			1.7	2.5			3.0	17.9
7	Wardha	6.3	113.8	72.9	72.9	0.9	1.1	100.0	103.0	180.0	290.8

(Contd.)

Annex: 10.3.1 (Concld.)

Sub Basin No.	Sub-Basin	MIDC (including 5 star Industrial Area)		Other than MIDC		Co-operative Industries and Sugar Industries		Thermal Power Stations		Total	
		1996	2030	1996	2030	1996	2030	1996	2030	1996	2030
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
8	Middle Wainganga	5.5	29.2	42.8	42.8	1.0	1.5	80.0	100.0	129.2	173.5
9	Lower Wainganga										
	a) Waiganga-Pranhita	0.0	6.1	3.2	3.2					3.2	9.3
	b) Inchampalli									0.0	0.0
	c) Indravati									0.0	0.0
	Godavari Basin	**34.8**	**512.5**	**132.0**	**132.0**	**24.8**	**33.7**	**250.4**	**317.5**	**441.9**	**999.6**
10	Purna (Tapi)	1.4	696.2	0.5	0.5	0.6	1.5	2.2	12.0	4.7	710.2
11	Girna	4.0	18.6	2.3	2.3	2.1	3.8			8.4	24.6
12	Panzra	0.7	11.4	1.8	1.8	0.6	0.8			3.0	13.9
13	Middle Tapi										
	a) Tapi (Satpuda)		0.9	3.9	3.9	8.0	8.8			11.9	13.5
	b) Tapi (South)		5.9	7.7	7.7	1.6	2.1	18.0	163.0	27.3	178.7
	Tapi Basin	6.0	733.0	16.1	16.1	13.0	16.9	20.2	175.0	55.2	941.0
14	Narmada									0.0	0.0
15	Upper Krishna (West)										
	a) North-West	5.2	70.7	2.0	2.0	16.0	20.2			23.2	92.9
	b) South-West		7.5	0.2	0.2	1.4	1.6			1.6	9.3
16	Upper Krishna (East)										
	a) Yerala	3.3	58.7	0.5	0.5	2.2	4.0			6.0	63.2
	b) Agrani					0.2	0.2			0.2	0.2
17	Upper Bhima (Upto Ujjani)	35.1	111.0	37.9	37.9	3.5	4.9			76.5	153.8
18	Remaining Bhima										
	a) Neera	6.1	37.6	7.0	7.0	2.6	3.3			15.6	47.8
	b) Downstream of Ujjani including Man		15.8			1.9	2.5			1.9	18.3
19	Sina-Bori-Benetura										
	a) Sina	8.6	20.5	1.5	1.5	2.5	4.3			12.6	26.3
	b) Bori-Benetura		2.6			0.7	1.1			0.7	3.7
	Krishna Basin	**58.3**	**324.3**	**49.0**	**49.0**	**30.8**	**42.1**	**0**	**0**	**138.2**	**415.4**
20	Damanganga-Par									0.0	0.0
21	North Konkan	181.0	428.0	615.0	688.0	0.5	0.5	0.9	2.9	797.4	1119.4
22	Middle Konkan	42.5	167.5	25.3	25.3					67.8	192.8
23	Vashisthi	4.8	44.3			0.1	0.4			4.9	44.7
24	South Konkan										
	a) Ratnagiri	3.8	30.0	1.8	1.8	0.2	0.5			5.8	32.3
	b) Sindhudurg	0.2	4.0	1.2	1.2	0.1	0.1			1.5	5.2
25	Terekhol-Tillari		3.1			0.1	0.2			0.1	3.3
	West Flowing River Basins in Konkan	**232.3**	**676.8**	**643.3**	**716.3**	**1.0**	**1.7**	**0.9**	**2.9**	**877.5**	**1397.7**
	Maharashtra	**331.4**	**2246.6**	**840.4**	**913.4**	**69.6**	**94.3**	**271.5**	**495.4**	**1512.8**	**3753.6**

Source: Lr.No. i) 2149/97 dated 7-7-97 from Chief Engineer, MIDC, ii) Correspondence with Maharashtra Pollution Control Board and MSEB.

Inference: Taking into consideration the industrial growth the requirement of water for the year 2030 is as above.

Reference Paragraph: 10.3.2

Annex: 10.3.2 Number of Main Workers in Industry

Sr.No.	Census year	No.of Farmers	Agricultural Labours	GR(A) 3+4	Mining and Forest worker	House Hold Industry	Factories	Gr.(B) 6+7+8	Construction Industry	Trade	Transport	Other services	GR(C) 10+11+12+13	Total Workers	Total Population	Population of eligible age group for working (Age 18 to 59)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1	1961	87.27	45.1	132.37	4.19	8.32	13.04	25.215	2.36	8.56	4.47	16.17	31.56	189.48	395.53	
		46.06%	23.80%	69.86%	2.16%	4.39%	6.88%	13.43%	1.25%	4.52%	2.36%	8.53%	16.66%	100.00%		
2	1971	65.27	53.93	119.2	2.96	6.08	18.32	" 27.36	2.76	12.32	5.61	16.55	37.24	183.9	504.12	
		35,49%	29.33%	64.82%	1.61%	3.31%	9.96%	14.88%	1.50%	6.70%	3.05%	9.00%	20.25%	100.00%		
3	1981	85.36	64.71	150.07	5.54	6.21	27.77	39.52	5.09	17.17	18.02	22.88	63.16	242.75	627.84	347
		35.16%	26.66%	61.82%	2.28%	2.56%	11.44%	16.28%	2.10%	7.07%	7.42%	9.43%	26.02%	100.00%		
4	1991	101.72	83.13	184.85	5.87	4.98	35.98	46.83	8.02	26.57	11.66	32.19	78.44	310.06	789.29	450
		32.81%	26.81%	59.62%	1.89%	1.61%	11.60%	15.10%	2.59%	8.57%	3.76%	10.38%	25.30%	100.00%		
5	Increase in No. wage earner (1961-1991)	14.45	38.03	52.48	1.78.	-3.34	22.94	21.38	5.66	18.01	7.19	16.02	46.88	120.58	393.76	

Source : 1) State Statistical Abstract 1989-1990 and 1990-1991

2) Economic Survey of Maharashtra - 1997-98

Inference: The increase in number of workers during 1961 to 1991 of Gr.A,B and C are 52.48, 21.38 and 41.88 lakhs respectively.

Reference Paragraph: 10.3.2

Annex 10.8.1
Quality of drinking water
physical & chemical standards

Sr.No.	Properties	Unit	Acceptable*	Cause-for Rejection **
(1)	(2)	(3)	(4)	(5)
1	Turbidity	NTU	2.5	10
2	Colour	Hasen Unit	5	25
3	Taste & Odour		Unobjectionable	
4	pH		6.5 to 8.5	< 6.5 or > 9.2
5	Total dissolved Solids	mg/1	500	2000
6	Total Hardness As $CaCO_3$	mg/1	300	600
7	Chlorides (as Cl_2)	mg/1	250	1000
8	Sulphates (as SO_4)	mg/1	200	400
9	Flurides (as F)	mg/1	1	1.5
10	Nitrates (as NO_3)	mg/1	45	100
11	Calcium (as Ca)	mg/1	75	200
12	Magnesium (as Mg)	mg/1	30	100
13	Iron (as Fe)	mg/1	>0.3	1
14	Manganese (as Mn)	mg/1	0.05	0.5
15	Copper (as Cu)	mg/1	0.05	1.5
16	Zinc (as Zn)	mg/1	5	15
17	Phenolic compounds (as Phenol)	mg/1	0.001	0.002
18	Anionic detergents (as MBAS)	mg/1	0.2	1
19	Mineral Oils	mg/1	0.01	0.03
	Toxic materials			
20	Arsenic (as As)	mg/1	0.05	0.05
21	Cadmium (as Cd)	mg/1	0.01	0.01
22	Cromium (as Hexavalent Cr)	mg/1	0.05	0.05
23	Cynide (as CN)	mg/1	0.05	0.05
24	Lead (as Pb)	mg/1	0.05	0.05
25	Selenium (as Se)	mg/I	0.01	0.01
26	Mercury (as total Hg)	mg/I	0.001	0.001
27	Polynuclear Aromatic Hydrocarbon (as PAH)	microgram/1	0.2	0.2
28	Pesticides	mg/1		0.001
29	Sodacity		200	600
30	Aluminium	mg/1	0.03	0.2
31	Boran	mg/1	1	5
	Radio Activity			
28	Gross Alpha Activity	Bq/1	-	0.1
29	Gross Beta Activity	Bq/1	-	1

* The figures indicated under the column ‘Acceptable’ are the limits upto which water is generally acceptable.
** Figures in excess of those mentioned under ‘Acceptable’ render the water not acceptable, but still may he tolerated in the absence-of alternative and better source but upto the limits indicated under column. "Cause for Rejection" above which the supply will have to be rejected.
Source : IS I 0500-1991.
Reference Paragraph:10.8.5

Annex: 10.8.2. Guideline Values for Bacteriological Quality

S.No. Quality of Water	Organism	Maximum Number per 100ml	Remarks
(1)	(2)	(3)	(4)
A Piped Water Supplies			
1) Treated Water entering the distribution system	Faecal Coliforms	0	Turbidity <1 NTU
	Coliform Organisms	0	For disinfection with chlorine, pH preferably 8.0, Free chlorine residual 0.2-0.5 mg/1 following 30 minutes (minimum) contact
2) Untreated Water entering the distribution sytem	Faecal Coliforms	0	
	Coliform Organisms	0	In 98% of samples examined throughout the year in the case of large supplies when sufficient samples are examined.
	Coliform Organisms	3	In an occasional sample, but not in consecutive samples, in a year.
3) Water in the distribution system	Faecal Coliforms	0	
	Coliform Organisms	0	In 95% of samples examined throught the year in the case of large supplies when sufficient samples are examined.
	Coliform Organisms	3	In an occasional sample, but not in consecutive samples in a year.
B Unpiped Water Supplies	Faecal Coliforms	0	
	Coliform Organisms	10	Should not occur repeatedly: if ocurence is frequentıand if sanitary protection cannot be improved an alternative source must be found.
C Emergency Water Supplies	Faecal Coliforms	0	
	Coliform Organisms	0	Advise public to boil Water

Source: Guidelines for Drinking Water Quality, Vol. 1, WHO Publication - 1996
Reference Paragraph : 10.8.3

Annex : 10.8.3
Quality of Water for Irrigation Water. Quality Ratings

Sr.No.	Nature of Soil	Crop to be Grown	Permissible limit for Electrical conductivity of water for safe Irrigation (Micro-mhos/cm)
1	Deep block soils & alluvial soils having more clay content.	Semi Tolerant	1500
2	Fairly to moderately well drained soils.	Tolerant	2000
3	Heavy textured soils having a clay content of20-30 %	Semi Tolerant	2000
4	Soils Well drained internally and having good surface drainage system	Tolerant	4000
5	Medium textured soils having a clay content of 10-20%	Semi Tolerant	4000
6	Soil very well drained internally and having good surface drainage system	Tolerant	6000
7	Light textured soils having a clay content of less that 10%	Semi Tolerant	6000
8	Soils having excellent internal & surface drainage	Tolerant	8000

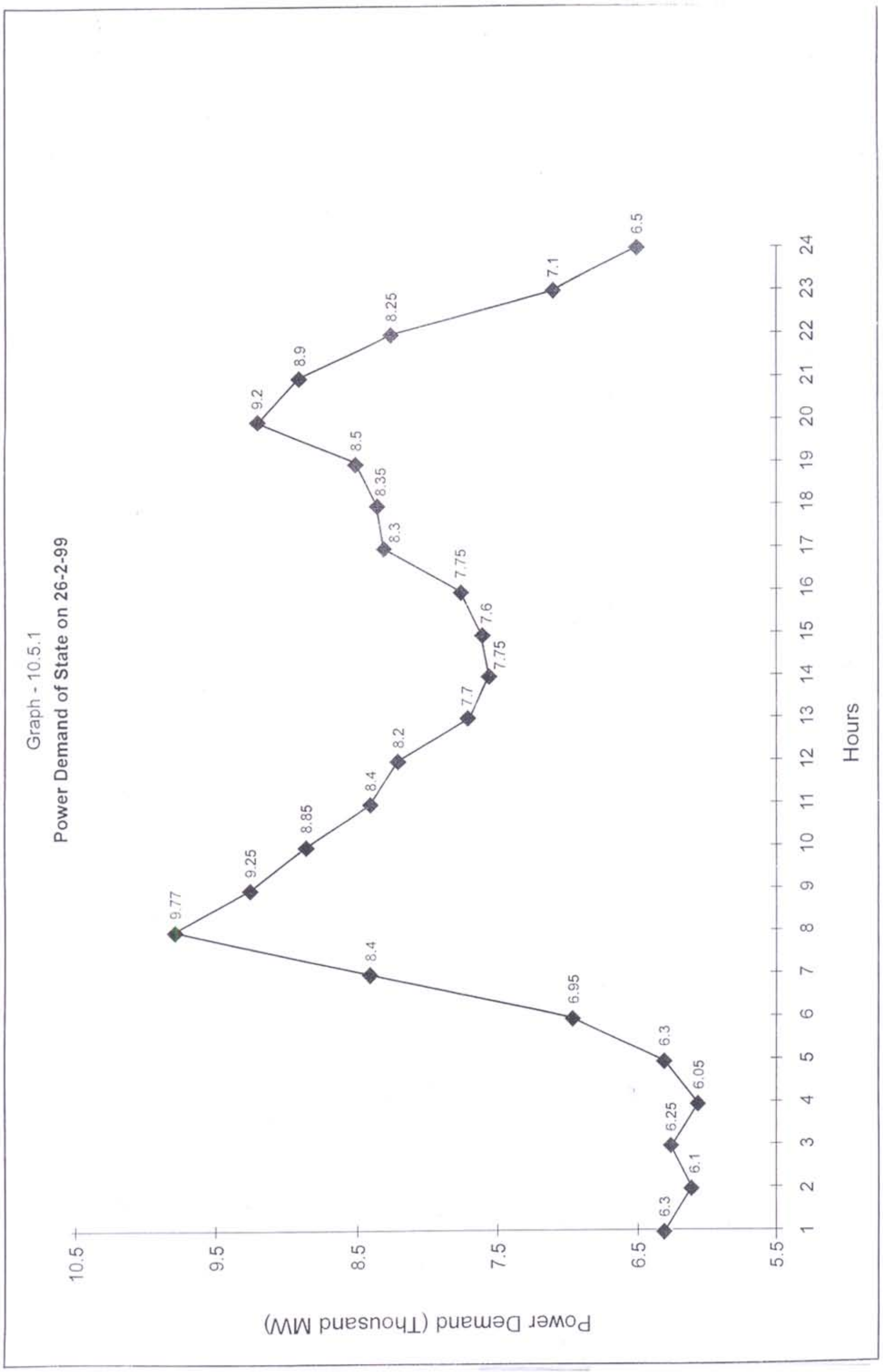
Notes: 1) These limits apply to the situations where ground water table is 1.5 m from the surface.

2) The Values will have to be reduced by half if the water table comes upto the root zone.

3) If the soils have impeded internal drainage either on account of presence of hard stratum, unusually hight amounts of clay, the values will have to be reduced to half.

4) The electrical conductivity shows the permissible levels of total salts in water. It may be pointed out that good drainage of the soils may be a more important factor for crop growth than the electrical conductivity.

Source: Water Quality for Irrigation - Bulletin No. 19, CSSRI, Karnal
Reference Paragraph: 10.8.6



Graph - 10.5.1
Power Demand of State on 26-2-99
Power Demand (Thousand MW)
Hours
10.5
9.5
8.5
7.5
6.5
5.5
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
6.3
6.1
6.25
6.05
6.3
6.95
8.4
9.77
9.25
8.85
8.4
8.2
7.7
7.75
7.6
7.75
8.3
8.35
8.5
9.2
8.9
8.25
7.1
6.5

BOOK REVIEW

Prasannan Parthasarathi, *Why Europe grew rich and Asia did not: global divergence, 1600-1850* Cambridge: Cambridge University Press, New Delhi, 2011, Pp. xviii+365. Price: $90.

This book is a welcome addition to the Great Divergence debate, following the publication of Before and Beyond Divergence by R.Bin Wong and Why the West Rules for Now by Ian Morris. This book tries to apply the 'California hypothesis' to the Indian case. The California Hypothesis was essentially postulated by Kenneth Pomeranz in his 'The Great Divergence: China, Europe and the Making of the Modern World Economy', published in 2001, and 'Re-Orient: The Global Economy in the Asian Age' by Andre Gunder Frank, published in 1998. The broad lines of argument here are that instead of falling behind since the Ming age, the Chinese economy actually functioned rather well till the 18th century. The Industrial revolution gave Europe a temporary advantage, leading to the emergence of the 'great divergence' in modern times. Parthasarathi has tried to apply this argument in the Indian context.

The title of the book is quite misleading; the book is not about Asia and Europe, but is about some regions of India on the one hand, and Britain on the other. There are some stray references to Japan and a few other European countries, but they are not a central part of the argument. Parthasarathi argues for the position that India, on the eve of the British rule, was not a stagnant, tradition bound, poor and ignorant society without sophisticated markets. In several ways, Parthasarathi argues, the Indian economy was on par with contemporary Britain. Then why did India fall behind Britain during the 19th century? To Parthasarathi, this is mainly because the colonial state in India did not provide the same support that was provided to British industry by the British state. British industry benefited from the deliberate protectionist and import substituting policies of the British government.

For a long time, it has been accepted that pre-British India was not entirely economically stagnant. The idea of India being inhabited by 'self-sufficient village republics' is long dead. Over the last two to three decades, several scholars, only some of whom are cited by Parthasarathi, have shown that portions of India were commercially vibrant, and boasted of dynamic economies that could have potentially generated substantial economic growth. Some regions of India were at least as highly urbanised as some contemporary continental countries. Markets played a much more significant role in the pre-British Indian economy than imagined by historian a generation or two ago. Political powers were not all predatory, several made significant efforts to increase cultivation, develop markets, build roads, etc. However, it is also the case that we know very little about the economic organisation of several major parts of India, where region specific studies are needed to put together whatever archival sources that exist in order to obtain a better understanding of the economic dynamics of eighteenth century India as a whole. The current state of scholarship and the material that have been brought to light is far from enough to support Parthasarathi's rather sweeping generalisations about India as a whole. In addition, we also know that in several significant areas, the Indian economy was fragmented, with poor communication infrastructure and large transactions costs of doing business. For example, in large parts of western India, we find that markets in agricultural land functioned very poorly because property rights in land were not well defined. Parthasarathi argues that some states like Mysore under Tipoo Sultan actively promoted industry. We also know that some indigenous powers were interested in setting up and expanding markets. They also provided developmental subsidies to agriculture, mainly by giving tax concessions to individuals who were willing to invest in infrastructure like building dams and roads. But whether this would have led to the Indian economy taking off, just like 19th century Britain did, is a rather uncertain counterfactual, given the state of historical knowledge as of now. The problem with Parthasarathi's book is that it makes this counterfactual, but does not really provide any supporting concrete evidence, beyond what has already been known for quite a long time now. What is known and accepted is that the caricature of the pre-British Indian economy as a tradition bound, backward, poor economy with non-functional markets is overdrawn. Parthasarathi admirably marshals the evidence in this regard. But to my knowledge at least, no serious scholarship has made the claim the Parthasarathi is making. This is simply because the incontrovertible evidence to make this counterfactual simply does not exist, or has not been put together from the rich archival bases that exist in several of the regional and national archives in India.

Parthasarathi also ignores several sources of weaknesses that existed in the economy of 18th century India. Though a complex market economy surely existed, it can be argued that the transactions costs of doing business would have been very high. Weights and measures varied a great deal from region to region. Villages situated not too far apart used very different measures of land size, political powers could often coerce people into paying impossibly high taxes, though wholesale abandonment of villages was a commonly used strategy to counteract this. Armies criss-crossing the countryside often had devastating impact on the livelihoods of people. The caste system strictly forbade occupational mobility and technical innovation, with some exceptions that are easy to overplay. Many regions were caught in a low equilibrium trap through eking out an uncertain living in drought prone agriculture. Scholars have also pointed out to significant cultural differences. For example, studies of textile workers in India show that even when wage costs in India were only one-sixth of that in England, Indian textile industry did not have any significant cost advantages because the efficiency of India labour was quite low.

Parthasarathi has argued for the dynamism of Indian science and technology in the 18th century, but by his own admission, this area of research is still in its infancy. Yet, his conjecture does not find support in the writings of an important Indian researcher in this field whom Parthasarathi, surprisingly, does not cite. Dharampal maintains that 'It is possible that the various sciences and technologies were on a decline in India around 1750 and, perhaps, had been on a similar course for several centuries previously' but that it was hard to know because of the 'general incommunicativeness of eighteenth century Indian scholars and specialists in the various fields' which may have been due to 'the usual secretiveness of such persons' (http://www.scribd.com/doc/29011033/Dharampal-s-Collected-Writings-Vol-1-5, p. 5). This quote from a leading authority in this area again points to the basic weakness of Parthasarathi's book: It is making a rather sweeping statement that is not really supported by adequate empirical evidence.

As pointed out by Joel Mokyr in his review, Parthasarathi's interpretation of the British industrial revolution too suffers from a one - sided interpretation. Parathasarathi sees the British Industrial revolution as primarily a revolution in coal and textiles. To Parthasarathi, British Industrial revolution is indebted to India. Exposure to fine Indian textiles developed the British taste for them, which helped British cotton textile industry once their importation into England was banned. However, coal and textiles were not the only industries that saw technical innovations. Several others, for example gas-lighting, too saw significant technical change. Also, he exaggerates the role of the British government in ushering in the Industrial revolution, while at the same time, attributing too much potentiality to local Indian powers in the same direction.

This is not to deny the merit of Parthasarathi's ambitious hypothesis, but it just points to the large amount of primarily regional based research that still needs to be carried out if this hypothesis is to have serious support. India is rather rich in regional archives. They have not been used as extensively as they ought to be. Detailed regional studies of the diverse Indian regions, exploring the complex interplay of state power, markets, livelihoods of people, challenges posed by the ecology among other things is perhaps the only way forward if we have to seriously approach this conjecture.

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Professor A. L. Nagar

Profesor A.L. Nagar, a doyen among world econometricians, Emeritus Professor, and former Pro-Vice Chancellor, Delhi Universitypassed away on February 4, 2014, at the age of 84 years. He was Visiting Fellow at the Indian School of Political Economy during the past three years.

After doing his Ph.D. in econometrics from Netherlands School of Economics, Rotterdam in 1959, Prof. Nagar joined Delhi School of Economics in 1963 and taught there till his retirement, when he was made Pro-Vice Chancellor of Delhi University. He spanned a long and illustrious career in teaching and reseach in econometrics and economics. He was visiting professor at the Brookings Institution; Wharton School of Finance and Commerce, University of Pennsylvania; University of Western Ontario; Australian National University; McGill University, and many other institutions. He has extensively published in international journals (Econometrica, Journal of American Statistical Association, Indian Economic Review, etc) and authored many books.He was elected Fellow of the Econometric Society in 1971.

Professor Nagar made profound contributions to structursl modelling as well as time series econometrics. The Theil-Nagar test for serial correlation in small samples is, of course, well-known. In his highly aclaimed work on k-class estimators of parameters in simultaneous equations models,of which two-stage least squares estimator as well as Limited Information Maximum Likelihood estimators are special cases, Prof. Nagar established the properties and biases in these estimators in small samples. As most simultaneous equations economic models are estimated over time spans often involving relatively small number of observations, these results are very pertinent.

His work on simulatons of the Brookings econometric model has been referred to in almost all econometric works on the working of macroeconomy and policy simulations. He helped the Ministry of Finance, Government of India, to develop an econometric model to forecast tax revenues and contributed to the UNCTAD Report on Trade and Development Index.

Prof. Nagar’s paper (jointly with others) on Interface of Income, Health and Environment: An Econometric Investigation, published in the present volume is nothing short of a path breaking study. It presents a structural model econometrically estimating the interdependent relationships among per capita income, health and respirable particulate air pollution in a simultaneous equations framework for the Indian economy during the last 25 years. In the process, the paper also suggests a new method of constructing indices of a large number of variables by using *all* and not afew selected Principal Components. This can potentially enable one to estimate the effect of any particular variable from the index, if deemed necessary. Use of such indices could help compress the number of variables in the equations enough to convert, as Professor Nagar frequently emphasized to me, an over-identified model to a just identified one, making it possible to estimate the structural parameters from the reduced form. He was greatly excited about the potentialities of such applications of the index developed in this paper. In his hand-written correspondence during the last few months, sent through couriers, he suggested the possibility of writing a joint paper on this theme. As he lived at the other end of Pune city from our residence, when I said to him over the telephone that I would visit him at his residence to discuss this idea in detail, as soon as I get a driver to take me there, he exclaimed in his characteristic way: "Our paper cannot wait for the driver!"

Now those words will keep ringing in my ears all the time.

He was working till his very last moment, and has left a great and inspiring legacy for all of us and the future generation of econometricians.

Vikas Chitre