21

Water Resources

21.1 The Eleventh Plan recognized the special challenges of water resources management facing India and the likelihood that these would only intensify over time due to rising population, expected growth in agricultural and industrial demand, the danger of pollution of water bodies and, over the longer term, the effect of climate stress on water availability in many parts of the country. On reviewing these issues in the course of the Mid Term Appraisal (MTA), problems in this area appear even more serious than originally assessed and solutions are almost certainly more difficult.

21.2 The central message emerging from the MTA is that we cannot expect to find a solution unless we can come out of the silos into which we have divided water and take a holistic view of the hydrologic cycle. For example, responsibility for ensuring adequate availability of water for agricultural use is divided between the Ministry of Water Resources (MoWR), which is responsible for major, medium, and minor irrigation, the Department of Land Resources, which is responsible for watershed management, the Department of Rural Development, which is responsible for the Mahatma Gandhi Rural Employment Guarantee Act (MGNREGA) that is strongly oriented to deal with water conservation issues, and the Department of Agriculture, which deals with water use efficiency. Similarly, rural drinking water is dealt with by the Department of Drinking Water Supply (DDWS) within the Ministry of Rural Development (MoRD), but rural drinking water overwhelmingly relies on groundwater and the sustainability of this source depends crucially on interventions by other players and schemes that lie outside DDWS's purview. As India urbanizes, issues of urban and industrial water supply will gain in importance and demand action by the Ministry of Urban Development (MoUD). Ideally, this should be in close coordination with rural-centred schemes for very often they are both tapping the same source of supply. These examples can be multiplied. They all illustrate a common point that we cannot continue to compartmentalize the different uses to which water is put, as these are competing for the same unitary resource.

21.3 This chapter briefly recounts the major features of the water problem facing the country followed by a review of the performance of the major schemes dealing with water in the Eleventh Plan. We then present an outline of the alternative approach that is necessary, which will have to be elaborated into an operational strategy to be implemented in the Twelfth Plan.

INDIA'S WATER RESOURCE PROBLEM

21.4 Estimates of India's water budget, i.e., annual flow of water available for human use after allowing for evapo-transpiration and minimum required ecological flow, vary considerably. The water budget derived from MoWR estimates, which are summarized in the first column in Table 21.1 show utilizable water of 1,123 billion cubic metres (BCM) against current water use of 634 BCM suggesting more than adequate availability at the aggregate level given current requirements. This is based on the Central Water Commission's estimates of India's water resource potential as 1,869 BCM. The standing sub-committee of MoWR estimates total water demand rising to 1,093 BCM in 2025, thus reaffirming a comfortable scenario.

21.5 More recent calculations based on higher estimates of the amount of water lost to the atmosphere by evapo-transpiration are much less comforting. Narasimhan (2008)[1] has recalculated India's water budget, using an evapo-transpiration rate of 65 per cent, which compares with worldwide figures ranging from 60 per cent to 90 per cent instead of the 40 per cent rate assumed in official estimates. The results summarized in Table 21.1 are sobering. After allowing the same 48.8 per cent for ecological flows, his estimate of water utilizable for human use comes to only 654 BCM, which is very close to the current actual water use estimate of 634 BCM.

21.6 In addition to the fact that aggregate estimates suffer from data infirmities and arbitrary assumptions and are still being debated and contested, it is also important to emphasize that in a country of such immense physiographic, hydrogeological, and demographic diversity, and also vastly different levels of economic development (hence water use), water balances for the country as a whole are of limited value since they hide the existence of areas of acute water shortages and also problems of quality. What is required is a much more disaggregated picture, accurately reflecting the challenge faced by each region. The exact level at which regions need to be defined would depend on the purposes of the exercise, as also the unifying features of the region, such as basin and aquifer boundaries.

21.7 Traditionally, efforts to address water supply problems have focused on major and medium irrigation projects. However, use of water in India is characterized by an increasing dependence on groundwater for irrigation. The annual extraction of groundwater in India (210 billion cubic metres) is by far the highest in the world. As shown in Table 21.2, groundwater today provides for more than 60 per cent of the net irrigated area. It accounted for over 85 per cent of the addition to the irrigated area in the last 30 years. The area irrigated by canals and tanks has actually undergone a decline even in absolute terms since the 1990s.

21.8 Unfortunately the growing dependence on groundwater has taken the form of unsustainable extraction, which is lowering the water table and

TABLE 21.1
India's Water Budget (BCM), 2009

	Analysis Based on Estimates of Ministry of Water Resources	Estimates Based on Worldwide Comparison
Annual rainfall	3,840	3,840
Evapo-transpiration	3,840–(1,869 + 432) = 1,539 (40 per cent)	2,500 (65 per cent) Worldwide Comparison
Surface run-off	1,869 (48.7 per cent)	Not used in estimate
Groundwater recharge	432 (11.3 per cent)	Not used in estimate
Available water	2,301 (60 per cent)	1,340 (35 per cent)
Utilizable water	1,123 (48.8 per cent of 2,301) Gupta and Deshpande (2004)[2]	654 (48.8 per cent of 1,340)
Current water use	634	634
Remarks	Current use (634) well below 1,123	Current use (634) close to 654

Source: T.N. Narasimhan and V.K. Gaur (2009): *A Framework for India's Water Policy*, National Institute for Advanced Studies, Bangalore.

[1] T.N. Narasimhan, 'A Note on India's Water Budget and Evapotranspiration', *Journal of Earth System Science*, Vol. 117, 2008.

[2] S.K. Gupta and R.D. Deshpande, 'Water for India in 2050: First Order Assessment of Available Options', *Current Science*, Vol. 86, 2004.

adversely impacting rural drinking water. Table 21.3 shows that between 1995 and 2004, the proportion of unsafe districts (semi-critical, critical, and over exploited) grew from 9 per cent to 31 per cent, the proportion of area affected from 5 per cent to 33 per cent, and the population affected from 7 per cent to 35 per cent.

21.9 Recent work based on data from NASA's Gravity Recovery and Climate Experiment (GRACE) satellites[3] reveals significant rates of non-renewable depletion of groundwater levels over large areas. The declines were at an alarming rate of as much as one foot per year over the past decade. During the study period of August 2002 to October 2008, groundwater depletion in Rajasthan, Punjab, Haryana, and Delhi was equivalent to a net loss of 109 cubic km of water, which is double the capacity of India's largest surface-water reservoir. Annual rainfall was close to normal throughout the period and the study shows that other terrestrial water storage components (soil moisture, surface water, snow, glaciers, and biomass) did not contribute significantly to the observed decline in total water levels. The study concludes that unsustainable consumption of groundwater for irrigation and other anthropogenic uses is likely to be the cause.

21.10 A major contributor to this rapid depletion in the water table is the overwhelming dependence on deep drilling of groundwater through tube wells, which today account for over 40 per cent of irrigation. Indeed, we are close to entering a vicious infinite regress scenario where an attempt to solve a problem

TABLE 21.2
Long Period Averages of Net Area Irrigated by Different Sources, 1950–2007

Years	Canals	Tanks	Total Surface Water	Tube Wells	Other Wells	Total Groundwater	Others (incl. both sw/gw)	NIA
1950–51 to 1964–65	42	18	60	3	29	32	8	100
1965–66 to 1979–80	40	12	52	16	24	40	8	100
1980–81 to 1994–95	37	7	44	29	21	50	6	100
1995–96 to 2006–07	28	4	32	39	21	60	8	100

Source: Indian Agricultural Statistics (various issues); CWC (2007).

TABLE 21.3
Comparative Status of Level of Groundwater Development, 1995 and 2004

Level of Groundwater Development*	of Total Districts		of Total Area		of Total Population	
	1995	2004	1995	2004	1995	2004
0–50 ('Safe')	82	55	89	52	80	45
50–70 ('Safe')	10	15	7	16	13	20
70–90 ('Semi-critical')	4	13	2	14	3	17
90–100 ('Critical')	1	4	1	5	1	3
>100 ('Over-exploited')	4	14	2	14	3	15
Total	100	100	100	100	100	100

Source: CGWB, *Dynamic Ground Water Resources of India,* Central Ground Water Board (2006).
Note: * Level of groundwater development is the ratio of gross annual groundwater draft for all uses to net annual groundwater availability. Net annual groundwater availability is defined as the annual groundwater potential (total annual recharge from monsoon and non-monsoon seasons) minus the natural discharge during the non-monsoon season (estimated at 5–10 of the total annual groundwater potential).

[3] M. Rodell, I. Velicogna, and J.S. Famiglietti, 'Satellite-based Estimates of Groundwater Depletion in India', *Nature,* dci 10.1038, 2009.

reintroduces the same problem in the proposed solution. This development has been termed 'hydro schizophrenia',[4] which entails taking a schizophrenic view failing to recognize the unity and integrity of the hydrologic cycle. The most striking example of this in India is the increased reliance on tube wells both for irrigation and drinking water, not recognizing that one can potentially jeopardize the other. This leads to the phenomenon of villages 'slipping' back after being covered under rural drinking water schemes.

21.11 Issues related to water quality have also emerged as a major new concern over the last decade or so. Till the 1970s, quality issues had to do with biological contamination of the main surface water sources due to poor sanitation and waste disposal, leading to repeated incidence of water-borne diseases. But today this has been supplemented by the serious issue of chemical pollution of groundwater, with arsenic, fluoride, iron, nitrate, and salinity as the major contaminants. This is directly connected with falling water tables and extraction of water from deeper levels. States continually report an increasing number of habitations affected with quality problems.

21.12 According to DDWS, out of the 593 districts from which data is available, there are problems from high fluoride in 203 districts, iron in 206 districts, salinity in 137 districts, nitrate in 109 districts, and arsenic in 35 districts. Biological contamination problems causing enteric disorders are present throughout the country and are a major concern, being linked with infant mortality, maternal health, and related issues. Estimates made for some of these water quality related health problems suggest a massive endemic nature—fluorosis (65 million (Susheela 2001)[5] and arsenicosis (5 million in West Bengal [WHO 2002][6] and several magnitudes more, though not estimated from Assam and Bihar).

21.13 Fluorosis caused by high fluoride in the groundwater leads to crippling, skeletal problems, and severe bone deformities. On the other hand, arsenicosis leads to skin lesions and develops into cancer of the lungs and the bladder. Both these diseases have also been related to a variety of other problems, including brain disorders. Apart from adults who are already affected, these two problems alone threaten a whole generation of children from physical and psychological disabilities and life-threatening diseases. Being physically distinguishable, these diseases create a social stigma for affected persons and lead to several misconceptions about the root cause of problems.[7]

21.14 The Eleventh Plan contains a number of schemes aimed at tackling different aspects of the water problem, including special promotion of surface water irrigation, schemes for groundwater conservation and recharge, rural drinking water, and urban water supply. A brief assessment of progress in these schemes together with recommendations for improvements in the future is now discussed.

IRRIGATION THROUGH SURFACE WATER

21.15 The Eleventh Plan had established a target of creating an additional irrigation potential of 16 million ha (9 mha through major and medium irrigation and 7 mha through minor irrigation projects). Progress so far has been slow. Against the anticipated annual rate of creation of irrigation potential of about 3.2 million ha, the average rate of creation of irrigation potential during the first three years will be about 1.83 million ha per year (Table 21.4).

21.16 The poor rate of achievement of target reflects deep-seated problems with major and medium irrigation projects. Major irrigation projects normally have a gestation period of 15–20 years while medium projects take 5–10 years for completion. Against these norms, a

[4] R. Llamas and P. Martinez-Santos, 'Intensive Groundwater Use: Silent Revolution and Potential Source of Water Conflicts', *American Society of Civil Engineers Journal of Water Resources Planning and Management*, Vol. 131, No. 4, 2005; Jarvis, T. et al. 'International Borders, Ground Water Flow and Hydro schizophrenia', *Ground Water*, Vol. 43, No. 5, 2005.

[5] A.K. Susheela, *A Treatise on Fluorosis.* Fluorosis Research and Rural Development Foundation, Delhi, 2001.

[6] *WHO, 'An Overview: Gaps in Health Research on Arsenic Poisoning',* 27th Session of WHO South-East Asia Advisory Committee on Health Research 15–18 April 2002, Dhaka, Bangladesh, *2002.*

[7] S. Krishnan, *The Silently Accepted Menace of Disease Burden from Drinking Water Quality Problems*, Submission to the Planning Commission, 2009.

TABLE 21.4
Eleventh Plan Target and Achievements in the Irrigation Sector (million ha)

Project	XI Plan Target	Achievement		Target for 2009–10	Percentage Achievement	Proposed Revised Target
		2007–08	2008–09			
Major & medium irrigation	9.00	0.84	1.02	0.90	31	5.00
Minor irrigation	7.00	0.89	0.90	0.90	38	4.50
Total	16.00	1.73	1.92	1.80	34	9.50

large number of major as well as medium projects are continuing for 30–40 years or even more. This is due to poor project preparation and implementation as well as a thin spreading of available resources. There is a spillover of 553 projects (182 major, 273 medium, and 98 ERM projects) into the Eleventh Plan from previous Plan periods. Around 56 per cent of these 553 projects have not been approved by the Planning Commission and are not eligible for central assistance.

21.17 The overall allocation in the first three years of the Eleventh Plan has been about 58 per cent of the originally proposed outlay (Table 21.5).

ACCELERATED IRRIGATION BENEFIT PROGRAMME

21.18 Irrigation is a state subject but the Centre supports the states' effort through the Accelerated Irrigation Benefit Programme (AIBP). AIBP was launched in 1996–97 for accelerating the implementation of large major and multi-purpose irrigation projects, which were beyond the resource capabilities of the states and to complete ongoing major and medium irrigation projects which were in an advanced stage of completion. Originally AIBP assistance was in the form of a loan to the states. In 2004–05 a grant component was introduced and from 2005–06 grants were provided only under AIBP. The standard norm is grant assistance of 25 per cent of the project cost but for drought/flood-prone and tribal areas 90 per cent grant assistance is being provided since December 2006. In general, a new AIBP project is allowed in a state only when the ongoing project has been completed. However, for drought-prone/tribal areas (including KBK districts of Orissa), projects under the PM's package for agrarian distress districts of Andhra Pradesh, Karnataka, Kerala, and Maharashtra and states with irrigation development below the national average, this criterion has been relaxed. The Central Loan Assistance (CLA)/grant released and the irrigation potential created since the inception of AIBP are given in Table 21.6.

21.19 Overall 278 major/medium/ERM irrigation projects and 10,339 minor irrigation projects have received CLA/grant under AIBP since 1996–97. Of the 278 projects, 126 are major, 118 are medium, and 34 are ERM projects. Central assistance under AIBP has grown dramatically from a mere Rs 500 crore in 1996–97 to Rs 7,598 crore in 2008–09. During

TABLE 21.5
Outlays and Allocations during the Eleventh Plan

(Rs crore)

Description	Total Outlay for XI Plan	Allocation in 2007–08	Allocation in 2008–09	Allocation in 2009–10	Total Allocation in 2007–10	Allocation in Percentage of Total XI Plan Outlay
State plan	1,82,050					
State sector schemes of Central Plan	47,015					
Sub-total states	2,29,065	38,456	47,195	46,429	1,32,080	58
Central sector	3,246	550	600	600	1,750	54
Total	2,32,311	39,006	47,795	47,029	1,33,830	58

TABLE 21.6
CLA/Grant and Irrigation Potential Created through AIBP, 1996–2009

Year	Amount of CLA/ Grant Released (Rs crore)	Irrigation Potential Created (in '000 ha)
1996–97	500	72
1997–98	952	200
1998–99	1,119	257
1999–2000	1,450	220
2000–01	1,856	531
2001–02	2,602	443
2002–03	3,062	272
2003–04	3,129	357
2004–05	2,867	409
2005–06	1,900	703
2006–07	2,302	938
2007–08	5,446	544
2008–09	7,598	538
2009–10	6,946	1,050
Total	39,457	6,535

Source: MoSPI, *Annual Report on Performance of AIBP*, Ministry of Statistics and Programme Implementation, Government of India (2009).

2002–08, AIBP funded 42 per cent of all major and medium irrigation projects in India.

Review of AIBP's Performance

21.20 Of the targeted irrigation potential of 119 lakh ha under AIBP-assisted major and medium projects, the irrigation potential created up to March 2009 was just 55 lakh ha, which is about 46 per cent of the target. What is truly incredible is that during the years in which AIBP has been implemented, net irrigated area through canals has actually undergone an absolute decline, rather than achieving accelerated growth. From an average contribution to Net Irrigated Area of around 17.5 million ha in the mid-1990s, the area irrigated by canals came down to less than 15 million ha in the first decade of the twenty-first century.

21.21 Of the major and medium projects sanctioned under AIBP between October 1996 and March 2008, only 40 per cent were reported as completed. For minor irrigation projects the figure was 3,253 out of 6,855 (47 per cent).

21.22 The Comptroller and Auditor General (CAG) conducted a performance appraisal of AIBP for 1996–2003 based on a test check of 99 (out of the then 172) projects in 19 states covering around 59 per cent of the expenditure under AIBP. CAG's findings are sobering. As of March 2003, no potential was created in 57 projects in 16 states, even after 1–7 years of their inclusion in the programme. In 67 per cent of the projects, the potential created was less than 50 per cent of the envisaged irrigation potential.

21.23 The utilization of irrigation potential was also unsatisfactory. In 71 per cent of the projects, the utilization was less than 50 per cent of potential created. The gap between the potential created and the potential utilized has been increasing over time. One reason for this is that the irrigation potential is defined on the basis of a certain volume of water expected in the reservoir, which is divided by a presumed depth of irrigation required for a presumed cropping pattern. However, the actual values of these variables rarely approach their presumed values. Studies by four Indian Institutes of Management (Ahmedabad, Bangalore, Kolkata, and Lucknow) of 34 states and UTs completed in 2009 show that the IPC–IPU gap also reflects implementation issues, such as faulty project designs, poor lining and desilting, and shoddy maintenance of distribution channels.

21.24 Institutional weaknesses are also significant. There is lack of coordination between concerned department officials (resulting in delays in implementation and implementation without proper technical assessment) as also inadequate technical and managerial capacity of irrigation department staff. The absence or ineffectiveness of Water Users Associations (WUAs), is also mentioned as a significant contributor to the IPC-IPU gap. The need to increase the involvement of WUAs and PRIs in all stages of planning, design, construction, and maintenance is widely accepted. This must include systematic training of their members in organizational development, leadership, maintenance of financial and operational records, basic technical components of the canal system, and methods of monitoring technical work.

21.25 An important weakness in AIBP is that although originally visualized as a 'last mile' initiative to help complete projects in their final stages, which were being held up due to shortage of funds, in practice AIBP projects have not been selected along these lines. The use of nebulous terms, such as 'substantial progress', 'advanced stage', 'little resources', and 'beyond the resource capability of a state' in the original guidelines gave wide leeway to include all kinds of projects under the programme. As a result, projects where no or very low investments had been made, or where hardly any irrigation potential had been pre-created were also selected. Thus, 74 per cent of AIBP projects in 1996–2003 had an investment level of less than 75 per cent prior to their inclusion under AIBP and 80 per cent of the projects had created less than 75 per cent of their irrigation potential prior to their inclusion. Such projects should not have been part of AIBP in the first place.

21.26 AIBP projects have typically tended to suffer from time and cost over-runs. The pattern of taking up new projects without completing ongoing ones has characterized the programme throughout. Non-completion of 32 projects within the stipulated period in the states of Andhra Pradesh, Chhattisgarh, Jharkhand, Karnataka, Kerala, Punjab, and West Bengal, resulted in substantial cost over-runs of Rs 4,775 crore and a time over-run of 24 to 84 months, even after the projects were brought under AIBP.

21.27 The AIBP guidelines envisaged a detailed monitoring mechanism to be instituted at the central, state, and project level. CAG has pointed to weaknesses in the functioning of monitoring bodies at the central, state, and project levels. The National Remote Sensing Centre of the Department of Space has assisted in monitoring progress of 53 AIBP projects on the advice of the Planning Commission.

21.28 The record on evaluation is also unsatisfactory. There has hardly been any evaluation of the programme other than the one by the CAG in 2004 and one that CAG is expected to complete shortly. The Indian Institute of Management, Lucknow, is currently carrying out a study on AIBP for the Planning Commission which is likely to be completed by June 2010.

FINANCIAL VIABILITY OF IRRIGATION SYSTEMS

21.29 A major problem affecting irrigation systems in the states is the severe erosion of the financial status of these systems owing to very low water charges. Not only does this encourage inefficient water use and a tendency for head-end canal users to shift to water intensive crops, it also creates an environment in which irrigation charges do not cover even operating costs leading to progressive neglect of maintenance which further reduces efficiency.

21.30 In 1977–78, irrigation revenues from water rates were around Rs 100 crore, which covered only 75 per cent of O&M costs. If costs on account of interest on accumulated investments up to that year (at the average interest rate on the outstanding debt of state governments as a whole) and depreciation (at 1 per cent of the cumulated investment) were included, revenues covered only 16 per cent of the total costs. The losses amounted to Rs 420 crore. By 1994–95, total costs (inclusive of depreciation and interest) had increased 14-fold but revenue realizations had increased less than four-and-a-half times. Revenues covered barely 15 per cent of the working expenses and only 5 per cent of the total costs and losses had grown dramatically to around Rs 7,000 crore.

21.31 The pricing of irrigation water is obviously a critical issue. Vaidyanathan (2006)[8] has argued, 'as far as the farmer is concerned, access to irrigation leads to a huge increase in the productivity of his land and, therefore, in his income ... Water should be treated like any other input and priced on the basis of the cost of supply, leaving it to the farmer to decide which combination of inputs (including quantum of irrigation) would be to his best advantage.' Rate increases will also incentivize a more careful use of water and lead to choice of cropping patterns more in tune with both location-specific agro-ecology and projected assumptions. Of course, since we are so far below where we need to be, the hikes would have to

[8] A. Vaidyanathan, *India's Water Resources: Contemporary Issues on Irrigation*. New Delhi: Oxford University Press, 2006.

be brought about in a manner that also addresses the genuine concerns of the farmers. The case for pricing irrigation water is weakened by the uncertain quality of irrigation service (in terms of quantum, reliability, and timeliness of supply) but that to some extent is also a consequence of financial weaknesses resulting from low pricing. The challenge, therefore, is to define an agenda of reforms that can improve the performance of canal irrigation in India.

THE NEED FOR SYSTEMIC IRRIGATION REFORM

21.32 From the viewpoint of irrigators, the performance of an irrigation system is judged by the level of water control it offers. Water control can be defined as the capacity to apply the proper quantity and quality of water at the optimum time to the crop root zone to meet crop consumptive needs and soil leaching requirements. Irrigation reforms should aim at closing what Tushaar Shah[9] has termed the three gaps which currently bedevil the system:

- Gap I: Gap between the area (and farmers) designed to be served by gravity irrigation and the area (and farmers) actually served after the system begins operation.
- Gap II: Gap between the level of 'water control' promised at the planning stage and the level of 'water control' actually delivered after the beginning of the operation.
- Gap III: Gap between the level of 'water control' demanded by farmers at the present point in time and the level of 'water control' actually offered by the system.

21.33 Gap I arises because irrigation systems are over designed to make them appear more viable and beneficial than they can actually become. The irrigation depth assumed is lower than realistic so that a larger design command area can be shown. Once the system gets commissioned, the gap tends to expand because of: (a) acts of commission, which include water thefts, vandalism, violation of water distribution norms, and unauthorized diversion or lifting of water from canals by head-reach farmers, and (b) acts of omission, which include farmers' own failure to cooperate in maintenance and repair, to pay irrigation charges, and so forth.

21.34 Gap II generally arises because of inept system management as well as physical deterioration of the system and re-engineering by farmers. Also important are operating rules for reservoir and main system management. In multi-purpose projects, often the hydro-electric plants determine the protocol and schedule for releasing water from reservoirs without much regard for the needs of irrigation.

21.35 Gap III arises from the changing pattern of irrigation demand, mostly due to diversification of farming towards high-value crops. With growing urbanization and rising incomes, farmers are shifting from rice/wheat rotation to high-value fruit and vegetable crops that impose a completely different irrigation schedule.

21.36 A drastic reform of the irrigation bureaucracy at the cutting-edge level of implementation (the irrigation commands), is critical for improving the performance of large irrigation projects. This entails deployment of a very different profile of human resources (moving away from exclusively engineer-centric departments towards more multi-disciplinary structures) who would be able to face up to the real challenges of mobilizing farmers to actively participate in irrigation management. It also requires innovative pedagogies of training farmers in understanding the technical and managerial aspects of running these systems. Careful attention would have to be paid to the design principles of successful management of Common Property Resources (CPRs) over long periods of time identified by scholars led by Elinor Ostrom, the 2009 Nobel Laureate in Economics.

21.37 Participatory Irrigation Management (PIM), which aims at involving stakeholders, is a critical element of any systemic reforms and is an acknowledged element of policy. Recognizing the need for a sound

[9] Tushaar Shah, 'Past, Present and Future of Canal Irrigation in India', Paper Commissioned for the MTA of the Eleventh Plan by the Planning Commission, 2009.

Box 21.1
Success Story of PIM

One of the most successful examples of PIM in India is being implemented jointly by the government of Gujarat and the Development Support Centre, Ahmedabad since 1994 on the right bank canal of the Dharoi project on the Sabarmati river covering about 48,000 hectares. 175 WUAs and two branch-level federations have been formed. Each WUA services a command area of about 300 to 500 hectares and has about 200 to 350 members. The branch-level federations service an area of 7,000–14,000 hectares.

The WUAs in Dharoi are registered as cooperatives. Each farmer within the command area has purchased a share to become a member. There are about 35,000 members. They have carried out canal rehabilitation work worth Rs 55 million wherein the members have contributed about Rs 10 million. They have appointed their own president, secretary, and canal operators who ensure that the WUA financial and administrative systems as well as the physical system are in shape before the irrigation season. These operators and the secretary are paid by the WUA without any grants from the government. They have installed gates at the outlet level with their own funds and devised a system of water distribution wherein no member is given water without a pass. They prepare an annual budget and decide the water charges, which are often over and above the government rate. The office bearers collect the water charges in advance from the farmers and pay them to the Irrigation Department.

The WUAs charge penalties to members in case they break the rules finalized at the annual general body meeting and this penalty is double for office bearers. Some of them have also carried out pilots on volumetric supply of water and water use efficiency. They have built reserve funds that serve as a contingency fund during scanty rainfall years.

legal framework for PIM, MoWR brought out a model Act in 1998 to be adopted by state legislatures for enacting new irrigation acts or amending the existing acts for facilitating PIM. Fifteen state governments (Andhra Pradesh, Assam, Bihar, Chhattisgarh, Goa, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Sikkim, Tamil Nadu, and Uttar Pradesh) have enacted a PIM Act or made amendments in existing irrigation acts. Other state governments (Punjab, Haryana, Manipur, Arunachal Pradesh, and Himachal Pradesh) are in the process of taking action.

21.38 Despite these developments, actual progress in implementing PIM has been limited. By the end of 2007, only about 20 per cent of the total command of existing irrigation projects (13.5 million ha) had been covered through about 56,934 WUAs.

21.39 Studies on PIM reveal that it has several potential advantages related to a sense of ownership amongst the users, which motivates them to make judicious use of water (see Box 21.1). It is estimated that PIM provides about 20 per cent saving in water use with greater equity in distribution across the command area. However, these studies also reveal that PIM works only under certain facilitating conditions, which explains its tardy progress so far. Vermillion (2004)[10] has studied successful WUAs across the world and identified 10 elements of PIM reforms that are generally needed and are effective if designed and implemented in ways appropriate for local circumstances:

1. Clear, high-level support for PIM
2. Clear and strong legal status of WUAs and basis for PIM
3. Clear water use rights for WUAs and farmers
4. Full decision making authority transferred to WUAs
5. WUAs federate to the main system level
6. Irrigation agency reorients itself to building capacity and providing support services to WUAs and regulating the sector
7. Shift to farmer financing of O&M and cost sharing for incidental repairs and improvements, rehabilitation, and modernization

[10] D.L. Vermillion, 'Creating an Enabling Environment for Productive and Sustainable WUAs', Keynote Paper presented at 7th International Seminar on PIM (Tirana, Albania), 2004.

8. Stakeholder consultations and public awareness campaigns
9. Institutional reform precedes rehabilitation
10. Parallel programme to develop agriculture, agri-business, and marketing

21.40 The case for stakeholder participation in irrigation management is unexceptionable. However, the most significant weakness of these WUA experiments is that they do not afford a direct dovetailing with the constitutionally mandated PRIs. This not only weakens their legal status, it also compromises their democratic legitimacy and inclusive character. WUAs only include landowners and land occupiers as members. Only exceptionally do they include reservation for women or SC/STs. A possible way forward is provided by the Madhya Pradesh and Chhattisgarh legislations, which extend membership to all those using 'water for agriculture, domestic, power, non-domestic, commercial, industrial or any other purpose from a Government source of irrigation'. WUAs must function as committees within the PRI constitutional set up.

21.41 In recent years, India has seen a new architecture of regulatory reforms in the water sector. The first entirely new regulatory entity was the Andhra Pradesh Water Resources Development Corporation created under an act by the same name in 1997. But the most sweeping institutional reforms have been introduced in Maharashtra through the Maharashtra Water Resources Regulatory Authority (MWRRA) Act, 2005. Arunachal Pradesh and Uttar Pradesh have adopted substantially the same legislation. There is a direct link between the MWRRA Act and the Maharashtra Management of Irrigation Systems by Farmers Act, 2005 (MMISFA), which empowers WUAs to participate in the construction and operation of command area systems. MWRRA is obliged to issue entitlements to WUAs as per the criteria given in the act. The aim is to take an independent view on water that reflects the needs and aspirations of stakeholder farmers in the river basin in an equitable manner. The strength of such an independent regulator would derive from a holistic view of the social, environmental, and economic aspects, reflecting the concerns of all stakeholders in the region. The orders passed by MWRRA in the Nira Deoghar Irrigation Project[11] and Maharashtra Airport Development Company cases in November 2008 where it strongly protected the interests of stakeholder farmers are landmark judgments, setting standards for future adjudication. Of course, MWRRA's work needs to become even more broad-based with greater stakeholder participation and strengthening of the authority with a wider range of relevant expertise. One of the most attractive features of the MWRRA Act is its potential to severe the link between control over land and control over water because the nexus between land rights and access to water is socially inequitable and environmentally unsustainable. But the notion that water entitlements can be privately traded is difficult to reconcile with the public trust doctrine enunciated by the Supreme Court. This requires additional safeguards to be built into acts like MWRRA (Cullet 2009).[12]

21.42 Andhra Pradesh provides an alternative approach that emphasizes efficiency and community action and puts public need first instead of creating rights of individuals. Since 2008–09 Andhra Pradesh is using a mobile-based information system for monitoring reservoir storage and canal flows. The mobile-based system needs extremely low investment and recurring costs. The inflow, outflow levels, and capacity of the reservoirs and canal flow at strategic locations can be monitored on a regular basis through use of this technology.

21.43 A web-based work tracking system is also being used effectively by Andhra Pradesh since 2008–09 to monitor progress of O&M work in irrigation projects and for evaluating their quality, assisting the administration in decision making for timely implementation, and monitoring financial plans, requirements, and expenditure for works.

[11] PRAYAS, *Independent Water Regulatory Authorities in India: Analysis and Interventions*, Pune, 2009.
[12] P. Cullet, *Water Law, Poverty and Development: Water Sector Reforms in India,* Oxford University Press, New Delhi, 2009.

WAY FORWARD FOR AIBP

21.44 The steps that would make AIBP an effective programme, actually delivering water to the farmers who need it and providing a real boost to canal irrigation in India, leading to a rise in agricultural productivity, may be summarized as:

Project Approval, Design, and Implementation

- No new projects should be taken up until resources are found to complete the ongoing schemes.
- MoWR should ensure that BC ratios are properly and accurately calculated for each project (based on valid data and assumptions relating to costs, revenues, and cropping patterns, etc.).
- Funds should be released by the government in time (not in the last quarter/March) to the state governments. Further, state governments should be directed to ensure release of government of India funds (along with the state share) within the stipulated period of 15 days. MoWR should have systems for monitoring such releases on a project-wise basis.
- Creation of irrigation potential should be recognized only where: (a) there are no gaps in the main branch canals, and water is capable of flowing right through the sections recognized for creation of IP; and (b) not just the main/branch canals, but also all associated minors and distributaries have been completed.
- Except for preliminary expenditure, no major investment on a project should be made unless the issues of land acquisition, relief and rehabilitation, and forest clearance are sorted out as a whole for the projects. Government of India funds should be released only after the state government certifies that the major portion of the land required for the project (not just for the dam/head-works but also for the canals) has already been acquired. Future releases should be linked to progress in land acquisition.
- It should not happen that the dam is constructed but the distribution system is not making headway making the investment idle and at times infructuous. The construction programme of major projects should be phased in such a way that a specified length of the main canal, minors, and distributaries are taken up and completed together, so as to yield phase-wise benefits.

Command Area Development (CAD) and Improved Water Use Efficiency

- Command area development should occur *pari passu* with the creation of infrastructure. MGNREGA funds could be used for much of the CAD work. This is already being done in states like Madhya Pradesh.
- CAD must carefully integrate traditional water harvesting systems already existing in the command. The coming of canal irrigation must not lead to their decline; rather their deep complementarities must be harnessed. To begin with at least 10 per cent of the AIBP command must mandatorily be provided with water saving micro-irrigation. Subsidy for micro-irrigation can be drawn from ongoing programmes of Ministry of Agriculture (MoA).
- An agricultural improvement programme focused on improving water efficiency and agricultural productivity must be dovetailed into the AIBP and undertaken not as an afterthought but as an integral part of the AIBP itself.

Stakeholder Participation, Deployment of Multi-disciplinary Professionals, and Regulation

- For command area development to be effective the participation of farmers as stakeholders in the process must occur right from the planning and implementation stage to monitoring and maintenance. For this, WUAs need to be set up within the framework of the PRIs and provided with autonomy, incentives, and powers. This requires investment of time and money in a process of institution building of WUAs and federations of WUAs. Capacity building must be undertaken by officials of the irrigation department in partnership with PRIs and civil society organizations with experience in PIM.
- The entire profile of the officials of the irrigation department also needs to be broadened to include not only engineers (who will provide technical inputs) but also social mobilizers (including social workers and anthropologists) who would understand the

social dynamics of farmer stakeholders and their motivational structure.

- Monitoring mechanisms mandated under AIBP must function effectively, independent evaluations of AIBP projects must be undertaken by credible academic institutions, and participatory social audits would help improve farmer stake in the programme.
- All of this must occur within a new institutional, legal, and regulatory framework that draws lessons from both the strengths and weaknesses of especially the Maharashtra Water Resources Regulatory Authority.

GROUNDWATER DEVELOPMENT

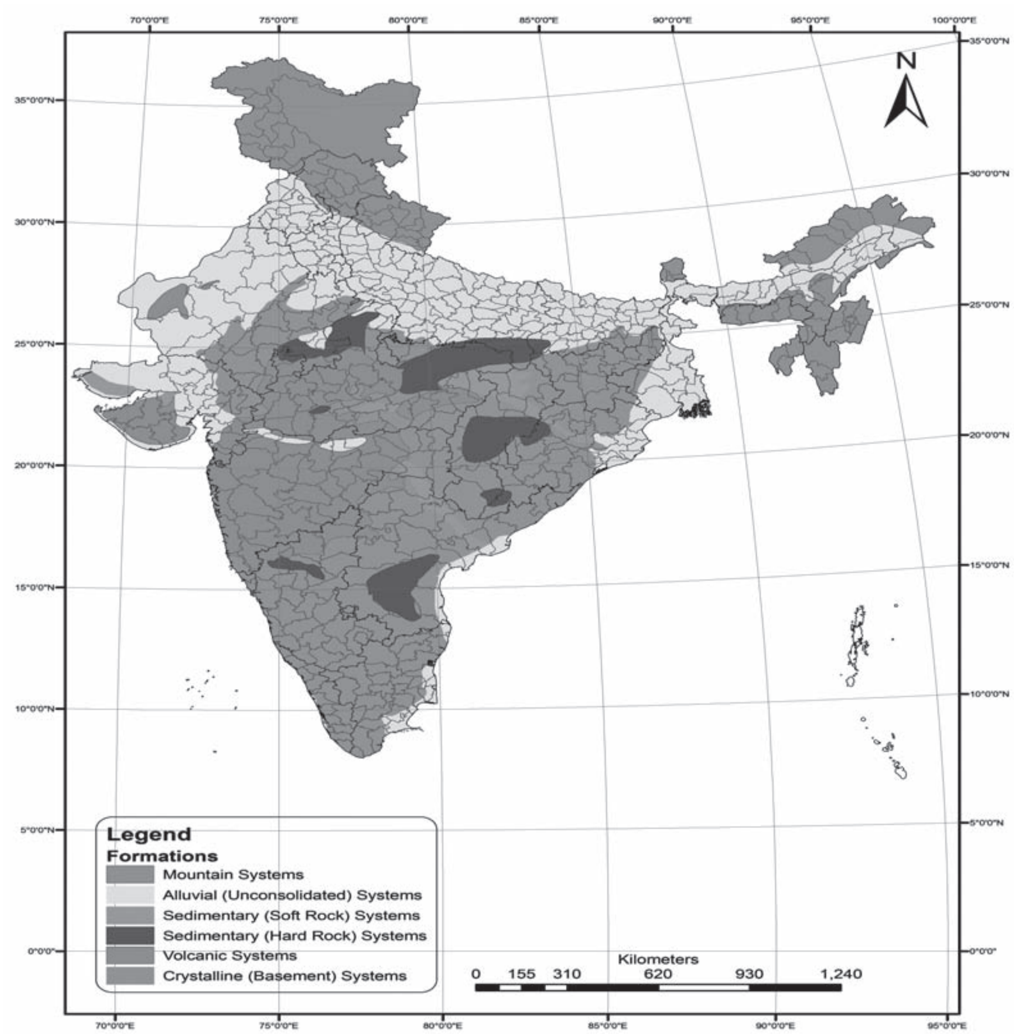
21.45 As pointed out the overwhelming dependence on groundwater, especially that extracted through tube wells, is leading to a steady depletion in water tables. The main reason for this is that groundwater, though a finite exhaustible resource, is not being managed as a common pool resource. Under the present legal and regulatory structure it can be extracted without limit by anyone sinking a tube well on his/her land. The fact that electricity for agriculture is grossly underpriced increases the incentive to do so, but it is important to remember that even if electricity were 'properly priced' the incentive to overuse water would be strong because negative externalities of a falling water table are not borne by the individual farmer but by all farmers. This is a classic problem of the need for collective action to regulate the use of a common pool resource.

21.46 The nature of the groundwater problem varies considerably across the country because of hydrogeological variations. The Advanced Centre for Water Resources Development and Management (ACWADAM), Pune, has developed a typology of six broad hydrogeological settings presented in Figure 21.1 and Table 21.7. About 54 per cent of India (comprising mainly the continental shield) is underlain by formations usually referred to as 'hard rocks' (settings 4–6 in Table 21.7). 'Hard rock' is a generic term applied to igneous and metamorphic rocks with aquifers of low primary inter-granular porosity (for example, granites, basalts, gneisses, and schists). Groundwater resource in hard rock is characterized by limited productivity of individual wells, unpredictable variations in productivity of wells over relatively short distances, and poor water quality in some areas.

21.47 Initially, the expansion of tube wells following the Green Revolution was restricted to India's 30 per cent alluvial areas (setting 1), which are generally characterized by relatively more pervious geological strata. From the late 1980s, tube well drilling was extended to hard rock regions where the groundwater flow regimes are extremely complex. Deeper seated aquifers often have good initial yields, but a tube well drilled here may be tapping groundwater accumulated over hundreds (at times even thousands) of years. Once groundwater has been extracted from a deeper aquifer, its replenishment depends upon the inflow from the shallow system or from the surface several hundred metres above it and the rate of groundwater recharge is much lower. This poses a severe limit on the expansion of tube well technology in areas underlain by these strata. Similarly in the mountain systems (setting 3 in Table 21.7), which comprise 17 per cent of India's land area, effects of groundwater overuse do not take very long to appear.

21.48 As the processes of groundwater accumulation and movement are vastly different in different geological types, the implications of any level of Groundwater Development (GD) will vary significantly across types of geological settings. A much lower level of GD (defined as draft on groundwater as a percentage of net annual groundwater availability) in settings 3–6 in Table 21.7, which account for 71 per cent of India's land area, could be as 'unsafe' as a comparatively higher level in settings 1 and 2. Thus, we need to exercise far greater caution in settings 3–6 as soon as the level of GD crosses 50 per cent.

21.49 However, even in the alluvial heartlands of the Green Revolution (that is, setting 1 in Table 21.7) for which tube well technology is relatively more appropriate, we are moving into crisis zone. Three states, Punjab, Rajasthan, and Haryana, have reached a stage where even their current level of groundwater extraction is exceeding recharge and is, therefore, unsustainable. Three other states, Tamil Nadu, Gujarat, and Uttar Pradesh, seem to be fast approaching that stage (Table 21.8).



Source: H. Kulkarni, P.S. Vijay Shankar, and S. Krishnan, 'Synopsis of Groundwater Resources in India: Status, Challenges and a New Framework for Responses', Paper Commissioned for the MTA of the 11th Plan by the Planning Commission.

FIGURE 21.1: Typology of Hydrogeological Settings in India with State and District Boundaries

21.50 The problem was recognized earlier, and the Government of India in 2005 prepared a Model Groundwater Control Bill for adoption by the states. However, this model legislation does not address the central problem of how to limit exploitation to appropriate levels. It only proposes restriction on sinking new tube wells in areas with falling water tables while allowing existing tube wells to continue. This only confers a monopoly on existing tube well owners who could actually extract more water than they need for their own use and sell it to neighbouring farmers. Surface and groundwater are still treated separately, completely ignoring the integrity of the hydrologic cycle. There is no reference to environmental concerns or to PRIs. The link between land and groundwater is not broken. The model bill does not clearly prioritize uses of groundwater, nor does it differentiate between commercial and non-commercial uses.

21.51 Karnataka, Maharashtra, Madhya Pradesh, Goa, Himachal Pradesh, Kerala, Tamil Nadu, and West Bengal have adopted groundwater legislations although they broadly accept the outmoded framework of the

TABLE 21.7
Typology of Hydrogeological Settings in India—States and Areas

S. No.	Hydrogeological Setting	Area (km^2)	States	Percentage of Total Area
1	Alluvial (Unconsolidated) Systems	9,40,719	Arunachal Pradesh, Assam, Bihar, Delhi, Diu & Daman, Gujarat, Haryana, Himachal Pradesh, Jharkhand, Kerala, Madhya Pradesh, Maharashtra, Orissa, Pondicherry, Punjab, Rajasthan, Sikkim, Tamil Nadu, Uttar Pradesh, Uttarakhand, West Bengal	29
2	Sedimentary (soft rock) systems	78,729	Andhra Pradesh, Chhattisgarh, Gujarat, Madhya Pradesh, Maharashtra, Orissa	2
3	Mountain systems	5,57,790	Arunachal Pradesh, Assam, Haryana, Himachal Pradesh, Jammu & Kashmir, Manipur, Meghalaya, Mizoram, Rajasthan, Sikkim, Uttar Pradesh, Uttarakhand, West Bengal	17
4	Sedimentary (hard rock) systems	1,94,797	Andhra Pradesh, Bihar, Chhattisgarh, Jharkhand, Karnataka, Madhya Pradesh, Orissa, Rajasthan, Uttar Pradesh	6
5	Volcanic systems	5,25,034	Andhra Pradesh, Bihar, Dadra & Nagar Haveli, Diu & Daman, Gujarat, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, West Bengal	16
6	Crystalline (basement) systems	10,30,018	Andhra Pradesh, Bihar, Chhattisgarh, Goa, Gujarat, Haryana, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Pondicherry, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal	32

TABLE 21.8
Groundwater Availability, Net Draft, and Level of Development, 2004

States	Net Annual Groundwater Availability	Net Draft	Balance Groundwater Resource for Future Use	Level of GW Development
	BCM/yr	BCM/yr	BCM/yr	Per cent
Punjab	21.4	31.2	(–) 9.9	145
Rajasthan	10.4	13.0	(–) 3.9	125
Haryana	8.6	9.5	(–) 1.1	109
Tamil Nadu	20.8	17.7	3.1	85
Gujarat	15.0	11.5	3.1	76
Uttar Pradesh	70.2	48.8	19.5	70
INDIA	398.7	230.4	161.9	58

Source: CGWB (2006).

model bill. But within this limitation, there are some innovative aspects in some state legislation, which deserve attention and need to be more widely adopted. Andhra Pradesh links surface and groundwater in a broader framework of environmental conservation. West Bengal is the only state that gives its groundwater authority a mandate to conserve groundwater and facilitate people's participation and involvement in the planning and use of groundwater. Himachal Pradesh's legislation gives first priority to drinking water.

21.52 The proposed model groundwater legislation is simply not adequate to deal with the steadily worsening situation that we face. There is need for a more comprehensive legislation, which takes account of the need to prioritize different uses and effectively introduces limits on total use. Such legislation would have to take into account the need to involve all stakeholders, including those not owing land who have a legitimate claim on groundwater for domestic use.

21.53 Legislation needs to be backed by action on the ground involving partnerships between stakeholders at the village-level, on the one hand, and hydrogeologists along with social mobilizers, on the other, who would guide collective sharing and sequential use of groundwater based on a careful understanding of the storage and transmission characteristics of different aquifers in the diverse hydrogeological settings outlined in this chapter.

21.54 Promising work on a reasonable scale has started in this direction in Andhra Pradesh. The Andhra Pradesh Farmer Managed Groundwater Systems (APFAMGS) project is funded by the Food and Agriculture Organization and implemented by NGOs in seven drought-prone districts of the state. The core concept of APFAMGS is that sustainable management of groundwater is feasible only if users understand its occurrence, cycle, and limited availability. The project employs participatory hydrological monitoring by engaging farmers in data collection and analysis, and building their understanding of the dynamics and status of groundwater in local aquifers. This is complemented with crop water budgeting, whereby the quantity of water required for dry crops is assessed at the aquifer level and compared with the amount of groundwater actually available. Crop water budgeting is conducted in aquifer-wide meetings in which the budget is produced with thousands of farmers in attendance. The total outreach of the programme is estimated at 1 million farmers.

INTERLINKING OF RIVERS

21.55 The current proposal to link Himalayan rivers with the Peninsular rivers for inter-basin transfer of water is estimated to cost around Rs 5,60,000 crore. Land submergence and R&R packages would be additional to this cost. There are no firm estimates available for the running costs of the scheme, such as the cost of power required to lift water.

21.56 Several technical problems have to be addressed in order to interlink rivers and for them to become economical. In a country like India, which gets seasonal rainfall from monsoons, the periods when rivers have 'surplus' water are generally synchronous across the subcontinent. Another key issue is how the reasonable needs of the basin states, which will grow over time, will be taken into account while planning inter-basin transfers. Further, given the topography of India and the way links are envisaged, it might totally bypass the core dry land areas of central and western India, which are located on elevations of 300+ metres above MSL. It is also feared that linking rivers could affect the natural supply of nutrients through curtailing flooding of the downstream areas. Along the East Coast of India, all major peninsular rivers have extensive deltas. Damming the rivers for linking will cut down the sediment supply and cause coastal and delta erosion, destroying the fragile coastal eco-systems. It is also pointed out that the scheme could affect the monsoon system significantly. The presence of a low salinity layer of water with low density is a reason for maintaining high sea-surface temperatures (greater than 28 degrees Celsius) in the Bay of Bengal, creating low pressure areas and intensification of monsoon activity. Rainfall over much of the subcontinent is controlled by this layer of low saline water. A disruption in this layer could have serious long-term consequences for climate and rainfall in the subcontinent, endangering the livelihoods of a vast population.

21.57 It is, therefore, necessary to move forward on this proposal with due diligence. Work on a few specific links is currently underway. DPR preparation has been completed for only one inter-basin water transfer link.

HIMALAYAN WATER RESOURCES

21.58 The Himalayan states are regions of high precipitation, rain, and snow. But there are dry pockets in the rain shadows, deforested slopes along river beds rendered dry by dams, mountain crests, and cold deserts. Traditional mountain communities have adapted to precipitation patterns, harvesting it for use round the year. The entire Himalayan region has a strong tradition of rainwater harvesting. Even today it contributes about 35–40 per cent of the annual rural household demand for water (People's Science Institute, 2009).[13] Earlier traditions of maintaining sacred

[13] Paper commissioned by the Planning Commission.

groves, found in almost all the Himalayan states, helped sustain perennial flows in rainfed rivers. This tradition needs to be strengthened. Springs and streams in many mountain areas are drying up due to extensive deforestation in the past. The concept of spring sanctuaries is very relevant to the Himalayan region. Sikkim and Himachal Pradesh have developed state-level programmes for this. MGNREGA funds could be used to expand the coverage of these initiatives in the Himalayan region.

21.59 One of the biggest crises in the Himalayan states, particularly the less-forested and lower rainfall western states, is the drying up of important rivers. The natural flows of Himalayan rivers are threatened by shrinking glaciers, loss of year-round inflows, and the construction of hydropower projects. Reviving sub-surface flows to rainfed rivers, minimizing short range and long range threats to glaciers, ensuring environmental flows downstream of dams, and legislating protected river zones to preserve pristine rivers and their wilderness are critical measures that need prioritization.

21.60 Drinking water supply management in the mountain areas requires integrated management of forests and water. Ultimately this can only be done at the community level. In the Himalayan region a culture of conservation of natural resources still exists. Hence, local communities must be given greater control and autonomy over their resources. Rural water supply agencies must have foresters and social workers as part of their professional staff in addition to engineers. Enhanced funds for catchment treatment work and resource conservation should be earmarked in departmental budgets. Given the high rainfall in this region, the goal of water resources development must be to provide a higher quantum of water for domestic use, as done in Himachal Pradesh. Resource conservation must precede resource development, a lesson that emerged from the Swajal scheme.

21.61 Mountain towns and cities have grown rapidly and haphazardly in the last decade. This has led to the destruction of local natural water sources and their catchments, creating severe water shortages. In urban areas, roof rainwater harvesting must be made mandatory for all new buildings, existing government buildings, institutions, and hotels. Most urban settlements on mountain slopes and river banks release their untreated waste water into nearby streams and rivers. Commercial establishments should be encouraged through tariffs and incentives to recycle the treated waste water in their toilet systems and for irrigating lawns. Planned development support for setting up waste water treatment plants in larger towns and cities on river banks must be taken up on priority. In smaller towns and urban settlements on mountain slopes, greater emphasis must be given to decentralized waste water treatment systems.

21.62 Irrigation has the potential to double agricultural productivity in mountain states. Its utilization will be enhanced if it is part of a larger package of measures to make agriculture more remunerative. This requires extension of credit, identification of niche agricultural crops and products, and better connectivity to markets. The principles of the System of Rice Intensification (SRI) have been successfully applied to other food grains with a fair degree of success in the mountain regions. Hence this concept, which reduces water consumption, must be vigorously promoted in these regions. SRI has already been successfully introduced in Tripura, Uttarakhand, and Himachal Pradesh. In Tripura and Uttarakhand, it is a part of the government's annual agricultural plan and Himachal is likely to follow suit in 2010–11.

21.63 In recent years, the Himalayan region has emerged as a focus for India's hydropower development as other options appear to be narrowing down. In developing these plans certain factors need to be kept in mind. The Himalayas are comparatively young mountains with high rates of erosion. Their upper catchments have little vegetation to bind soil. Deforestation has aggravated the problem. Rivers descending from the Himalayas tend, therefore, to have high sediment loads. A 1986 study found that 40 per cent of hydro-dams built in Tibet in the 1940s had become unusable due to siltation of reservoirs (K. Pomeranz 2009, 'The Great Himalayan Watershed'). Studies by engineering geologists with the Geological Survey of India record many cases of power turbines becoming dysfunctional following massive siltation in run-of-the-river schemes.

21.64 Climate change is making predictability of river flows extremely uncertain. This will rise exponentially as more and more dams are built in the region. Diverting rivers will also create large dry regions with an adverse impact on local livelihoods (fisheries and agriculture). Rapid rise of the Himalayas (from 500 to 8,000 metres) gives rise to an unmatched range of eco-systems, a biodiversity that is both enormous and fragile. Recent research published in *Science* (R. Kerr and R. Stone 2009: 'A Human Trigger for the Great Quake of Sichuan') on Zipingpu reservoir-induced seismicity as a trigger for the massive Sichuan earthquake in 2008 raises doubts about the wisdom of extensive dam-building in a seismically active region.

FLOODS AND FLOOD MANAGEMENT

21.65 Floods have become an annual feature in some parts of the country. Of late, the intensity and severity of floods has been increasing. The Eleventh Plan emphasized prevention, protection, and management of floods. A separate state sector programme, the Flood Management Programme, has been initiated with an estimated cost of Rs 8,000 crore. Rs 2,715 crore has been allocated for the programme in the Eleventh Plan. About 308 schemes in various states have been included under the programme and the Centre had released Rs 670 crore till June 2009.

21.66 While structural measures are funded through this programme, non-structural measures like flood forecasting and warning, flood-proofing, and flood plain zoning are required to be promoted. Protection measures must be based on the recurrence interval of the flood. There is a need for systematic delineation of flood prone areas based on hydrologically agreed methods. The issue of flooding of the lower riparian states by sudden release of water from the dams of upper riparian states is emerging in some of the inter-state river basins. We need to have a relook at the reservoir operational rules for all the major reservoirs in such basins for addressing this issue. Also real time flood forecasting and ensuring a flood cushion during emergencies would help moderate floods. This exercise needs to be carried out by the states with assistance from the Central Water Commission.

21.67 Related to the flood problem is the issue of waterlogging, which refers to the condition where the underground water table rises close to the surface (depth to water table being not more than 2 metres) and water collects in topographical depressions due to insufficient drainage. This can occur due to three different reasons: (a) poor drainage because of natural factors or due to disturbances in surface hydrology causing obstructions to flow of water; (b) inundation by river water during high floods; and (c) over irrigation leading to rise in the water table in the canal commands. Each of these problems differs in nature needing very specific interventions for remedial action. The earliest estimate of the waterlogged area in India was given by the Irrigation Commission in 1972 (4.84 million ha). More recent estimates by MoA (1990) put the figure at 8.5 million ha while that of the National Bureau of Soil Survey and Land Use Planning (NBSS-LUP) comes up with a figure as high as 11.6 million ha (8.3 per cent of the net sown area).

21.68 The land situation in a typical waterlogged area can be classified into three: (a) waterlogged lowland, called *chaur* in north Bihar; (b) midland, which are temporarily flooded but remain dry from December onwards; and (c) uplands, which are not flooded at all. *Chaur*s are the saucer-shaped, topographically low-lying areas where rainwater collects and accumulates due to inadequate drainage. The surface area of a *chaur* can be very large, covering portions of several villages. Traditional management of *chaur*s included cropping systems to suit this complex eco-system. Prominent among them was the sugarcane–paddy sequential system where a local variety of sugarcane, was followed by local varieties of tall paddy called *jager* and *darmi* in alternate years. But cultivation of these varieties has been given up over the years on account of their low productivity and high risk. As a result, the current cropping systems are not adapted to this eco-system.

21.69 The most urgent task in a new package for waterlogged areas is to make a comprehensive drainage plan by linking up the *chaur*s with the nearest watercourse. The low land slopes in the flood plains pose a serious problem here, requiring careful planning and coordination across several villages and panchayats. This is a major social mobilizational challenge. Part of the construction of the drainage system would involve clearing existing drainage channels and correcting their locations. In many places existing drainage channels have either got obstructed due to cultivation or encroachment or are wrongly constructed so that water does not drain out. Natural drainage gets disturbed due to construction of railway lines, roads, embankments, and irrigation canals. Part of the waterlogged area could be used for construction of small multi-purpose farm ponds. The mud in the pond is raised on the side as embankments on which crops like banana, papaya, mango, pigeon pea, and cashew nut can be grown. The pond water is used to irrigate the non-waterlogged, upland area. Experiments have shown that in waterlogged areas, cultivation of water chestnut (*Trapa bispinosa*) can be quite profitable. Research and field-level trials should proceed towards identification of extra-tall varieties of paddy that can grow fast and can tolerate waterlogging. The national research system has released some promising new varieties with these characteristics.

21.70 Waterlogging is often aggravated by the mismanagement of rainwater in the upper catchment. In situ rainwater conservation in the upper catchment and intensification of the use of groundwater through shallow tube wells are possible interventions to mitigate the problem. Through integrated management of land, water, and nutrients, agricultural productivity of these uplands could be stabilized and enhanced, which would, in turn, have a positive impact on the waterlogged lowlands. Funds under MGNREGA could be productively used for this purpose.

RURAL DRINKING WATER

21.71 The National Drinking Water Mission was established in 1986. Within 10 years, the mission claimed that only 63 problem villages were left to be covered. In 1999, the unit was narrowed down to habitations and a new target of universal coverage of 15 lakh habitations was set by the end of the Tenth Plan. According to the DDWS, the number of 'slipped-back habitations' that had to be 're-covered' in the Bharat Nirman period (2005–10) had grown to 4,19,034. The Eleventh Plan re-set the goal to 'provide clean drinking water for all by 2009 and ensure that there are no slip-backs by the end of the Eleventh Plan'. But slip-backs continue to happen on an ongoing basis. The National Rural Drinking Water Programme (NRDWP), was provided with Rs 39,490 crores in the Eleventh Plan. The states are to spend a total of Rs 49,000 crore (Table 21.9). This is nearly three times what was provided for in the Tenth Plan provision. However, as the 2009 DDWS document 'Movement towards Ensuring People's Drinking Water Security in Rural India' recognizes the objective of providing adequate drinking water to the rural community is yet to be achieved 'in spite of the collective effort of the state and Central Governments and huge investments of about Rs 72,000 crores in the rural water supply scheme under both state and Central Plans up to 2009'.

TABLE 21.9
Investments in Rural Drinking Water, 1951–2012

Plan period	Investment made/ proposed (Rs crore)	
	Centre	State
Ist (1951–56)	0	3
IInd (1956–61)	0	30
IIIrd (1961–66)	0	48
IVth (1969–74)	34	208
Vth (1974–79)	157	348
VIth (1980–85)	895	1,530
VIIth (1985–90)	1,906	2,471
VIIIth (1992–97)	4,140	5,084
IXth (1997–2002)	8,455	10,773
Xth (2002–07)	16,254	15,102
XIth (2007–12)	39,490	49,000

21.72 The DDWS document correctly argues that groundwater sources identified as the basis for rural drinking water supply schemes have proved to be unsustainable because of falling water tables and the associated problem of pollution. Since rural drinking water is overwhelmingly supplied by groundwater our ability to tackle drinking water problems cannot be delinked from our ability to evolve a sustainable policy for groundwater for irrigation. It is also necessary to have coordination with rural sanitation and primary healthcare programmes since faecal contamination is a major problem.

21.73 The management of rural drinking water schemes raises institutional issues of agencies which should be responsible for their maintenance and upkeep. Although responsibility for operation and maintenance of water supply schemes lies with the PRIs, in many states this responsibility is poorly defined and not supported by transfer of adequate funds and trained manpower to the PRIs. PRIs and Village Water and Sanitation Committees (VWSCs) are not willing to take over completed schemes in which they were not involved at the planning and implementation stages. Inadequate water resource investigation, improper design, poor construction, sub-standard material and workmanship, and lack of preventive maintenance also lead to rapid deterioration of water supply schemes.

21.74 DDWS has proposed transfer of management and financial responsibility and autonomy to VWSCs formed under the gram panchayats so that they can develop village water security plans taking into consideration present water availability, reliability, its different uses, and equity. A VWSC can also outsource development of the water supply scheme to an agency of its own choice after consultations in the gram sabha. Communication and Capacity Development Units (CCDUs) are to be established in all states/UTs to create awareness among rural people on all aspects of rural water supply and for capacity building of local communities, especially of women.

21.75 DDWS argues that the level of service should be linked to the issue of demand, commonly expressed through user willingness to pay. However, the issue of equity and the basic minimum need concept should be kept in mind while designing the schemes. Willingness to pay under adverse conditions cannot be interpreted as affordability to pay. But the cost of water beyond the basic minimum need is to be borne by the consumer.

21.76 WHO 'Guidelines for Drinking Water Quality' (2004) and 'Guidelines for Safe Use of Wastewater and Grey Water' (2006) are to be adopted and a water testing laboratory is to be established at each sub-division level.

21.77 There is also a commitment to move beyond habitation to the household in the definition of coverage. Thus, installation of a water supply system in a habitation should not automatically confer on the habitation the status of a fully covered habitation unless every household in the habitation has been fully covered with potable water in sufficient quantity.

21.78 This constitutes a major breakthrough in drinking water policy and strategy in India. But it needs further deepening in terms of database, understanding, strategic content, and direction.

HARNESSING THE POTENTIAL OF TRADITIONAL SYSTEMS

21.79 India has a rich tradition of water harvesting systems. Their neglect would be a terrible mistake in an era of piped drinking water supply or water supply from hand pumps and bore wells. *Kuin* or *kuia* was a type of well constructed in a few parts of Rajasthan (Churu, Bikaner, Jaisalmer, and Barmer). The *kuin* was an unusual kind of well in that it did not depend on underground water. In the *kuin*, water accumulates very slowly. The rainwater so retained by sand gradually percolated to the bed of the well and was usually not more than three earthen pots a day. The significance of these wells lies in the fact that they made life possible in the Rajasthan desert region by supplying essential drinking water. *Bera* or *beri* is another variation of a well constructed near a water body or on the dry bed of a water body. *Kund* or *kundi* comprises direct accumulation of rainwater in an underground brick-lined tank. It was primarily constructed for potable purposes in north-western Rajasthan, where groundwater was either brackish or available at great depths or both. *Tanka* is an underground cavern used to collect and store rainwater for drinking purposes.

21.80 A traditional system still prevalent in desert districts like Barmer, Jodhpur, Jaisalmer, and Jhunjhunu . Depending on the location, the water from rooftops is also diverted into the *tanka*s to enhance storage. *Nadi* is a village pond, constructed in areas where the underground strata is less sandy and could hold water till December. At times, these *nadi*s are lined if clayey material is locally available to reduce percolation. They serve the purposes of irrigation as well as drinking water. *Dhara* or springs are the main source of drinking water in Central Himalayas. They are built at a place where the stream spouts from underground to the surface on the side of a hill. The stream originating from a *dhara* is channelled along the hillside and directed to fields as well as used for drinking water purposes. At times, metal spouts are attached to these springs to get water to flow out and fill small, tank-like structures constructed below them. *Naulah*s or *noellah*s are similar structures found in the Kumaon hills. Unlike *dhara*s, water in a *naullah* does not come out as a spring but slowly seeps out and gets collected in small *kund*s. These structures are present in areas where the underground water table intersects the ground surface. Usually, these *naullah*s are protected by enshrining deities within their structure, making it part of the religious culture of the area. Revival of traditional water harvesting systems should be the first charge on MGNREGA funds.

NEW STRATEGIC FRAMEWORK FOR RURAL DOMESTIC WATER

21.81 A common resource in private hands places major responsibility of managing it sustainably on the private appropriators themselves. The state needs to play a key facilitating role to ensure that this does indeed happen. This requires a major inter-ministerial partnership through coordination of activities, which are currently happening within departmental silos, across which there is little conversation, let alone partnership. DDWS has to work closely with MoWR, as also other related departments. The Tenth Plan proposed the setting up of an inter-ministerial coordination committee at the level of Secretaries under Member, Planning Commission. The following key elements of a new implementation strategy for drinking water security in rural India require closely coordinated action:

1. *Create an essential data- and knowledge-base to enable water appropriators to make informed decisions.* Knowledge levels in this area are low not just among farmers, but also among officials and even among scientists. The manner of data collection even on drinking water sources is extremely loose. Aquifer mapping and delineation has not even started to get off the ground. The present MoWR scheme called 'Groundwater Management and Regulation', has been concerned with neither. Most of these 'small' MoWR schemes have been suffering neglect, with focus being exclusively on the large AIBP. It is the 'soft-aspect' schemes that hold the key to transforming large outlays into real outcomes. Its first task should be to build a comprehensive database of aquifers in India along with a spelling out of strategies for assuring safe and sustainable drinking water in each setting. This effort needs to be dovetailed with the Development of Water Resources Information System scheme (implemented by CWC and ISRO), which aims to put in place a web-enabled water resources information system. While developing its own new MIS, DDWS must work closely with these agencies to arrive at a holistic picture of drinking water prospects in each block of India. Water Security Action Plans (WSAPs) rightly need to be prepared for each village and district.
2. *Develop aquifer management plans so that holistic management of groundwater with a clear sense of priorities is possible.* These interventions would necessarily vary, depending on which hydrogeological setting we are seeking to address. Each hydrogeological setting demands a different approach, since each setting has variable implications for rates of groundwater recharge and drinking water security.
3. *Provide the necessary framework and resources for awareness generation and capacity building among stakeholders to help them make high-quality informed decisions.* Major partnerships have to be forged between apex technical institutions like the National Water Academy and the Rajiv Gandhi National Groundwater Training and Research Institute (both under MoWR) and a whole host of government initiatives (NIRD, SIRDs, Water and Land Management Institute, and CAPART), and leading non-government training institutions, which can reach different levels of stakeholders. Training is required in sustainable and equitable groundwater management, water quality

monitoring, water level recording, O&M of drinking water supply systems, and social audit. DDWS must encourage use of its allotted funds for Water and Sanitation Support Organizations (WSSOs) for building partnerships with these kinds of training and social mobilizational institutions.

4. *Break the energy–irrigation gridlock.* A major factor contributing to a rapid fall in water tables in India is the availability of free or cheap power. Now the latter has also become a consequence of the former, as farmers need power to reach lower depths to extract groundwater. Complete elimination of power subsidies would have a major negative impact on farm livelihoods. But there is a way out as shown especially by the *Jyotigram* scheme in Gujarat. Feeders supplying power to tube wells are separated from other rural feeders. Now villages get full day three-phase power for domestic use, schools, hospitals, and village industries. Farmers get eight hours of full-voltage three-phase power according to a pre-announced schedule. Predictable, reliable, high-quality, even if rationed power, appears a better deal for farmers than the earlier erratic, poor quality supply that incentivized stolen power. This has made possible real-time co-management of electricity and groundwater of which there are few other examples across the globe (Shah 2009).[14]
5. *Create the supportive legal regulatory framework to facilitate stakeholder action.* The rights of appropriators to devise their own institutions should be protected, while seeing to it that they do not violate legally enshrined principles of rights, equity, and sustainability. Separate groundwater legislations are needed if aquifers are to be protected. DDWS must realize that it cannot leave this task merely to MoWR. This is a national priority and must become a conditionality for further support under NRDWP, given the overwhelming importance of groundwater for rural drinking water supply.
6. *Set up multiple layers of nested institutions within which appropriation, provision, monitoring, regulation, enforcement, conflict resolution, and governance activities can be organized.* This task has to begin now and will require armies of social mobilizers mainly drawn from civil society organizations who need to help generate awareness about the need for collective management of groundwater for drinking water security. But before this can even begin a massive national effort at capacity building of these social mobilizers is essential to ensure that they understand CPR management and groundwater in the first place.
7. *Deploy adequate human resources at the cutting-edge level of implementation at the block level and below.* The block-level inter-disciplinary team of experts in hydrogeology, anthropology, and social work will identify and build teams of barefoot water experts (*jal mitaans*) deployed by VWSCs within each gram panchayat level. The VWSCs will:

   - Select barefoot water experts (*jal mitaans* or water friends) who will be trained by experts at the block-level.
   - Oversee work of these *jal mitaans* who will:
     - generate household-level information about the extent of water insecurity in each habitation in each season both in terms of quantitative availability and quality and feed these into the MIS;
     - engage the people in preparing water security plans for their GP which clearly prioritizes domestic water and livelihood water needs over all other demands and takes care of the interests of disadvantaged sections like women, poor, and SC/STs;
     - report cases of water insecurity to VWSCs and in gram sabha meetings and seek redressal from gram sabha and gram panchayat;
     - take charge of O&M of domestic water supply schemes;
     - monitor water levels and water quality;
     - implement urgent measures to mitigate quality problems, wherever possible;
     - 'sensitize' members of the VWSCs;

[14] T. Shah, *Taming the Anarchy: Groundwater Governance in South Asia*. Resources for the Future, Washington DC and International Water Management Institute, Colombo, 2009.

- monitor availability of safe drinking water in schools, anganwadis, and other public feeding programmes and report to the VWSC; and
- operate in tandem with anganwadi workers and ASHAs to spread awareness on the water-health nexus to ensure that cases of water-borne diseases are treated on time.

- Monitor compliance with water security plans and norms of water supply schemes.
- Organize social audit of drinking water in the GP.

8 *Address water quality issues on a high priority.* This requires the following:

a. Comprehensive geological and geochemical understanding of aquifers: Research is needed on the cause behind water quality problems. A water quality research fund needs to be made available for partnership-based research with academic and civil society groups to work together on water quality issues. This may be drawn from the Research and Development Fund under NRDWP.

b. Continuous monitoring of water quality: We need a system of frequent water quality monitoring in a participatory manner. The responsibility for such monitoring may be carried out by district-level laboratories along with civil society groups and PRIs. Portable water quality kits can be provided to *jal mitaans* for identification of major quality problems.

c. Identification of health impacts of poor water quality: Today we do not have techniques for easy detection of fluorosis and arsenicosis or answers on how to tackle them. District hospitals need to have specialized health referral centres for these diseases, especially in the affected areas.

d. Creation of demand for mitigating impacts of poor water quality: Doctors have a significant role to play in this since only they can link the symptom, for example, pain, to the root, that is, water (for example, in fluorosis). Instead, if the doctor recommends a pain killer, an opportunity is lost. Therefore, a national level communication programme through mass media, doctors, and other avenues needs to be activated (as has been done in the case of polio and HIV programmes).

e. Services for mitigation of health problems: The specialized health referral centres need to offer services for treatment of these health problems. A range of solutions—nutrition enhancement, corrective surgeries, and ameliorating interventions—has to be tried together on the affected people.

f. Preventing further problems due to poor water quality:
   - Low cost filters
   - Rapid spread of better sanitation and hygiene practices, including solid and liquid waste management systems, and their integration with drinking water supply schemes
   - Water harvesting and recharge
   - Nutrition programmes for mitigation of health problems
   - Providing alternative safe sources of water

URBAN WATER SUPPLY

21.82 The urban population in India in 2001 was around 286 million (about 28 per cent of the total population) spread over 5,161 urban agglomerations of which 35 were 'million-plus' cities constituting about 37 per cent of the urban population. It is estimated that surface water and groundwater sources cater to 75 per cent and 25 per cent of the urban population respectively. Provision of water supply facilities in cities is becoming increasingly challenging due to depletion of fresh water sources, increasing urbanization, industrialization, vagaries of the monsoon, depletion of groundwater, declining quality of groundwater due to contamination, and other factors. The cost of water supply schemes is also increasing due to non-availability of water in nearby locations necessitating dependence on far-off water sources. These problems will intensify as the urban population increases, reaching about 50 per cent by 2050.

21.83 The scale of the challenge can be judged from the fact that water availability in urban areas at present varies widely with many cities grossly underserved. In 2006, out of 35 metro cities, 12 had per capita water supply more than the national norm of 150 lpcd and

23 cities had per capita water supply less than 150 lpcd. It is also pertinent to mention that the distribution within the city is not equitable and hardly any city receives 24×7 supply of water.

ELEVENTH PLAN INITIATIVES

21.84 The Eleventh Plan identified a total requirement of Rs 53,666 crore in order to provide 100 per cent water supply coverage to the urban population. Out of the total allocation of Rs 50,000 crore under JNNURM, 40 per cent of the funds, that is, Rs 20,000 crore are envisaged to be for water supply projects. Additional central assistance of Rs 7,726 crore was released in March 2010.There are 16 ongoing Externally Aided Projects, the details of which are as follows:

- World Bank—1 project, $ 48 million
- JICA—9 projects, $ 2,195 million (¥ 201,464 million)
- ADB—6 projects, $ 1,307 million

JAWAHARLAL NEHRU NATIONAL URBAN RENEWAL MISSION

21.85 The mission as on March 2010 had sanctioned 559 water supply projects at an approved cost of Rs 27,388 crore, under the Urban Infrastructure Governance (UIG) and Urban Infrastructure and Development Scheme for Small and Medium Towns (UIDSSMT) components of JNNURM. Water supply projects sanctioned under JNNURM incorporate features, such as reduction of non-revenue water below 15 per cent, volumetric tariff, 100 per cent metering of all connections, creation of water districts with bulk flow metering and district metering areas, and 24×7 water supply. The strategy identified for ensuring operational and financial sustainability of water supply includes the following:

i. Incentives to providers of basic services to the urban poor, with improved monitoring and oversight
ii. Mechanisms to strengthen consumer voice, including passage of public disclosure law and community participation law and associating elected ULBs with the 'city planning function'
iii. Introduction of a system of e-governance using IT applications
iv. Improved information through better metering
v. Improved management autonomy for water providers to judiciously upgrade, rehabilitate, and expand distribution systems, and even treatment capacity as required
vi. Benchmarks for service level and introduction of benchmarking and surveillance systems
vii. Target subsidies to capital costs, not recurring costs, which should be fully covered by user charges
viii. Adoption of a modern, accrual-based double entry system of accounting
ix. Levy of reasonable user charges with the objective of cost recovery for O&M and re-investment for augmentation and replacement
x. Measures to improve the credit worthiness of water utilities
xi. Implementation of the 74th Constitution Amendment Act regarding empowerment of ULBs
xii. Structural reforms, such as ring fencing of water utilities, professional management, capacity building and autonomy of water utilities, and encouraging PPPs

SERVICE-LEVEL BENCHMARKS

21.86 Establishing service-level benchmarks is an essential step towards the reform of the urban water sector. MoUD formulated benchmarks in the urban water and sanitation sector in August 2008. The process involved a definition of performance indicator, identification of data requirements, establishing the methodology for the indicator to be measured, arriving at a methodology for reliable measurement of indicators, setting the frequency of measurement of indicators, fixing the jurisdiction (geographical entity) of measurement, and arriving at a consensus on the benchmarks.

21.87 A pilot project in the implementation of benchmarking has been initiated in 28 cities and the first stage, that is, establishing baseline levels of performance has been completed. This will be followed by the preparation of plans for improvement of information systems and performance. This initiative of the MoUD has generated considerable enthusiasm among the states. Karnataka has rolled out benchmarking to the entire state and has developed an online application for compiling SLB data. It has also linked disbursement of finance commissions to the achievement of benchmarks.

21.88 Madhya Pradesh and Andhra Pradesh have initiated benchmarking in 11 towns each in addition to those included in the MoUD pilot exercise. Orissa has initiated steps towards institutionalization/state-wide rollout of benchmarking by earmarking funds in the state budget. Documentation of baselines will be followed by the preparation of information systems improvement plans, which would comprise household surveys, installation of bulk meters at production points, installation of flow meters at key distribution points and consumer-level metering, documentation of hours of supply, use of pressure gauges to monitor pressure levels, development of complaint recording and monitoring systems, and ring fencing of water and sanitation utility accounts. Performance improvement plans will comprise measures, such as reduction of illegal connections and encouraging legal connections, especially amongst the urban poor.

Training Programmes

21.89 These programmes aims at building technical capacity in the sector catering to the needs of professionals working in various Water Supply and Sanitation Departments (water utilities). The following training programmes have been introduced and are being conducted through academic and research institutions and field departments:

- *Postgraduate course in public health/environmental engineering*. The duration of the PG course is two years. There are 11 recognized premier institutions, where in-service engineers are deputed for undergoing the course.
- *Short-term course in public health/environmental engineering* is being imparted in two institutions. The duration of the course is three months.
- *Refresher courses on various aspects of design, construction, operation, and maintenance of water supply and sanitation facilities* are conducted by 20 recognized academic and research institutes and field departments. The duration of the courses vary from one week to four weeks.

As of March 2009, about 30,600 technical personnel, at various levels, had been trained under these programmes.

Centrally Sponsored Accelerated Urban Water Supply Programme

21.90 This programme launched in March 1994, provides central assistance for provision of safe drinking water supply facilities in towns with a population of less than 20,000 (as per the 1991 Census). Under this programme, 50 per cent of the estimated cost of the water supply scheme is provided by the Government of India as grant, 45 per cent by the respective state government as grant, and the balance 5 per cent is mobilized through beneficiary contribution. Since 2005–06, this scheme has been subsumed into the UIDSSMT, which aims to cover all small and medium towns excluding those to be covered under JNNURM. So far, 1,243 schemes have been approved and 1,088 schemes have been commissioned/and completed.

PPPS IN URBAN WATER SUPPLY

21.91 Since the water supply sector in urban areas requires huge investments in infrastructure and management models that promote efficient, effective, and good quality basic urban services on a sustainable basis, there is a role for well-conceived, structured, and transparently-executed PPPs. There are a few projects in the PPP mode, but these need to be examined. Water supply and sanitation services have been seen as 'public goods' that need to be provided at affordable prices and this has led to low water and sewerage tariffs that make water supply and sewerage projects non-bankable necessitating general revenue support even for operations and maintenance. The financially precarious state of most ULBs makes it difficult for them to assure such support.

21.92 With the launch of the reform-driven and part-grant financed JNNURM, both the macro-environment as well as the project-level micro-environment is becoming more and more congenial for PPPs in the urban water supply sector. Many of the JNNURM-supported reforms are expected to create a favourable governance and institutional framework for the private sector to feel more confident to venture into. Another initiative taken by the Government of India in partnership with KfW is the proposal to establish a PPP urban infrastructure fund exclusively for social infrastructure (water supply, sanitation, and Solid Waste Management) through service and management contracts. The assistance will cover capacity building, project development funding, and facility to finance required investment. A mix of loan and grant support for PPP-UIF (Urban Infrastructure Fund) would be made available under the Indo-German Development Cooperation. Up to Euro 200 million (Rs 1,200 crore) could be offered as re-finance support for the fund. Further, grant assistance up to Euro 3 million could be provided for capacity building and project development.

21.93 Private sector participation in this area would be facilitated by addressing issues that affect PPP generally, such as development of local capital markets, development of a long-term capital bond market, encouraging new products, such as credit enhancement and bond insurance, encouraging participation by FIIs, insurance companies, and pension funds in infrastructure investment, capacity building, especially in the areas of project evaluation and fund management skills. The state governments need to enact model municipal laws to enable PPP, set up regulatory authorities, set up state-level urban infrastructure institutions, and create cadres of professionals at the ULB and state levels. There is also a critical need for building regulatory capacity in areas, such as managing the regulatory structure; tariff fixation; ensuring better bidding process; contract management/dispute resolution process; project finance; and clear policy direction for non-compete clauses.

LEARNING FROM INTERNATIONAL EXPERIENCE

21.94 Many examples from all over the world can provide right directions for the reform of the urban water supply sector in India. These include, for example, the Cooperativa de Servicios Publicos Santa Cruz Ltda (SAGUAPAC), Santa Cruz, Bolivia. SAGUAPAC is financially independent and ensures that all costs are recovered from water users.

21.95 Another example is the Departamento Municipal do Agua e Esgoto (DMAE), Porto Alegre, capital of Rio Grande do Sul, Brazil. While DMAE is an autonomous public body, separate from the municipal government, and makes its own decisions on how to invest the revenues that it earns, the mayor appoints the director-general of DMAE, and the representatives on its deliberative council. This is similar to the French municipally-owned régies à personnalité morale et autonomie financière. The European Union describes these as trading bodies whose borrowing and debts would not be counted as government debts for the purposes of monetary control (Hall et al. 2002).[15] The operations and investment decisions of DMAE are discussed through a participatory budgeting process and citizens are involved in checking the quality of the services provided (Maltz 2005).[16] DMAE is self-financed through the water tariffs paid by approximately 1.4 million city residents. An annual surplus of about 20–25 per cent of the budget goes into new investments.

21.96 The Empresa de Acueducto y Alcantarillado de Bogotá (EAAB), Bogotá, Columbia is another international example of successful reform in the 1990s. By 2001, 95 per cent of the population had clean tap water, while 87 per cent were connected to the sewage system, an impressive achievement considering the rapidly growing population of the city. The expansion was financed by introducing a progressive tariff system.[17] Participatory practices have also been successfully followed in the Municipality of Recife in Brazil (Miarnada 2005).[18]

[15] David Hall et al., *Water in Porto Alegre, Brazil—Accountable, Effective, Sustainable and Democratic,* Porto Alegre, 2002.

[16] Helio Maltz, *Porto Alegre's Water: Public and for All.* Transnational Institute (TNI) & Corporate Europe Observatory (CEO), 2005.

[17] Manthan, *Public Private Partnerships in the Water Sector*. Badwani, 2010.

[18] Antonio Miranda, *Recife, Brazil: Building Up Water And Sanitation Services through Citizenship*, Transnational Institute (TNI) & Corporate Europe Observatory (CEO), 2005.

21.97 There is absolutely no alternative to reforming the water sector in urban areas. A key element of this has to be planning for safe disposal of waste. It is estimated that about 80 per cent of the water used by households is disposed of as waste. This waste is polluting either our groundwater or our rivers, which are the sources of fresh water. Reform of the urban water sector must follow international practice, which is committed to reducing dependence on fresh water and is focused on treatment and recycling of waste water, which also reduces pollution. We must learn from the examples of countries like Singapore which have reduced their dependence on fresh water and where even a high-quality water demanding sector like the semiconductor industry uses recycled water. Today our installed capacity to treat waste is less than 20 per cent of what we need. The investments we are making in cleaning rivers have little chance of yielding results unless we have better plans in place for safe disposal of waste, which continues to pollute our rivers.

21.98 Most Indian cities today spend anywhere between 50–70 per cent of their water supply accounts on electricity to pump water. As the distance increases, the cost of building and then maintaining the water pipeline and its distribution network also increases. If the network is not maintained then water losses also increase. Today, municipalities officially report anywhere between 30–50 per cent of the water supplied as 'lost' in leakages. It would be far more efficient to revive traditional and local water bodies, which also help recharge groundwater.

CLEANING OUR RIVERS

21.99 The National River Conservation Plan (NRCP) was launched in 1995 to check pollution levels in identified polluted stretches of major rivers. At present NRCP covers 35 stretches of polluted rivers in 164 towns across 20 states. A Planning Commission report[19] prepared for the Supreme Court in 2009 finds that while the Eleventh Plan outlay for NRCP is Rs 2,100 crore for the entire country, the utilization was less than 40 per cent in the first three years of the Plan period.

21.100 In the Ganga basin, Sewage Treatment Plant (STP) capacity is only 31 per cent of the domestic sewage generation. In Class I and II towns along the main stem of the Ganga river, the corresponding figure is 35 per cent. Thus, a gap of around 65 per cent exists between domestic sewage generation and STP capacity resulting in untreated sewage flowing into rivers and other water bodies. As a result, in many locations along the Ganga, BOD/COD has worsened. According to the report, the coliform count in the river has increased particularly at pilgrimage places due to bathing of pilgrims who also pollute the river.

21.101 The report estimates that NRCP projects for all the rivers in the country would cost about Rs 33,000 crore for creating additional 38,000 MLD STP capacity by 2020. As the report concludes, the ultimate goal should be to provide sewerage facilities for all and zero discharge of untreated sewage into our rivers.

CONCLUSION

21.102 The Planning Commission is currently engaged in preparing a Comprehensive Water Security Management Policy for the consideration of the government. It will carry forward the ideas expressed in this chapter for taking a unitary view of the hydrologic cycle and moving beyond the silos into which we have divided our approach to water. Meanwhile, in the next two years of the Eleventh Plan, there is a need to take urgent steps to:

a. protect sources of drinking water both in terms of levels as well as quality;
b. protect and rehabilitate traditional water harvesting structures;
c. rapidly move towards rainwater harvesting and recharging of groundwater through investments

[19] Planning Commission, *Report on Utilisation of Funds and Assets Created through Ganga Action Plan in States under GAP*, New Delhi, 2009.

under the Integrated Watershed Management Programme (covered in Chapter 4 on Agriculture) and MGNREGA (covered in Chapter 12 on Rural Development);

d. bridge the gap between the irrigation potential created and utilized in surface water irrigation projects;

e. improve efficiency of water use in AIBP projects through both management and technology innovations;

f. improve systems of waste disposal, especially in urban areas; and

g. set up greater capacity of sewage and effluent treatment plants.