2

Water Management and Irrigation

INTRODUCTION

2.1 Sustainable development and efficient management of water is an increasingly complex challenge in India. Increasing population, growing urbanization, and rapid industrialization combined with the need for raising agricultural production generates competing claims for water. There is a growing perception of a sense of an impending water crisis in the country. Some manifestations of this crisis are:

- There is hardly any city which receives a 24-hour supply of drinking water.
- Many rural habitations which had been covered under the drinking water programme are now being reported as having slipped back with target dates for completion continuously pushed back. There are pockets where arsenic, nitrate, and fluoride in drinking water are posing a serious health hazard.
- In many parts, the groundwater table declines due to over-exploitation imposing an increasing financial burden on farmers who need to deepen their wells and replace their pump sets and on State Governments whose subsidy burden for electricity supplies rises.
- Many major and medium irrigation (MMI) projects seem to remain under execution forever as they slip from one plan to the other with enormous cost and time overruns.
- Owing to lack of maintenance, the capacity of the older systems seems to be going down.
- The gross irrigated area does not seem to be rising in a manner that it should be, given the investment in irrigation. The difference between potential created and area actually irrigated remains large. Unless we bridge the gap, significant increase in agricultural production will be difficult to realize.
- Floods are a recurring problem in many parts of the country. Degradation of catchment areas and loss of flood plains to urban development and agriculture have accentuated the intensity of floods.
- Water quality in our rivers and lakes is far from satisfactory. Water in most parts of rivers is not fit for bathing, let alone drinking. Untreated or partially treated sewage from towns and cities is being dumped into the rivers.
- Untreated or inadequately treated industrial effluents pollute water bodies and also contaminate groundwater.
- At the same time water conflicts are increasing. Apart from the traditional conflicts about water rights between upper and lower riparians in a river, conflicts about quality of water, people's right for rainwater harvesting in a watershed against downstream users, industrial use of groundwater and its impact on water tables and between urban and rural users have emerged.

2.2 India with 2.4% of the world's total area has 16% of the world's population; but has only 4% of the total available fresh water. This clearly indicates the need for water resource development, conservation, and optimum use. Fortunately, at a macro level India is not short of water. The problems that seem to loom large

over the sector are manageable and the challenges facing it are not insurmountable.

AVAILABILITY OF WATER

Water Resources

2.3 The water resource potential of the country has been assessed from time to time by different agencies. The different estimates are shown in Table 2.1. It may be seen that since 1954, the estimates have stabilized and are within the proximity of the currently accepted estimate of 1869 billion cubic metre (bcm) which includes replenishable groundwater which gets charged on annual basis.

TABLE 2.1
Estimates of Water Resources in India

Agency	Estimate in bcm	Deviation from 1869 bcm
First Irrigation Commission (1902–03)	1443	–23%
Dr A.N. Khosla (1949)	1673	–10%
Central Water and Power Commission (1954–66)	1881	+0.6%
National Commission on Agriculture	1850	–1%
Central Water Commission (1988)	1880	+0.6%
Central Water Commission (1993)	1869	–

Utilizable Water Resources Potential

2.4 Within the limitations of physiographic conditions, socio-political environment, legal and constitutional constraints, and the technology available at hand, the utilizable water resources of the country have been assessed at 1123 bcm, of which 690 bcm is from surface water and 433 bcm from groundwater sources (CWC, 1993). Harnessing of 690 bcm of utilizable surface water is possible only if matching storages are built. Trans-basin transfer of water, if taken up to the full extent as proposed under the National Perspective Plan, would further increase the utilizable quantity by approximately 220 bcm. The irrigation potential of the country has been estimated to be 139.9 MH without inter-basin sharing of water and 175 MH with inter-basin sharing.

2.5 While the total water resource availability in the country remains constant, the per capita availability of water has been steadily declining since 1951 due to population growth. The twin indicators of water scarcity are per capita availability and storage. A per capita availability of less than 1700 cubic metres (m^3) is termed as a water-stressed condition while if per capita availability falls below 1000 m^3, it is termed as a water-scarcity condition. While on an average we may be nearing the water-stressed condition, on an individual river basin-wise situation, nine out of our 20 river basins with 200 million populations are already facing a water-scarcity condition. Even after constructing 4525 large and small dams, the per capita storage in the country is 213 m^3 as against 6103 m^3 in Russia, 4733 m^3 in Australia, 1964 m^3 in the United States (US), and 1111 m^3 of China. It may touch 400 m^3 in India only after the completion of all the ongoing and proposed dams.

Ultimate Irrigation Potential (UIP)

2.6 The demand for irrigation water in India is very large. However, the limits to storage and transfer of water restrict the potential for irrigation. UIP reassessed by the Committee constituted by the MoWR in May 1997, the potential created, and the potential utilized up to end of the Tenth Plan are given in Table 2.2.

2.7 The assessment of UIP needs to be periodically reviewed to account for revision in scope, technological advancement, inter-basin transfer of water, induced recharging of groundwater, etc. The creation of irrigation potential depends upon the efficiency of the system for delivering the water and its optimal use at the application level. With the modern techniques of integrating micro irrigation with canal irrigation as has been done in the case of Narmada Canal Project, Rajasthan, the UIP can further be increased. Similarly in the case of groundwater, innovative methods of recharging the groundwater and also storing water in flood plains along the river banks may enhance the UIP from groundwater to more than 64 MH.

Water for Nature

2.8 The question of a trade-off between competing claims on water becomes most important in the context of ecological requirement. The National Water Policy (NWP) places ecology in the fourth place in the order of priorities for water use. Yet, there is a general agreement amongst all that any water diversion

TABLE 2.2
Ultimate Irrigation Potential, Potential Created and Potential Utilized

(in MH)

Sector	Ultimate Irrigation Potential	Potential Created		Potential Utilized	
		Till End of Ninth Plan	Anticipated in Tenth Plan	Till end of Ninth Plan	Anticipated in Tenth Plan
MMI	58.47	37.05	5.3	31.01	3.41
MI					
Surface water	17.38	13.6	0.71	11.44	0.56
Groundwater	64.05	43.3	2.81	38.55	2.26
Subtotal	81.43	56.9	3.52	49.99	2.82
Total	139.9	93.95	8.82	81.00	6.23

needs to take care of river ecosystem downstream. The problem is of quantifying the Environment Flow Releases (EFR), that is the flow required for maintaining ecosystems. Usable water will be reduced to that extent. During 2004–05, the Ministry of Environment and Forests (MoEF) appointed a committee headed by Member, Central Water Commission (CWC), to develop guidelines for determining the EFR. The committee submitted its report in 2005. Depending on what the final accepted recommendation is, the minimum flow required for maintaining the river regime and environment will be decided and considered in water resources development and management.

Climate Change and Uncertainty in Water Availability

2.9 The threat of climate change is now considered an established fact. General Circulation Models simulate the behaviour of the atmosphere and paint 'what if' scenarios for various levels of greenhouse gas emissions. Using these models the weather experts have predicted that global warming will intensify the hydrologic cycle; more intense rainfall will occur in fewer spells; floods and droughts both will become more intense; the floods will be more frequent; the rainfall will shift towards winter; and there may be a significant reduction in the mass of glaciers, resulting in increased flows in the initial few decades but substantially reduced flows thereafter.

2.10 The MoWR has already initiated some studies in co-operation with research institutions and reputed academic institutions to assess the impact of climate change on water resources.

2.11 The hydrologists are yet to translate what climate change means for the water availability, its distribution in time and space, and changes in demand. An increase in mean temperatures would increase the energy flux for evapo-transpiration. The increased potential evapo-transpiration in the forests could trigger major changes in the environment, and it would result in an increased crop water requirement in the farms. The changes in seasonal temperatures could change the crop seasons. Enough data is now available to paint 'what if' scenarios for different possibilities, and to formulate some tentative plans to respond to these possibilities.

2.12 In the post-climate change scenario, systems that are more resilient will fare better than systems that are less resilient. Engineering infrastructure that enables the water managers to store and transfer water with greater certainty can reduce the impact of uncertainty. Climate change considerations need to be factored in as we plan water resource infrastructure.

WATER REQUIREMENT

2.13 The requirement of water for various sectors has been assessed by the National Commission on Integrated Water Resources Development (NCIWRD) in the year 2000. This requirement is based on the assumption that the irrigation efficiency will increase to 60% from the present level of 35–40%. The Standing Committee of MoWR also assesses it periodically. These are shown in Table 2.3.

TABLE 2.3
Water Requirement for Various Sectors

Sector	Water Demand in km³ (or bcm)					
	Standing Sub-Committee of MoWR			NCIWRD		
	2010	2025	2050	2010	2025	2050
Irrigation	688	910	1072	557	611	807
Drinking water	56	73	102	43	62	111
Industry	12	23	63	37	67	81
Energy	5	15	130	19	33	70
Others	52	72	80	54	70	111
Total	813	1093	1447	710	843	1180

WATER RESOURCES DEVELOPMENT AND USE: IRRIGATION

HISTORICAL DEVELOPMENT

2.14 The planned development of irrigation sector started in a big way since the First Five Year Plan (1951–56). New projects were taken up in the Second Five Year Plan, the Third Five Year Plan, and the Annual Plans 1966–69. During the Fourth Five Year Plan emphasis was shifted to the completion of ongoing schemes. The widening gap between potential creation and utilization was felt in the Fifth Plan (1974–78) and accordingly Command Area Development (CAD) programme was launched. The Annual Plans 1978–80 and the Sixth Plan witnessed new starts and then the focus was shifted towards completion of irrigation projects. By the end of the Eighth Plan (1996–97), central assistance was provided under AIBP to help the State Governments in early completion of the projects.

2.15 Although plan expenditure on irrigation has increased from Rs 441.8 crore in the First Plan to Rs 95743.42 crore (outlay) in the Tenth Plan, the share in total plan expenditure has decreased from 23% in the First Plan to 6.3% in the Tenth Plan. The trends in change of per cent of total plan expenditure on irrigation sector are shown in Figure 2.1.

2.16 The anticipated irrigation potential created up to March 2007 is 102.77 MH, which is 73.46% of the UIP of 140 MH. MMI projects have an UIP of 58.47 MH against which irrigation potential created is 42.35 MH. MI potential created is 60.42 MH against the UIP of 81.43 MH. The irrigation potential creation and its corresponding utilization during the plan periods is given in Annexure 2.1.

2.17 The gross irrigated area in the country is only 87.23 MH. With an average irrigation intensity of 140%, the actual net irrigated area is likely to be around 62.31 MH, which is only 43% of the net sown area of the country (142 MH). Even after achieving the UIP of 139.89 MH. and considering the average irrigation intensity of 140%, the ultimate irrigated area in the country would be only 70% of the net sown area.

2.18 The increasing difference between irrigation potential created and utilized is ascribed to a number of reasons. Irrigation systems are designed for extensive irrigation for a 75% confidence level. Thus water availability in some basins would be less the designed amount. Excess withdrawal by farmers near the head

FIGURE 2.1: Expenditure on Irrigation

of canals deprives farmers at the tail end of water. Inadequate development of field channels, required to be developed by farmers, contribute to the gap. The missing links or breaks in the canal network may also reduce utilization. A part of this gap can be reduced by command area development programmes. Under the CAD Programme, 311 projects [with total culturable command area (CCA) of 28.58 MH] have been included so far. Till the end of March 2006, the construction of field channels has been completed in an area of 17.43 MH. The programme is presently being implemented in 136 projects with total CCA of 17.06 MH.

2.19 Details of the physical progress achieved in respect of core components under the Command Area Development and Water Management (CADWM) Programme during the Tenth Plan till the end of March 2006 and progress likely to be achieved till end of Tenth Plan are given in Table 2.4.

2.20 The total anticipated State share expenditure for the Tenth Plan under the CADWM Programme works out to Rs 1591.57 crore.

Major and Medium Projects

Physical and Financial Performance

2.21 The potential creation target fixed for the Tenth Plan by the Planning Commission was 9.93 MH. It was revised to 6.5 MH during the MTA of the Plan. The performance during the first three years of the Tenth Plan and anticipated performance for remaining two years is given in Table 2.5.

Completion of Projects

2.22 A total number of 490 projects spilled into the Tenth Plan from previous plans, and another 231 projects were to be taken up during the Tenth Plan. Besides, based on the current financial and physical status of the projects, it was also anticipated that 103 major, 210 medium, and 62 extension, renovation, and modernization (ERM) projects could be completed with adequate provision of funds. Since irrigation is a State subject, the projects are largely executed by State Governments. The Working Group for Water Resources for the Eleventh Five Year Plan has now assessed that 179 new projects have been taken up in the Tenth Plan, while 178 projects including 48 major, 91 medium, and

TABLE 2.4
Physical Progress under CAD and Water Management (CADWM) Programme in the Tenth Plan

(in MH)

S. No.	Item	Progress till the End of March 2006	Anticipated Progress during 2006–07	Total Anticipated Progress for Tenth Plan
1	Field channels	1.671	0.373	2.044
2	Field drains	0.476	0.108	0.584
3	*Wara Bandi*	0.929	0.124	1.053
4	Land levelling*	0.050	–	0.050

Note: * This component was discontinued w.e.f. 1 April 2004.

TABLE 2.5
Physical and Financial Performance of MMI Sector during the Tenth Plan

Year	Physical (in MH)		Financial (in Rs Crore)	
	Potential Created	Potential Utilized	Revised Outlay	Expenditure
2002–03	0.812	0.532	13131.51	9655.68
2003–04	0.922	0.639	12334.79	11046.40
2004–05#	1.064	0.685	15483.05	15483.05
2005–06#	1.069	0.625	30263.83	30263.83
2006–07*	1.428	0.928		
Total	5.295	3.409	71213.18	66448.96

Note: # anticipated; * targeted.

39 ERM projects would be completed during the Tenth Plan. The reasons for non-completion of the projects from the projected level include inadequate funds due to thin spread of funds over many projects, revision in the estimated costs, change in scope of the works, unforeseen bottlenecks involving other agencies, opposition by the project-affected persons (PAPs), etc.

Spillover Projects into Eleventh Five Year Plan

2.23 In the course of analysing the status of ongoing projects likely to spill over, it is observed that a number of previously unreported projects have now been reported; some of the ongoing projects deferred while some of the projects have been interchanged among the classified heads of major, medium, and ERM projects. After accounting for the number of new projects taken up in the Tenth Plan, projects likely to be completed in the Tenth Plan, and other factors inducing changes in the number of projects, the number of spillover projects into the Eleventh Five Year Plan works out to be 477 including 166 major, 222 medium, and 89 ERM projects. The status is given in Table 2.6.

2.24 Projects of all three types have been under execution for many years, some from as far back as the Second Five Year Plan. Around 63% of the above 477 projects are unapproved by the Centre and are ineligible for central assistance.

TABLE 2.6
Spillover Major, Medium and ERM Projects into the Eleventh Plan

Plan of Start of Project	Major	Medium	ERM	Total
I	0	0	0	0
II	2	0	0	2
III	5	1	0	6
1966–69	2	0	0	2
IV	8	5	4	17
V	33	19	1	53
1978–80	2	9	3	14
VI	25	19	6	50
VII	10	13	11	34
1990–92	2	2	0	4
VIII	19	48	11	78
IX	20	40	17	77
X	38	66	36	140
Total	166	222	89	477

Major and Medium Projects in Drought-prone Areas and Tribal Areas

2.25 Projects in drought-prone areas and tribal areas are approved with a lower cut-off ratio of benefits to costs to reflect the higher weight given to benefits accruing to these areas. About one-third of the total geographical area of the country is recognized as drought-prone area. A total of 99 districts in 14 States are identified as drought prone. These districts have cultivable area of about 77 MH which is 42% of the country's total cultivable area of 184 MH. Among the States, Gujarat and Rajasthan are the most drought-prone States followed by Karnataka and Maharashtra. At the beginning of Eleventh Five Year Plan, of the 477 projects under implementation, 148 major and 195 medium projects envisaged benefits to drought-prone districts. Among these, 76 major and 102 medium projects benefit tribal areas as well.

Unapproved Projects

2.26 The schemes under the Plan sector require formal investment clearance from the Planning Commission before execution. Accordingly, major schemes are scrutinized for techno-economic feasibility, inter-state and international aspects, ecology and environmental aspects, and rehabilitation aspects by the concerned Central ministries. Recommendations of various expert agencies are then considered by the Advisory Committee of the MoWR. Thereafter the proposal is considered by the Planning Commission for investment clearance. In case of MMI projects the State Planning Boards are empowered to clear the proposals if inter-state issues are not involved. In spite of well-defined policy and guidelines in place, a large number of major and medium projects have been under execution without investment clearance from Planning Commission. The unapproved projects in the Tenth Plan comprising 90 major, 136 medium, and 74 ERM projects are likely to spill over into the Eleventh Five Year Plan. Expenditure likely to be incurred on these projects up to the Tenth Plan will be about Rs 41128 crore with the break-up as shown in Table 2.7.

Accelerated Irrigation Benefit Programme (AIBP)

2.27 The additional irrigation potential created in the country from the beginning of the Sixth Plan (i.e. 1980)

TABLE 2.7
Unapproved Major, Medium and ERM Projects

	Number of Unapproved Projects	Latest estimated cost (Rs in Crore)	Expenditure up to Tenth Plan (Rs in Crore)	Ultimate Potential (thousand hectare)	Potential created up to Tenth Plan (thousand hectare)
Major projects	90	100017.85	31004.66	5960.58	930.85
Medium projects	136	12947.09	5943.78	809.82	153.16
ERM	74	9095.30	4234.31	1177.07	135.10
Total	300	122060.24	41127.75	7947.47	1219.11

to the end of the annual rolling plan of 1992 for the period of 12 years was 24.48 MH, which is at the rate of 2.04 MH per annum. This rate of creation sharply came down to 1.03 MH per annum during the Eighth Plan. Responding to this sudden decline in the rate of creation of irrigation potential as well as allocation to the irrigation sector in the States Annual Plan, the Central Government initiated AIBP from the year 1996–97 under which Central assistance is being extended to large irrigation schemes for the early completion and accelerating creation of additional irrigation potential.

2.28 Under this programme all the projects which have the investment approval of the Planning Commission are eligible for assistance. The programme which was entirely a loan from the Centre in the beginning had been modified as per programmes of the Normal Central Assistance (NCA) with a grant and loan component (mixed) from 2004–05. Also reform measures such as revision of water rates to cover Operation and Maintenance (O&M) charges have been introduced but the results were not satisfactory because of the sluggish efforts of State Governments to comply with the reform measures. Moreover, the incentive to the State Government, that is 70% loan, was not attractive enough to carry out the reforms. In the year 2005–06, the GoI launched Bharat Nirman Programme where 10 MH of additional irrigational potential creation was targeted in a period of four years and to achieve this target, the AIBP guidelines were further modified in December 2006 wherein Central assistance has been kept in the form of 25% grant of project cost under AIBP for non-special category States and 90% grant of project cost for special category States and projects benefiting drought-prone and tribal areas. It was also decided to treat projects in the undivided Koraput, Bolangir, and Kalahandi (KBK) districts of Orissa at par with special category States.

Performance of AIBP

2.29 A total of 229 MMI projects have been included under AIBP, out of which, 91 have been reported completed by July 2007. The UIP of the AIBP-assisted major and medium projects/components is 82.76 lakh hectare. Out of this, the irrigation potential created up to March 2007 is 43.56 lakh hectare which is about 53% of the UIP of all AIBP projects. Up to March 2007, 6205 MI schemes were provided assistance under AIBP of which 4418 schemes have been completed. The UIP of MI schemes included in AIBP was 3.85 lakh hectare and potential of 1.87 lakh hectare has been created up to March 2007. The completion rate has been quite satisfactory in respect of AIBP-assisted MI schemes as these have low gestation periods.

2.30 However, the performance of MMI projects in terms of completion of the projects as well as the potential creation is not very satisfactory. The outlays under the AIBP have been continuously stepped up since 1996–97. Creation of irrigation potential in the country under major and medium sector received a fillip after commencement of AIBP. During the Eighth Plan period, irrigation potential of 22.10 lakh hectare was created in the country under major and medium sector at an annual rate of 4.4 lakh hectare per annum. During the Ninth Plan, when AIBP was in operation, irrigation potential created in the major and medium sector was 41.0 lakh hectare out of which 16.5 lakh hectare (nearly 40%) was through AIBP schemes. The highest creation of irrigation potential from the First Plan to the Eighth Plan is in the Fifth Plan and

TABLE 2.8
Performance of AIBP Projects

(Rs Crore/Thousand Hectare)

Year	Central Loan Assistance (CLA)/ Grant Released	Potential Created (Normal)	Potential Created (Fast Track#)	Total Potential Created under AIBP	Total Potential Created
1996–97	500.00	72.08		72.08	559.97
1997–98	952.19	200.02		200.02	645.18
1998–99	1119.18	257.41		257.41	592.15
1999–2000	1450.48	220.21		220.21	666.04
2000–01	1856.20	531.43		531.43	983.53
2001–02	2601.98	443.37	0.00	443.37	1214.59
2002–03	3061.70	272.43	182.93	455.36	812.00
2003–04	3128.50	357.20	89.83	447.03	1004.00
2004–05	2867.34	408.67	82.58	491.25	1000.00*
2005–06	1900.31	735.85	144.09	879.94	1500.00*
2006–07	2301.97				
Total	21739.85	3498.67	499.43	3998.10	

Note: # Projects which are to be completed in two agricultural season (one year) with higher Central assistance; * Tentative.

this is 40.28 lakh hectare. With the introduction of AIBP the same pace of additional irrigational potential could be restored in the Ninth Plan and subsequently in the Tenth Plan. The year-wise funds released and potential created are shown in Table 2.8.

Minor Irrigation (MI)

2.31 Over the period 1951–2007, irrigated area from major projects has increased to 3.47 times, from tanks 1.9 times, and from groundwater 6.3 times. Groundwater use has expanded as it provides control over irrigation to the farmer and its growth stimulated by spread of electrification and subsidized power. Even in the command area of major irrigation projects, farmers often use groundwater as a matter of routine to supplement canal water to maximize agricultural production.

2.32 The outlay provided for the Tenth Plan by the Planning Commission was Rs 13873 crore for a target of 6.8 MH. The outlay has been subsequently revised to Rs 14764 crore and during MTA the target was revised to 4.0 MH. However, it is now anticipated that the achievement may be around 3.5 MH, out of which 2.81 MH is anticipated through groundwater development. The performance during the first three years of the Tenth Plan and anticipatory performance for remaining two years is given in Table 2.9.

TABLE 2.9
Physical and Financial Performance of MI Sector during the Tenth Plan

Year	Physical (in MH)		Financial (in Rs Crore)	
	Potential Created	Potential Utilized	Revised Outlay	Expenditure
2002–03	0.687	0.548	1950.45	1639
2003–04	0.628	0.502	2634.63	1957
2004–05	0.740	0.592	2780.35	2780.35
2005–06#	0.545	0.440	7398.75	7398.75
2006–07*	0.918	0.734		
Total	3.518	2.816	14764.18	13775.1

Note: # anticipated; * targeted.

2.33 The broad reasons for low performance are mentioned below:

- Poor economic status of small and marginal farmers.
- Non-availability of assured power supply.
- Highly subsidized water rates in canal command, whereas, no provision of subsidy for development of groundwater.
- In hard rock areas, probability of obtaining groundwater resource is low.
- Over-extraction in critical areas which has caused depletion of water tables resulting in failure of wells.

2.34 The rapid development of groundwater has led to over-exploitation of groundwater in the country. In 15% of the blocks the annual extraction of groundwater exceeds annual recharge and in 4% of the blocks it is more than 90% of recharge. As the groundwater recedes wells have to be deepened and more energy has to be used to pump water. Figure 2.2 shows the status of groundwater use in the country. The map shows two challenges: first, how to restrain groundwater use to sustainable level in over-exploited regions and second, how to develop the large untapped ground water potential in eastern India.

2.35 Rural electrification through the RGGVY is being completed in Eastern Uttar Pradesh, Bihar, and West Bengal. In the Eleventh Plan the objective should be to bring large part of the cultivable area in these States under irrigation through electrified agricultural pump sets. This would be the key to the breakthrough in the agricultural production and food security. As this is a viable action plan would need to be drawn up by the States involving provision of (i) adequate power for irrigation, (ii) soft credit for farmers to install tubewells, and (iii) subsidized rates for grant of electricity connections. With the implementation of the tariff policy of differential pricing for peak and off-peak supply of electricity, it should be possible to have modest rates for supply of off-peak electricity to agriculture.

Minor Irrigation Surface Water Schemes

2.36 Surface water schemes based on tanks and ponds have developed slowly. Due to the success of the Government in providing canal irrigation and heavily subsidized electricity for use of ground water there has been neglect of local storage through village ponds, tanks, etc. Many of these have begun to disappear. This is partly due to village communities losing a sense of their own responsibility for managing water optimally. Restoration of water bodies has been taken up in 24 districts of 14 States, namely, Andhra Pradesh, Chhattisgarh, Gujarat, Himachal Pradesh, Jammu and Kashmir, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu, and West Bengal. In the Eleventh Five Year Plan 20000 water bodies are likely to be renovated and restored.

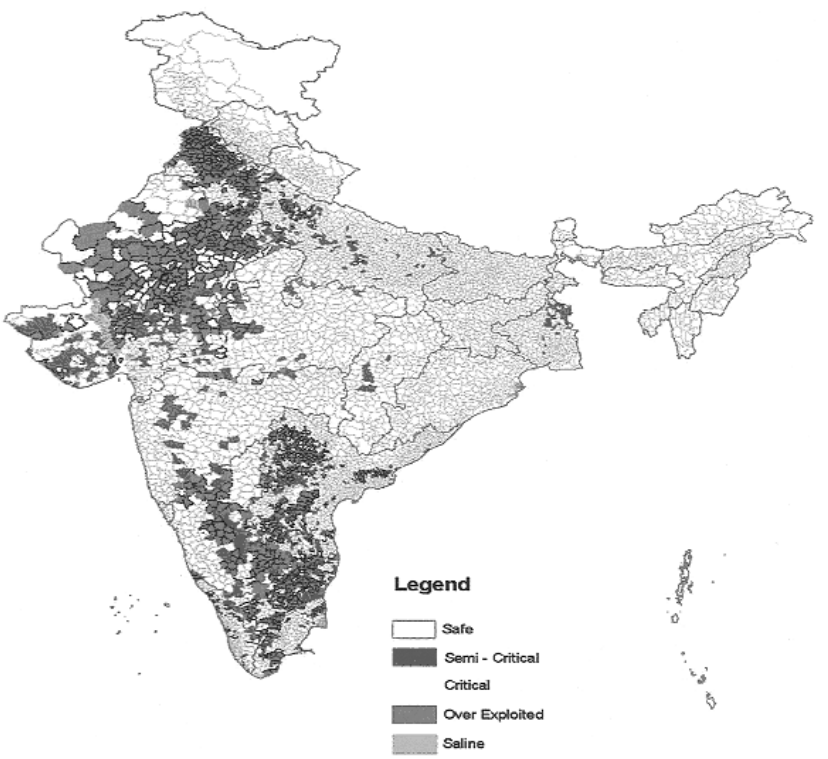

FIGURE 2.2: Categorization of Blocks/Mandals/Talukas as on March 2004

Flood Management

Physical Achievements

2.37 At the beginning of the Tenth Plan (2002), the area benefited or the area provided with a reasonable degree of protection was about 16.44 MH. The Planning Commission approved an outlay of Rs 4619 crore for State sector to protect 1.93 MH. The area likely to be protected as reported by the States in their respective annual plan documents is 1.78 MH. Thus, total area reasonably protected against flood by end of the Tenth Plan is likely to be 18.22 MH. The physical achievements per unit investment follow a reducing trend because of cost escalation and increased allocation for stabilization of existing works.

2.38 The year-wise outlays of the State and Central sectors for the Tenth Plan and the actual/anticipated expenditures are given in Table 2.10.

Flood Damages and Relief

2.39 During the first three years of the Tenth Plan, the flood damages as reported by the States and the relief fund released are given in Table 2.11.

2.40 The aforementioned relief funds also include assistance for cyclones and other such natural calamities. It would be seen from the above table that during the first three years of the Tenth Plan, the expenditure on relief was significantly high and the corresponding Plan outlays were inadequate. It is necessary that a more rational approach and optimum programme of works is adopted for flood management.

2.41 The preceding paragraphs describe the situation analyses of the irrigation sector in the country. As has been indicated at the beginning of the chapter, water scarcity and uncertainty in availability of water are important constraints that would need to be addressed in the Eleventh Five Year Plan. The strategy to be followed in the Eleventh Five Year Plan for this sector is described in the following section.

Eleventh Five Year Plan Strategy for Major, Medium, and Minor Irrigation

2.42 The GoI launched Bharat Nirman Programme in 2005–06. The irrigation component of the programme envisages creation of an additional 6.2 MH of irrigation potential. This target will be achieved through major, medium, and minor projects for surface water and ERM schemes. Owing to comparatively low allocation by the States for irrigation projects, intervention of the Centre for creation of irrigation potential will be required. AIBP is the only programme under MoWR to assist State Governments to achieve the targets set under the surface water component of irrigation programme of Bharat Nirman.

TABLE 2.10
Financial Performance in Flood Management during the Tenth Plan

(Rs Crore)

Year	Approved/Revised Outlay			Expenditure (Actual/Anticipated)		
	States	Centre	Total	States	Centre	Total
2002–03	624	151	775	698	86	785
2003–04	496	156	652	523	96	619
2004–05	669	184	853	644	100	744
2005–06	933	232	1165	830	181	1011
2006–07	1034	680	2520	1116	194	1310
Total	4562	1403	5965	3811	657	4468

TABLE 2.11
Flood Damage and Relief in the Tenth Plan

(Rs Crore)

Year	Flood Damage Reported	Recommended Calamity Relief Fund
2002–03	2575	1600
2003–04	4434	1587
2004–05	3337	1286

2.43 The Prime Minister has announced a rehabilitation package for agrarian distress districts of Andhra Pradesh, Karnataka, Kerala, and Maharashtra which includes early creation of irrigation facilities in these districts. The package includes 65 MMI projects to be completed through assistance to be provided under AIBP out of which 28 projects are already included under AIBP assistance. It has also been decided to provide assistance under AIBP to the projects providing irrigation facilities to drought-prone tribal areas as well as to States which are having irrigation development of their potential below national average.

Linkage of AIBP with Command Area Development

2.44 It has been observed that utilization of the created irrigation potential through AIBP is not up to the expected level. One of the reasons for non-utilization or low utilization of created irrigation potential is non-completion of CAD work in the area where irrigation facilities have been created. The CAD Programme should be integrated with the project implementation and upon completion of the project the water should reach to the farm gate instead of creating the irrigation potential which is not immediately utilized. It is also pertinent to mention that the cost of land development works should also be integrated with the project cost which may be funded under AIBP. The inclusion of CAD component with the cost of the project may affect the benefit–cost ratio of the project.

National Projects

2.45 For quite sometime many State Governments have been raising the issue of declaring some irrigation projects as 'National Projects'. The criteria for the selection of these projects, their mode of implementation and pattern of funding, etc. are yet to be finalized. However, it is obvious that the projects which are on international borders and the projects benefiting two or more States should figure as National Projects.

Monitoring of the Projects with Remote Sensing

2.46 During the end of the Tenth Plan, the Planning Commission insisted on monitoring of the project funded under AIBP through remote sensing. Accordingly a pilot scheme for monitoring Teesta and Upper Krishna projects through remote sensing has been taken up. The results of remote sensing have been matched with the ground realities and were found to the extent of 90% close to actuals. Accordingly the MoWR has assigned the job of monitoring of 53 projects covering the area of 5 MH for remote sensing monitoring.

Strategy

2.47 The following steps could be taken for major, medium, and minor irrigation sector for the Eleventh Five Year Plan.

Major and Medium Irrigation Projects

- Funds would be earmarked by the Planning Commission in the State plans so that the ongoing schemes under AIBP can be completed in time and cost over-run is avoided.
- Since the fund requirement for medium or minor irrigation projects are less, adequate funds may be made available for completion of these projects, without jeopardizing the programme for major projects. ERM projects should be given due priority where the eroded potential can be restored with moderate expenditure.
- Foremost priority should be given for completion of the ongoing projects.
- Ongoing projects which have already achieved 90% or more of the ultimate potential should be considered as completed. It is also neceesary to critically review all such projects which are having only marginal benefit left or are near impossible to complete because of various problems, and declare them completed or curtailed or deleted. The balance cost of the remaining projects should be updated realistically for consideration during the Eleventh Plan.
- Inter se priority should be decided considering various aspects such as externally aided projects, inter-state projects, projects benefiting drought-prone or tribal areas, etc. as per the guidelines prepared by National Commission for Integrated Water Resources Development Plan.
- High priority should be accorded to the Pre-Seventh and Seventh Plan Projects for funding under AIBP to complete these projects during the Eleventh Plan.
- Schemes should be given out on fixed cost time certain contract basis with incentive and penalty clause.
- Remote sensing satellite monitoring should be the

basis for the performance of the implementation and accordingly the next release of funds should be made.
- The CAD works and project execution should be in one package to ensure the availability of water upon completion of the project.
- The ERM projects are being funded under AIBP assistance and their funding should be linked with improvement in efficiency of the irrigation system and for this purpose minimum threshold target efficiency should be considered.
- To improve efficiency, irrigation projects should be benchmarked for performance evaluation by an independent expert group so that optimum use of water is realized. The AIBP assistance in the form of grant should be made according to the performance parameters.
- A separate budget head up to 15% of Plan fund may be provided as Irrigation Maintenance Fund (IMF) and full amount of irrigation revenue as collected should be credited to the IMF.
- In addition to the liabilities of completed projects and provision for ongoing and new projects, the State plan proposals should incorporate provisions for special repairs of existing irrigation systems, dam safety measures, improved water management, and water development aspect encompassing survey and investigation, R&D, training, and National Hydrology Project.
- System maintenance and revenue realization should be handed over to beneficiaries groups or Water Users Associations (WUAs).
- The existing regional and State-level institutions such as Water and Land Management Institutes should be strengthened and brought into mainstream activities for irrigation management improvement.
- Dam safety measures should be taken up systematically for Disaster Prevention and Management. 5% of plan fund may be allocated for undertaking dam safety activities to ensure that dams in distress get special and timely attention.
- The performance evaluation of completed projects needs to be continued for benchmarking and improvement in irrigation efficiency.
- New projects should be undertaken only after confirming that adequate funds for ongoing programmes are available, in the State plan as well as the availability of Central assistance by the Planning Commission.
- Introduce the concept of National Projects.
- Review the requirements and process of environmental clearance.

Minor Irrigation Sector

- Renovation and restoration of old tanks as well as old diversion channels in hilly regions may be given high priority.
- Micro irrigation system in water deficit areas should be promoted.
- Groundwater development in areas having untapped and unutilized potential, particularly in the Eastern Region should be promoted through a time-bound programme.
- A comprehensive strategy as recommended by the expert group for regulation of groundwater development and use on sustainable basis should be implemented.

Groundwater Exploitation and Governance for Preventing Over-exploitation of Groundwater

2.48 The two concerns about groundwater are over-exploitation in parts of the country and under-utilization in large parts of the country. The region-wise potential is as follows.

- Alluvial areas of the east and north east regions (NER) (particularly Assam, Bihar, West Bengal, and Uttar Pradesh) with low stage of groundwater development have an additional potential of around 2.7 MH from the unconfined aquifers.
- Hard rock areas of peninsular India have an additional potential of around 0.8 MH by judicious and scientific development of groundwater in Andhra Pradesh, Chhattisgarh, Jharkhand, Kerala, Maharashtra, Orissa, Tamil Nadu, and parts of Madhya Pradesh.
- Hilly areas of the north and the NER have a marginal additional potential of around 0.04 MH in Arunachal Pradesh, Himachal Pradesh, Jammu and Kashmir, Manipur, Tripura, and Uttaranchal.
- Deeper confined aquifers in the alluvial plains of Uttar Pradesh, Haryana, and Punjab have an

additional potential of 1.0 MH by tapping deeper confined aquifers. However, there is need to undertake detailed studies to establish the 'Safe Yield' from such aquifers to avoid any adverse environmental impacts.

2.49 Sustainable groundwater development and management need to be taken up by incorporating studies on artificial recharge to groundwater and rainwater harvesting, management of salinity ingress in coastal regions, sustainable management in areas with high levels of groundwater development, conjunctive use of surface water and groundwater, and regulation of groundwater development. There are number of groundwater extraction structures in the country which are very old, have outlived their working life, and are not functional. These structures, in reality, do not contribute to irrigation potential. Such structures need replacement for restoration of old/already created potential. As suggested by NABARD, replacement may be planned at 0.5 MH during the Eleventh Five Year Plan in only safe and semi-critical blocks/units.

2.50 MI and groundwater development provide plenty of scope for employment of unskilled labour forces. It is, therefore, very important to link National Rural Employment Guarantee Programme (NREGP) with MI and groundwater development.

2.51 The UIP through ground- water resources has been assessed to be about 64 MH in the country, out of which 46.03 MH has been created upto the end of the Tenth Plan. Since groundwater is an open access resource and everyone is entitled to pump water below his own land, it is over-exploited in a number of blocks in the country and the water table is going down. This increases the cost of irrigation and farmers are required to periodically deepen their wells.

2.52 In order to address the issues of sustainable use of groundwater and the question of ownership of the groundwater, the Planning Commission has set up an expert group on 'GroundWater Management and Ownership' chaired by Member (Water and Energy) Kirit S. Parikh. The group recommended that the ownership of the groundwater below the land will continue to remain with the owner of the land as per the Easement Act 1882 as long as the exploitation of groundwater is not causing depletion in the ground water levels so the similar rights of the adjoining landowners and public at large are not encroached upon. Centre's intervention would be required when the groundwater level falls below the replenishable level. In such events, the affected area will be declared as an area under threat and any exploitation will be regulated. The Central Ground Water Authority, under the provisions of Environment Act 1986, is empowered to make such declarations and it would be the responsibility of the State Government to ensure that the exploitation in the area is regulated.

2.53 The group has noted that the experiences at national and international levels have shown that a command and control mechanism has not yielded good results in protecting the groundwater resources from over-exploitation. The regulation/reduction/restriction on the groundwater usage can be made effective by the State Government only with the co-operation of user groups and community participation involving PRIs. The user groups will be responsible for regulating the ground water usage among various sectors, that is irrigation, drinking, and industrial. Such regulations by the user group can be made effective only if the State/Central Ground Water Board (CGWB) monitors and provides information on safely extractable water on the basis of water table levels recorded scientifically.

AUGMENTING UTILIZABLE WATER

2.54 Usable water availability can be increased by tapping water that otherwise would have run-off to the sea. Water storage above ground through dams and diversion through weirs are the conventional means. However, water can also be stored underground by enhancing percolation through artificial recharge. Rain water harvesting in many small ponds through construction of bunds can also add to water availability. Inter-basin transfer of water through inter-linking of rivers can substantially expand availability.

Artificial Recharge and Rain Water Harvesting

2.55 The groundwater levels are declining in many parts of the country. Artificial recharge of groundwater

with rainwater is an important strategy to arrest this trend. The CGWB has already prepared a master plan to recharge 36 bcm of rainwater into groundwater at a cost of Rs 24500 crore. Except for pilot projects in the Eighth and Ninth Plans, no serious effort has been made to implement this on a mission mode. In urban areas, many cities have by-laws making rainwater harvesting compulsory for new buildings. However in rural areas there is no such programme.

2.56 Local storage is cost effective. There is significant potential for increasing the overall utilizable water through rainwater harvesting, construction of check dams, watershed management, and restoration of traditional water bodies as well as creation of new ones. In areas where groundwater is under severe stress, artificial recharging would need to be undertaken with proper technical support. Resources under the NREGP, BRGF, etc. are available for this purpose. The multilateral agencies such as World Bank and Asian Development Bank (ADB) have also been requested to provide financing for this purpose. Alternatively, a cess on the bottled water (since many negative externalities are associated with it like generation of plastic waste, their improper disposal, etc.) can be levied and funds from such levy could be used for revival of traditional water bodies or for recharging ground water with community participation. The challenge is to motivate the local communities to undertake this work on priority basis and to build their capacity for this purpose. Technical support systems for developing an optimal water management master plan for a micro watershed/ hydrological unit need to be created. Groundwater mapping, GIS mapping, satellite imagery, etc. need to be utilized for assisting the village community in preparing water resource development and management of master plans. With broadband connectivity expected to reach all over rural India in the Eleventh Plan this is feasible. It does however pose a difficult challenge in creating the institutional systems and delivery mechanisms for providing technical back-up support to the village community for preparing water management master plans.

2.57 The flood plains in the vicinity of rivers can be good repositories of groundwater. A planned management of groundwater in the flood plain aquifers offers an excellent scope of its development to meet the additional requirements of water. The development of groundwater in the Yamuna flood plain area in Delhi is an example of scientific management of water resources. During rainy season, the flood water spreads over the plains but due to very shallow water table the recharge is small and the rejected recharge result in river out flows. CGWB constructed 95 tubewells in Palla Sector in the depth range of 38–50 m for Delhi Jal Board. The total pumpage during the pre-monsoon period of 2002 was 40 million gallons per day which created a regional drawdown of about 5 m in the flood plain area. It was observed that immediately after rainy season, the depleted aquifer fully recouped. Thus over-development of shallow aquifers in flood plains creates the necessary subsurface space for augmentation of groundwater from the river flows during the monsoon. Induced recharge is an effective management tool to meet the gap of demand and supply in areas adjacent to rivers with active flood plains.

Inter-basin Transfers through Inter-linking of Rivers

2.58 The inter-linking of rivers and the transfer of surplus water, especially in the monsoon period from the surplus basins to the deficient basins has been championed by many experts over time. The task force on the inter-linking of rivers has drawn up a set of project proposals. The total amount of water that can be usefully transferred is estimated to be about 220 bcm. However, there are apprehensions that the assessed surplus is somewhat illusory for many basins and future generations would actually need all the water. Sceptics have reservations about the economic viability of such large projects. Environmental concerns would need to be addressed through the environmental appraisal process of each project. For these reasons the pace of progress in the Tenth Plan period has been quite modest and is summarized in Table 2.12.

2.59 The availability of water in the country has vast variation both in time and space. The bulk of the rainfall is concentrated in the monsoon months June to September. While 51.12 MH is affected by droughts, mainly in peninsular India, 40 MH is affected by floods mainly in Bihar and Assam. The per capita availability of water is 1820 m^3 which is above the water

TABLE 2.12
Progress of Inter-linking of Rivers

S. No.	Item of Work	Progress Made So Far
1	Preparation of feasibility reports (FRs) by National Water Development Agency (NWDA)	NWDA has already prepared 16 FRs (14 under Peninsular Component, 2 under Himalayan Component). Draft FR of 4 links under Himalayan Component in advance stage of completion and remaining are in progress.
2	Inter-linking of rivers is to be pursued continuously with a focus on peninsular component	The MoWR is laying special emphasis on undertaking the works of the peninsular components on priority and accordingly NWDA is working on this component.
3	Priority links Ken–Betwa	(i) After signing of MOU by concerned states of UP and MP for preparation of DPR for Ken–Betwa link on 25 August 2005, work started by NWDA.
	Parbati–Kalisindh–Chambal	(ii) Concerned States of MP and Rajasthan are discussing bilaterally to sort out differences for MOU of Parbati–Kalisindh–Chambal link.
4	Identification of another priority link	NWDA has identified three more links in Peninsular Component namely Damanganga–Pinjal and Par–Tapi–Narmada and Polavaram–Vijayawada link as priority links.

stress condition threshold value of 1700 m^3. However the per capita availability varies from 18417 m^3 in the Brahmaputra river to 380 m^3 in some east-flowing rivers in Tamil Nadu showing that many basins in the country are already critically starved of water. Out of the annual precipitation and snowfall of 4000 bcm, 747 bcm runs waste to the sea, mainly from the Ganga and Brahmaputra rivers systems, which have 60% of the water potential. Only 19% of the water potential is available in Mahanadi, Godavari, Krishna and Cauvery.

2.60 In the above backdrop, inter-linking of rivers assumes importance as a part of the 747 bcm running waste to sea (about 160–220 bcm) is proposed to be transferred through a series of 30 inter-linking proposals from surplus basins to deficit basins. Long-distance, trans-basin transfer of water is not a new concept. Many examples of existing projects can be given in this regard—Western Yamuna canal, Periyar project, Kurnool Cuddapah canal, Indira Gandhi canal, and Sardar Sarovar canal. International examples can be given of California water transfer project from north to central and southern parts of the US, China, the erstwhile USSR, Sri Lanka, and Mexico. Pioneering work was earlier done on a National Water Grid by K.L. Rao and Capt. Dastur. These were refined by the MoWR and 30 links identified—16 as peninsular component and 14 as Himalayan component. Prefeasibility studies of 16 links (14 in peninsular component) have also been completed.

2.61 Before detailed project reports (DPR) are taken up, consensus among States is required so that implementation can smoothly begin after the DPRs are appraised. Five links have already been identified for DPR preparation and dialogue with concerned States initiated by MoWR. Co-operation of States is thus a sine qua non for success of the inter-link projects. The National Common Minimum Programme (NCMP) also stresses for a consultative approach to the project. One could even think of monetary compensation to the donor States in the form of a royalty as is being done for other natural resources such as coal and oil.

2.62 Since water will be transferred at a great cost, the economics of the proposal will need a careful evaluation taking into consideration not only primary benefits but also secondary and tertiary benefits. The environmental impacts of such a large-scale transfer will also need a very careful study and integration into the economic evaluation. Stress needs to be laid on promotion of drip and sprinkler irrigation and horticulture crops from the point of view of water saving and optimum returns. The funding will have to come

from a mix of budgetary support, market borrowings, and external assistance. For the implementation of such a mega project, an authority may have to be set up akin to the National Highways Authority of India (NHAI) with full autonomy for raising loan, approvals, etc. The maintenance of the created assets will have to be properly done with required revenues generated from the project.

2.63 Inter-linking of rivers is a challenging project and is essential for meeting the looming water crisis in future. The syndrome of drought and floods is hampering the required growth in agriculture and inter-linking of rivers offers an effective solution to the problem. In the Eleventh Plan the inter-basin transfer of water needs to be pursued more vigorously. Where a consensus emerges regarding the prima facie feasibility of specific projects their DPR preparation, environmental appraisal and decision on investment as well as execution modalities need to be completed in a time-bound manner. The execution of some projects should commence in the Eleventh Plan period.

IMPROVING WATER USE EFFICIENCY

2.64 For a gross irrigated area of about 87 MH, the water use is 541 bcm which gives a delta of 0.68 m per ha of gross irrigated area. The average annual rainfall is 1170 mm (1.17 m). Taking 70% of the rainfall as effective for crop consumptive use, the gross water use is about 1.45 m (4.8 feet) per ha of the gross irrigated area. This is very high as compared to water use in irrigation systems in say the US where water allocation is about 3 feet. This overuse in the country reflects a low irrigation efficiency of about 25% to 35% in most irrigation systems, with efficiency of 40% to 45% in a few exceptional cases. A basin-wise study conducted by A. Vaidyanathan and K. Sivasubramaniam of the Madras Institute of Development Studies (MIDS) using potential evapotranspiration data and gross water withdrawals reports the overall irrigation efficiency in the country as 38%. The study reveals that the Krishna, Godavari, Cauvery, and Mahanadi systems have a very low efficiency of around 27% while the Indus and Ganga systems are doing better with efficiencies in the range of 43%–47%. This is understandable as the peninsular rivers have large areas under irrigation in delta areas, where the water management practices are poor, while the rotational water supply (wara bandi) is practised in the Indus and Ganga systems. However, this is only a macro-level study. Project-level data available on irrigation efficiency unfortunately is minimal. It needs to be appreciated that 55% of the area irrigated is by groundwater sources where the efficiencies are quite high (70%–80%) in view of absence of long conveyance systems. Consequently the efficiencies in surface irrigation systems must be much lower than the average figure of 38%.

REASONS FOR LOW IRRIGATION EFFICIENCY

2.65 The reasons that contribute to low irrigation efficiency can be identified as follows:

- Completion of dam/head works ahead of canals.
- Dilapidated irrigation systems.
- Unlined canal systems with excessive seepage.
- Lack of field channels.
- Lack of canal communication network.
- Lack of field drainage.
- Improper field levelling.
- Absence of volumetric supply.
- Inadequate extension services.
- Low rate for water.

2.66 The equitable and optimal use of water from canal irrigation has been a matter of continuing concern. The traditional approach of pursuing these objectives through the field-level functionaries of irrigation department had its limitations. The participation of actual beneficiaries through PIM and the maintenance of village-level distribution channels through WUAs have been found useful. There is broad consensus that this has been a step in the right direction. This needs to be pursued more vigorously with genuine empowerment of WUAs. The objective should be to cover the entire command of all major and medium projects with WUAs by the end of the Eleventh Plan. The experience across States has been uneven. It is reported that 55501 users associations has been created and their State-wise position is indicated in Table 2.13.

ON-FARM WATER MANAGEMENT

2.67 On-farm water management covers a gamut of areas such as field channels, field drains, land levelling,

TABLE 2.13
State-wise Number of WUAs Formed and Irrigated Area Covered

S. No.	Name of State	Number of WUAs Formed	Area Covered (Thousand Hectare)
1	Andhra Pradesh	10790	4800.00
2	Arunachal Pradesh	2	1.47
3	Assam	37	24.09
4	Bihar	37	105.80
5	Chhattisgarh	945	NA
6	Goa	42	5.00
7	Gujarat	576	96.68
8	Haryana	2800	200.00
9	Himachal Pradesh	875	35.00
10	Jammu and Kashmir	1	1.00
11	Karnataka	2279	1052.41
12	Kerala	3930	148.48
13	Madhya Pradesh	1470	1501.45
14	Maharashtra	1299	444.00
15	Manipur	62	49.27
16	Meghalaya	99	NA
17	Nagaland	25	NA
18	Orissa	11020	907.00
19	Punjab	957	116.95
20	Rajasthan	506	219.65
21	Tamil Nadu	7725	474.28
22	Uttar Pradesh	24	10.55
23	West Bengal	10000	37.00
	Total	55501	10230.08 (say, 10.23 MH)

and irrigation scheduling with the objective of reducing field application losses. The works below the outlet are traditionally taken as CAD works and are not included as a part of the scope of the irrigation project which stops at the outlet. Out of an investment of Rs148000 crore in major, medium, and minor irrigation till the Ninth Plan, the investment in CAD works has been only Rs 6800 crore or 4.6%. This low outlay is an important contributory factor to poor on-farm water management, viz. low application efficiency and shortage in supplies to tail-enders. Since stepping up of CAD allocations by the States will be difficult, one measure that could be taken is to include all CAD works as a part of the project itself so that infrastructure required for irrigation water to reach every field is implemented alongwith the dam. This, together with conjunctive use, will no doubt hike project cost but since compartmentalized approach has not succeeded, an integrated approach will have to be seriously considered. There is an option to dovetail these works with the rural development programmes such as NREGP, BRGF, district plan, etc.

MICRO IRRIGATION

2.68 Micro irrigation, comprising drip and sprinkler, has emerged as a tool for effective management of resources which save water, fertilizer as well as electricity and distribute water evenly unlike other irrigation systems. Drip irrigation is ideally suited for horticulture crops such as pomegranate, grapes, mango, banana, guava, coconut, *amla*, and cash crops such as sugarcane. Drip irrigation saves 25%–60% water and upto 60% increase in yield can be obtained. Sprinklers are useful in undulating land with cereals crops and save 25%–33% of water. Out of the 69 MH net irrigated area in the country, only 0.5 MH under drip and 0.7 MH under sprinkler has been achieved. Maharashtra has 46% of the area under drip in the country. Karnataka, Tamil Nadu, and Andhra Pradesh follow with percentage area of 21%, 14%, and 12%, respectively. Drip irrigation methods range from simple bucket kit systems for small farms to automated systems linking release of water to soil moisture conditions measured continuously by tensiometers.

2.69 It is suggested that while sanctioning new irrigation projects, it would be made obligatory for project authorities to implement micro irrigation in at least 10% of the command area. The various suggestions of the Task Force on Micro Irrigation also need to be taken note of as micro irrigation has the potential to transform Indian agriculture.

RURAL AND URBAN DRINKING WATER AND SANITATION

2.70 These issues and programmes are discussed in Volume II, Chapter 5, 'Drinking Water, Sanitation, and Clean Living Conditions'.

MEETING INDUSTRIAL WATER DEMAND

2.71 Industrial demand for water is growing. Also disposal of waste water from industries without appropriate treatment pollutes water bodies, underground aquifers, and soils. In addition long-term land use planning for urbanization and industrialization is now a necessity and provision of water on a sustain-

able long-term basis should be a key factor in such planning exercises. In the absence of such planning demand for water emerges in areas where the provision of water requires enormous investments in carriage systems over long distances or even treatment of sea water. With proper long-term planning in terms of location of special economic zones (SEZs), industrial parks, and townships it should be possible to optimize costs of industrial development. For meeting the water needs of industry the approach discussed next appears appropriate.

2.72 New industries should ideally be located only in planned industrial areas, industrial parks, townships on industrial/zones identified in township Master Plans. They should be provided water by the local authorities who should charge prescribed rates on a volumetric basis. These rates should fully cover:

- the cost of supply.
- a premium to reflect the scarcity value of water in areas where there is water shortage.
- the cost of treatment to enable the discharge to go back into the water system through drainage into irrigation canals, rivers, lakes, etc.

2.73 Where groundwater is the source of supply and is under stress, the cost of supply should include the cost of recharge wherever such recharge is required and the recharge component should be credited to a dedicated Recharge Fund (RF) so that its utilization is suitably monitored. For new and existing industries which would use groundwater on their own there should be a system of IT-based volumetric metering of actual extraction by water-intensive industries in those areas where ground water levels have become critical. For these areas, there should be prescribed rates for ground water use by industry in a particular hydrological unit. The option of recycling the water and using it for secondary needs, that is other than drinking, should be a strategy for the Eleventh Plan.

FLOOD MANAGEMENT

2.74 Every year some part or other of the country gets flooded. A multi-pronged approach consisting of measures of prevention, protection, management, forecasting, and early warning are needed.

Prevention and Protection

2.75 Floods can be prevented or significantly moderated by watershed management of the catchment area of rivers. Agriculture, which is the nodal ministry for the watershed management works, should work out a detailed programme in consultation with the MoWR. For international rivers originating in Nepal and Bhutan, a joint mechanism for watershed management needs to be evolved. Another way is to preserve and augment flood cushions like natural swamps and lakes which can be developed into detention basins. Also, capacity of existing depressions can be improved for absorbing flood waters. Special drives for development of Tal and Diara areas are needed. Construction of dams and reservoir schemes with adequate flood cushion provide long-term solution of flood problems. Efforts should also be made for utilizing the existing reservoirs in the country for flood moderation to the extent possible. Even in reservoirs constructed for power or other purposes, the rule curves may be framed in such way that effective flood moderation is achieved. Rule curves guide the operation of a reservoir and ensure that a desired level of storage cushion is maintained to absorb floods of specified probability. Raising and strengthening of the existing embankments, if required after detailed studies of hydrological, morphological, topographical, and developmental aspects, provide some protection.

2.76 Watershed management in the hilly catchments of the rivers originating in Nepal, Bhutan, and hilly areas of India should be selectively chosen and fully funded. Implementation should be done through a joint mechanism.

2.77 The ideal solution for flood control is the creation of adequate storages in flood prone river systems. The Damodar Valley Corporation (DVC) is the best example of a series of storage projects which have made floods in the Damodar river basin a matter of history. The Ganga–Brahmaputra–Barak basins are our most flood-prone basins. There is clearly a need to build storage reservoirs in the northern tributaries of the Ganga and in the Brahmputra and its tributaries in the NER. These storage projects need to be investigated designed and executed expeditiously.

For the northern tributaries of the Ganga, co-operation with Nepal would be required. Negotiations would need to be pursued with vision and constructive pragmatism.

2.78 The strategy of flood control through embankments has been pursued by the States over the years. A holistic view of an entire tributary or a large stretch of a tributary needs to be taken. Wherever feasible a one time decisive investment for a flood protection project should be made. The recommendations of expert groups and contemporary international experience in other rivers in Asia with monsoon climate need to be looked into.

Managing Floods

2.79 Construction at appropriate location of spilling sections/sluices in the flood embankment for the controlled flooding of the protected areas for restoring fertility, recharge of soil moisture and groundwater can be useful. Drainage sluices should be integral part of embankments to prevent water-logging in the protected areas. Flood management schemes should be integrated with other infrastructural development programmes in the sectors of roads, railways, inland waterways, and canal/command area development works. Drainage improvement in critical areas in the country should be given priority. Also dredging at selective locations, that is outfalls, etc. in the rivers and the tributaries, helps reduce flood levels in low-lying areas and also helps in quick drainage. Erosion of land by rivers should be minimized through suitable cost effective measures. The Centre should continue to assist the States in the Ganga and Brahmaputra Valleys through Plan Funds to counter land erosion by river action. In order to give adequate emphasis on the O&M of the flood protection measures already created, a percentage of outlay of the flood sector should be earmarked for this purpose. R&D activities for improved flood management need to be encouraged.

2.80 To the extent groundwater is intensively utilized for irrigation for multiple cropping in north Bihar and Bengal and local water bodies are restored, the capacity for recharge of groundwater in the monsoon period would increase and flooding would get mitigated partially. In other parts of India flash floods would get minimized if local drainage and restoration/creation of local water bodies was done with watershed planning under NREGP, BRGF, etc.

Forecasting and Early Warning

2.81 Development of digital elevation model of flood-prone areas for taking up schemes for inundation forecast, preparation of flood risk maps, planning of flood management schemes, etc. should be taken up. Steps should be taken to ensure implementation of Action Plan prepared by National Disaster Management Authority (NDMA) for flood management.

SUSTAINABILITY

2.82 Two major challenges are being faced in ensuring sustainability of water, that is quality and quantity, to meet the needs. Groundwater use has to be restricted to average recharge and quality of water has to be improved and should be protected from biological and chemical contamination. Sustainable use of groundwater has been already discussed.

Preserving Water Quality

2.83 The threats to water quality are from untreated industrial effluents and municipal wastes from habitations, pollution from open defecation, and run-off from farms containing fertilizers and pesticides. Upscaling total sanitation campaign (TSC) programme for rural sanitation (see Volume II, Chapter 5), strict enforcement of industrial effluent standards, and treatment of all municipal wastes are needed. At the same time farming practices have to be adjusted to use as little chemical fertilizers and pesticides and apply them in ways that minimize residues in run-off water, which is a waste for the farmer, are called for.

CONVERGENCE

2.84 The subject of water is presently being dealt at the Centre by a number of Ministries/Departments. The linkages of water with other sectors are many. Water availability and quality impact on social, human development and economic activities. Effective coordination among different ministries and convergence of programmes is essential. Suitable institutional arrangements would be made in the Eleventh Plan in this regard.

FINANCING THE ELEVENTH PLAN

2.85 The total projected GBS for the Eleventh Plan for MoWR is Rs 2870 crore (2006–07 price) and Rs 3246 crore (current price). As per the constitution, irrigation is a State subject; hence, the substantial investment will be contributed by the State Governments in this sector. The details of the recommended outlays for the Eleventh Five Year Plan and physical targets are indicated in Tables 2.14 and 2.15.

TABLE 2.14
The Overall Outlay for the Eleventh Five Year Plan

(Rs Crore)

State plan	182050
State sector schemes, i.e. AIBP and others	47015
Central plan	3246
Total	232311

2.86 The following five core programmes of MoWR have been identified as important:

- River management activities and works related to border rivers.
- CAD and water management.
- AIBP.
- Repair renovation and restoration of water bodies.
- Flood management programmes other than border rivers.

2.87 In recognition of the fact that the actual requirements of the water resources sector, in general, and above schemes, in particular, could exceed the provisions made in the plan document, the size of the actual yearly allocations may exceed the pro rata allocation during AP discussion and the issue of an overall increase could be revisited at the time of MTA.

EMPLOYMENT GENERATION

2.88 When irrigated area increases it generates additional employment year after year. Water resources projects, particularly irrigation development and flood control works, generate significant employment opportunities during construction period as well as in the post-project phase. The overall employment potential likely to be generated in the Eleventh Five Year Plan in irrigation sector is as per Table 2.16 below.

TABLE 2.15
Physical Target

No. of Projects included in Eleventh Plan	Major	Medium	ERM
(i) Completion of Projects			
Tenth Plan projects spilling into Eleventh Plan	166	222	89
New projects of Eleventh Plan	78	145	86
Total	244	367	75
Projects likely to be completed in Eleventh Plan	72	133	132
(ii) Creation of Potential (in MH)			
MMI sector	9.00		
MI sector	7.00		
Surface water	1.50		
Ground water	4.50		
Restoration of water bodies and ERM	1.00		
(iii) Physical Targets for CADWM (in MH)			
Development of CCA	3.5		
Correction of conveyance deficiency	6.25		
Reclamation of water logged, saline, and alkaline lands	0.5		
(iv) Physical Target under Flood Control Works (MH)			
Area to be benefited against flood: 2.18 MH			

TABLE 2.16
Overall Employment Potential

(Million Person Years)

	Direct Employment	Indirect Employment
MMI	2.1	10.1
MI	5	1.05
Flood Control	2.5	–
Total	9.6	11.15

THE WAY FORWARD

2.89 The measures suggested for the Eleventh Plan address the whole range of issues concerning water management and irrigation. The long gestation period in building irrigation infrastructure and thin spread of resources are the main reasons for delay in completion of a number of ongoing projects. During the Eleventh Plan a total of 477 projects including 166 major, 222 minimum, and 89 ERM projects are likely to spill-over. The spill-over cost of these projects during the Eleventh Plan is estimated to be about Rs 133746 crore. There is a need for reducing the gestation period and making available the benefits of irrigation to the users by way of integrating CAD programme with the projects. The projects should be implemented on a construction schedule not more than four to five years. The land acquisition and R&R works should be taken simultaneously with the project formulation. Irrigation efficiency in the systems needs to be upgraded from the present level of 35% to about 60% in case of surface water system and from about 65% to 75% in groundwater system. The efforts of the other departments such as Rural Development and Agriculture, etc. should be converged and an integrated approach for water resources development and conservation should be adopted. The various schemes of MoRD for rain water harvesting, watershed development, and NREG Act should be implemented in consultation with MoWR and Department of Drinking Water Supply (DoDWS). There is a need for (PPP) in development of water resource projects as this issue has already been addressed by NWP, 2002. The modern scientific development of water resources conservation, transfer, and application to the field is needed to be applied in the irrigation command. In flood management, the recurrence interval of the floods should be the guiding factor for taking up flood control measures. The flood control measures should not be taken in isolation but it should be based on master plan approach in an integrated manner. The sustainability of ground water is one of the core areas which require attention for meeting irrigation and drinking water requirements. Use of ground water should be limited and linked with the quantum of water being recharged. The issue of monitoring ground water levels through scientific methods such as Piezo meters, etc. should be left to the group of beneficiaries with proper technical support from the Central Government and the State Governments.

ANNEXURE 2.1
Plan-wise Cumulative Potential Created and Utilized

(In MH)

Plan	Potential Created					Potential Utilized				
	Major and Medium	SW	Minor GW	Total	Total	Major & Medium	SW	Minor GW	Total	Total
Upto 1951 (Pre-Plan)	9.7	6.4	6.5	12.9	22.6	9.7	6.4	6.5	12.9	22.6
First Plan 1951–56	12.2	6.43	7.63	14.06	26.26	10.98	6.43	7.63	14.06	25.04
Second Plan 1956–61	14.33	6.45	8.3	14.75	29.08	13.05	6.45	8.3	14.75	27.8
Third Plan 1961–66	16.57	6.48	10.52	17	33.57	15.17	6.48	10.52	17	32.17
Annual Plan 1966–69	18.1	6.5	12.5	19	37.1	16.75	6.5	12.5	19	35.75
Fourth Plan 1969–74	20.7	7	16.5	23.5	44.2	18.39	7	16.5	23.5	41.89
Fifth Plan 1974–78	24.72	7.5	19.8	27.3	52.02	21.16	7.5	19.8	27.3	48.46
Annual Plan 1978–80	26.61	8	22	30	56.61	22.64	8	22	30	52.64
Sixth Plan 1980–85	27.7	9.7	27.82	37.52	65.22	23.57	9.01	26.24	35.25	58.82
Seventh Plan 1985–90	29.92	10.9	35.62	46.52	76.44	25.47	9.97	33.15	43.12	68.59
Annual Plan 1990–92	30.74	11.46	38.89	50.35	81.09	26.31	10.29	36.25	46.54	72.85
Eighth Plan 1992–97	32.95	12.51	40.8	53.31	86.26	28.44	11.07	37.7	48.77	77.21
Ninth Plan 1997–2002	37.05	13.6	43.3	56.9	93.95	31.01	11.44	38.55	49.99	81
Tenth Plan 2002–2007	42.35	14.31	46.11	60.42	102.8	34.42	12	40.81	52.81	87.23