Water Resources Development in India: Critical Issues and Strategic Options

Executive Summary

India continues to struggle with growing financial crunch to complete its water sector infrastructure and its operation and maintenance cost. On the other hand, inadequate institutional reforms and effective implementation has affected its performance level. In recent years, the Government of India has initiated several steps to improve investment and management of water management sector, which includes: Accelerated Irrigation Benefits Programme, Hydrology Project, setting up of Water Quality Assessment Authority, Command Area Development and water management programme, National Project for Repair, Renovation and Restoration of Water Bodies directly linked to Agriculture, Flood Management, and River Basin Organizations.

Growing demand across competitive sectors, increasing droughts, declining water quality, particularly of groundwater, and unabated flooding, inter-state river disputes, growing financial crunch, inadequate institutional reforms and enforcement are some of the crucial problems faced by the country's water sector. Availability of safe drinking water is inadequate. Severe water shortages have already led to a growing number of conflicts between users (agriculture, industry, domestic), intra-state and inter-state. Emerging challenges include management of existing infrastructure and of the water resource itself. Water reform in India mostly focuses on organizational issues rather than the instruments that govern the relationship between the regulator and the user.

Provision of canal irrigation and water supply services in India has largely remained with the government agencies. Absence of enforceable water entitlements at all levels is at the root of service shortcomings, water use inefficiency, unregulated groundwater extraction, negligence of traditional and low-cost water bodies, financial problems and conflicts which plague the water sector. Faced with poor water supply services, farmers and urban dwellers have resorted to helping themselves by pumping out groundwater, which has led to rapidly declining water tables; in coastal areas this trend has led to salinity ingress. Financial crunch has also led to an enormous backlog of maintenance and thereby, inadequate performance levels of irrigation projects. Distortion in pricing of water services has further induced substantial overall economic costs by enlarging the gulf between prices and costs. Some of the causal factors are: inadequate revenue generation, chronically under-funded Operation and Maintenance (O&M) costs, revenues not channeled directly to expenditure, inappropriate prioritization of government expenditures.

India requires proper design and effective execution of suitable strategic options.

- The National Water Policy 2002 encourages private sector participation in planning, development and management of water resources project for diverse uses, which might help in generating financial resources and introducing corporate management and improving service efficiency and accountability to users. The policy also recommends some incentives to promote public private partnership. Also, competition in provision of public services could improve efficiency in provision of irrigation and water supply services.
- There is increased realization for a paradigm shift from water resources development to water resources management by restructuring and strengthening existing institutions for better service delivery and resource sustainability. Currently, integrated water resources management approach has also gained considerable importance.
- In tune with the National Water Policy-2002 focus to provide safe and adequate drinking water to all, India needs to refine its models of service provision. Stress should be laid on rainwater harvesting and conservation, followed by technological options for treatment, and institutional options for improved local management.

- Community-based tank rejuvenation across the country would enable to harvest rainwater and enable local management at low cost. This would also facilitate groundwater recharge. Tank water also helps to provide critical irrigation in dry land areas, thereby, improving the livelihoods of poor.
- Effective regulation of groundwater extraction laced with proper power subsidies and improved technological interventions would enable improved groundwater resources management in the country.
- Promoting vibrant River Basin Organisations with more focus on integrated water resources management would go a long way to address resource conservation, efficient utilization and related management – including, cross subsidization, pricing, collection, and investments. This needs to be supported by multi-level stakeholder platforms to play proactive role at all stages.
- Establishing water regulation authorities at state level, would elevate the state role more towards a facilitator and a regulator from the present role of operator and crisis manager.

1. Water Resources: An Overview

In India, the total utilizable water resource is assessed as 1123 BCM. Keeping a provision of about 71 BCM/yr out of 433 BCM of groundwater, 362 BCM/yr of the resource is estimated to be available for irrigation. The net draft of groundwater for irrigation is around 150 BCM/yr. The per capita availability of water at national level has been reduced from about 5177 cubic meters in 1951 to the estimated level of 1,820 cubic meters in 2001 with variation in water availability in different river basins. Given the projected increase in population by the year 2025, the per capita availability is likely to drop to below 1,000 cubic metres, which could be labeled as a situation of water scarcity (GOI, 2006). India has a highly seasonal pattern of rainfall, with 50% of precipitation falling in just 15 days and over 90% of river flows occurring in just four months. A total storage capacity of 212.78 Billion Cum (BCM) has been created in the country through major and medium projects. The projects under construction will contribute to an additional 76.26 BCM, while the contribution expected from projects under consideration is 107.54 BCM. The total availability of water in the 76 major reservoirs was 109.77 BCM at the end of the monsoon of 2005 (GOI, 2006). The irrigation potential of the country has been estimated at around 139.9 mha without inter-basin sharing of water and 175 mha with inter-basin sharing. The Central Ground Water Board (CGWB) has estimated that it is possible to increase the groundwater availability by about 36 BCM, by taking up rainwater harvesting and artificial recharge over an area of 45 mha through surplus monsoon runoff. Thus, the groundwater availability may correspondingly increase. The recent estimates (GOI, 2006) on water demand are made by a) Standing Sub-Committee of the Ministry of Water Resources (MoWR) and b) the National Commission for Integrated Water Resources Development (NCIWRD); their estimates (shown in Table 1) are made till the year 2050. Both of them have triggered warning bells on the intensity of the problem. The estimates by MoWR indicates that, by year 2050, India needs to increase by 5 times more water supplies to industries, and 16 times more for energy production, while its drinking water demand will double, and irrigation demand will raise by 50 percent. To address the water-related issues and thereby launch a massive awareness programme all over the country, the Government of India has declared year 2007 as "Water Year"[1].

Table 1. Water Demand (in BCM) for various Sectors:

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

Source: GOI, 2006**.**

2. High Stress on Irrigation Infrastructure

After independence, the Government of India gave high priority to the construction of major irrigation related infrastructure. At present, India has a capacity to store about 200 billion cubic meters of water, a gross irrigated area of about 90 million hectares[2] and an installed hydropower capacity of about 30,000 megawatts (World Bank, 2005). These investments in turn have largely impacted the economic and social development of the country. Assured water supplies have

[1] Some of the important activities planned during this year are: (a) National Congress on Groundwater; (b) Farmers Participatory Action Research Programme in 5000 villages to promote 'more crop and income per drop' of water; (c) Training of Water Masters in each Pani Panchayat and institution of an Award for the best Pani Panchayat; (d) Wider dissemination of know-how to the user level through electronic and print media (e) Organisation of workshops/seminars on water related technical and management issues; (f) Participation in festivals, fairs, training programme, mass awareness programmes etc.

[2] This refers to the potential utilization of capacity as per the World Bank (2005) estimates

consistently increased crop yields on irrigated land than yields from rainfed agriculture (see Figure 1) thereby promoting national food security. Similarly, investments in construction of large dams have resulted in 'direct benefits' in terms of providing both groundwater irrigation and hydropower, which in turn generate both inter-industry linkage impacts and consumption-induced impacts on the regional and national economy. Increased generation of electricity and irrigation from a multipurpose dam result in significant 'backward' linkages (i.e., demand for higher input supplies) and 'forward' linkages (i.e., providing inputs for further processing). In addition, as incomes rise, there is a further feedback loop deriving from increased demands for goods and services.

Poverty Reduction: Irrigation in India is not dominated by "big landlords" (see Figure 2). The more crucial concern is not who gets the water but how that water transforms the demand for inputs, especially labor (which is provided primarily by the landless and marginal farmers).. Fundamentally, the demand for agricultural labor is 50% to 100% higher on irrigated land (World Bank, 2005). Irrigation essentially implies higher and much more stable employment, especially for the poor marginal and landless farmers (Chambers, 1998) (Figure 3). At the national level, an analysis of the association between poverty and irrigation (percent of cropped area irrigated) in 54 national sample survey regions shows that in irrigated districts the prevalence of poverty is about one-third of that in unirrigated rural districts (World Bank, 1991).

Similarly, the relationship between electricity availability (mostly from hydropower) and poverty is also found to be strong (Figure 5). The major water infrastructure designed in India, to provide a platform for regional and national economic growth, has been found to be an important platform for the substantial reductions in poverty and it is actually the poor and landless who have been the biggest beneficiaries (World Bank, 1991).

3. Groundwater development

Groundwater: The total annual replenishable groundwater resources of the country have been assessed as 433 Billion Cubic meters (bcm) and the net annual groundwater availability is estimated as 399 bcm (GOI, 2006). The groundwater development level is 58 per cent. The development of groundwater in different areas of the country has not been uniform. Highly intensive development of ground water in certain areas in the country has resulted in over exploitation leading to decline in the levels of groundwater and sea water intrusion in coastal areas. There is a continuous growth in 'dark' and 'overexploited' areas in the country. Out of 5723 assessment units (Blocks/Mandals/Talukas) in the country, 839 units in various States have been categorized as 'Over exploited'[3]. In addition 226 units are 'Critical'[4]. There are 550 semi-critical units, where the stage of ground water development is between 70 per cent and 100 per cent (MoWR, 2007). The Central Ground Water Authority (CGWA) has notified 20 severely critical/over exploited areas in the country for regulation of groundwater development and management. Beginning around 1960, owing to the adoption of Green Revolution Technology, groundwater irrigation developed at an explosive rate (see Figure 6), while tank irrigation declined fast and surface water irrigation grew much more slowly.

Over time, availability of free or nearly free electricity for irrigators (Figure 7) and declining canal water supplies, have motivated farmers to turn to groundwater. Over the last two decades, 84% of the total addition to net irrigated area came from groundwater, and only 16% from canals. By the year 2000, the net area irrigated by private tubewells is about double the area irrigated by canals (see Figure 6). Groundwater supplies support 70% of the irrigated area, about 80% of domestic water supplies (World Bank, 2005).

India has also witnessed an inexorable increase in energy subsidies to groundwater irrigation pumpsets (amount of electricity used in agriculture grew, see Figure 8). According to the Planning

[3] The annual groundwater extraction exceeds the annual replenishable resource.
[4] The stage of groundwater development is above 90 per cent and within 100 per cent of annual replenishable resource

Commission, while the agriculture sector accounts for nearly one-third of the sales of the State Electricity Boards, the revenues from farmers account for only 3% of total revenue. The World Bank (2005) estimates that subsidies to farmers account for about 10% of the total cost of supply, or about Rs 240 billion a year, which is equivalent to about 25% of India's fiscal deficit and two and a half times the annual expenditure on canal irrigation, with large impacts on fiscal deficits at the state level (see Figure 9). In addition, sustainability of groundwater resource itself is a major concern. Many of the most highly productive localities are already under severe groundwater stress. This is undoubtedly a crucial water challenge facing India in the coming decades.

4.1 National Water Policy: 1987 and 2002

The National Water Policy adopted by the Indian National Water Resources Council recognizes that water is a scarce and precious resource and thereby outlines the broad principles that govern the management of the country's water resources[5]. The first National Water Policy was adopted in September, 1987. However, very little has been achieved in the fulfillment of the objectives laid down in the first policy. Hence, there was a need to revise the National Water Policy of 1987 and a new policy was thus adopted in 2002 with a few more provisions[6] (GOI, 1987; 2002).

4.2 11th Five Year Plan Focus

The 11th Five Year Plan (2007-12) lays down provisions for efficient management of water resources in the country. These are as follows (GOI, 2006):

a) With efficient management of resources three major projects namely Mahi, Bisalpur and Ratanpura distributory, four medium projects Panachana, Chaapi, Chauli, Bethali and 139 minor irrigation projects are likely to be completed by the end of Tenth Five-year Plan, which would create additional irrigation potential of 299.16 thousand hectare;
b) The *Jal Abhiyan Programme* was launched in December 2005 for mass awareness among the stakeholders about scarcity of water, method for recharging of ground water, management of surface and ground water for efficient utilization, which covered about 20,000 villages, developed 1 lakh water harvesting structures and revamped canal system;
c) Focus on water harvesting structures and improving water use efficiency through better maintenance of irrigation system and promoting efficiency through drip/ sprinklers;
d) State Water Policy is under consideration with main objective of utilizing all available water resources, (surface and groundwater), in a judicious, equitable and economic manner;
e) *Water Users Associations* are being formed for maintenance, distribution and revenue collection;
f) *Rural infrastructure*: The *Bharat Nirman Programme* launched in 2005 identifies seven major areas where infrastructure gaps need to be addressed. The programme currently extends into initial two years of the 11th Plan. Bharat Nirman is a time-bound business

[5] The broad goals of the policy are: 1) establish a well-developed *information system* for water related data at national/state level to ensure appropriate resource planning; 2) effective *water resources planning* by encouraging non-conventional methods of water use such as in inter-basin water transfers, artificial recharge of aquifers and desalinization of brackish water, as well as traditional water conservation practices like rainwater harvesting and incorporating quantity and quality aspects as well as environmental considerations; 3) develop and manage water resources by reorienting existing *institutions* and creating new ones wherever necessary; 4) establishing water allocation priorities as: first drinking water, second irrigation, third hydropower, fourth ecology, fifth industries, sixth navigation and then other uses; 5) preserving *quality* of environment and ecological balance implementing and operating a water resource project; 6) groundwater development; 7) Fixing water charges in such a way that they cover at least the maintenance and operation costs of providing the service initially, and a part of the capital costs subsequently; 7) ensuring treatment of effluents before discharging into natural streams; 8) promoting water conservation consciousness through education, regulation, incentives and disincentives.

[6] The National Water Policy-2002 stresses participatory approach in water resources management. It has been recognized that participation of beneficiaries will help greatly for the optimal upkeep of irrigation system and utilization of irrigation water. Since water is provided very cheaply or even free of charge by public water utilities, users do not feel the urge to use water as a resource economically. The new policy however fails to deal with this aspect and does not provide any guidance for pricing of water for various uses.

plan for action in rural infrastructure over the four year period (2005-2009). Under Bharat Nirman, action is proposed in the areas of irrigation (to create 10 million hectares of additional irrigation capacity), rural roads, rural housing, rural water supply, rural electrification and rural telecommunication connectivity.

The main objectives of the XI Plan, as pointed out in the MoWR working group report (GOI, 2006 are: a) Creation of additional potential of around 16 mha; b) Reducing gap between Potential created & its utilization; c)) Mitigation of flood damages; d) Promotion of mass awareness on water related issues. In order to achieve these objectives, the group recommends a few strategies viz., completion of ongoing irrigation projects and extension, renovation & modernisation of old schemes; improvement in the efficiency of irrigation system; Command Area Development and Water Management; Participatory Irrigation Management; sustainable groundwater development and management; research and development activities on priority areas; establishment of River Basin Organizations; information, education and communication for mass awareness. The plan emphasizes the creation of irrigation potentials and thereby highlights the need to close the gap between irrigation potential created and irrigation potential utilized so as to ensure effective 'development' and 'management'.

Some of the other important suggestions of the Working Group (GOI, 2006) are:

1) Creation of more storage is absolutely essential for future requirements. The State Governments could be provided with incentives for creation of additional storage, if necessary. Extension, restoration and modernisation projects should be given due priority where the eroded potential can be restored with moderate expenditure.
2) A separate plan fund may be provided as irrigation maintenance fund[7].
3) There is need to reorient the approach from groundwater development to management and a comprehensive act for regulation of groundwater development on sustainable basis. Artificial recharge to ground water and rain water harvesting should be implemented in identified areas through participatory approach.
4) Incentives may be provided for activities of WUAs. The WUAs should include women members from land owning house holds in the command area, irrespective of their ownership of land.
5) State Governments may institute Water Regulatory Authorities for fixing water rates.
6) While undertaking construction of dams, adequate flood cushion may be provided in reservoirs. If required, the Central Government may provide necessary support for the same.
7) Projects on interlinking of rivers should be expedited.
8) Training and capacity building scheme for State/Central Government officials may be made comprehensively.

5. Status of water sector development

5.1 (a) Institutional arrangements: Water being a State subject, a State Government has the primary responsibility for use and control of this resource. The administrative control and responsibility for development of water rests with the various State Departments and Corporations. At the central level, the Union Ministry of Water Resources is responsible for development, conservation and management[8] of the resource.

[7] Project authorities should adopt O&M cost norm of Rs 600/ha for utilized potential and Rs 300/ha for unutilized potential as suggested by 12th Finance Commission. Similarly, a percentage of outlay for flood sector should be earmarked for O&M of flood protection works.

[8] Some of its main functions are: 1) development of general policy, technical assistance, research and development training to the states on irrigation, multipurpose projects, groundwater exploration and exploitation, command area development, drainage, flood control, water logging, dam safety and hydraulic structures for navigation and hydropower; 2) regulation and development of inter-state rivers; 3) water quality assessment; 4) water laws, legislation including International Water Law; 5) matters relating to rivers common to India and neighbouring countries; 6) bilateral and external assistance and cooperation programmes in the field of water resources development. These functions are carried out through various Central Organizations.

(b) Domestic water supply and health: The National Water Policy has assigned the highest priority for drinking water supply needs followed by irrigation, hydro-power, navigation and industrial and other uses (GOI, 2002). In the successive five year plans and the intervening annual plans, efforts have been made to rapidly develop water supply and sanitation systems. As per policy adopted provision for drinking water is to be made in all water resources projects. Water development projects have, however, contributed positively to human health in the country[9]. The development of water development projects not only enabled the country to overcome floods and drought but have also provided enough food and fibre for the ever increasing population.

MDG target to halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation. The indicators of progress towards this target are; 1) proportion of population with sustainable access to an improved drinking water source (urban and rural); 2) proportion of population with access to improved sanitation. To meet the MDG sanitation target, over 1.6 billion people need to gain access to improved sanitation over the coming decade, The main challenge being in developing countries. This will reduce the unserved population by 800 million, from 2.6 billion in 2004 to 1.8 billion in 2015 (WHO and UNICEF, 2006). However, achieving the MDG drinking water and sanitation target poses two major challenges: a rapid pace of urbanization, which requires a major effort even to keep up the current coverage levels; a huge backlog of rural people unserved with basic sanitation and safe drinking water, which calls for an intensive mobilization of resources to reduce the vast coverage gap between urban and rural populations.

In consonance with the MDG goals, the Ministry of Water Resources (GOI, 2006) assert that the water development projects have facilitated in providing safe water for human consumption, considering scarcity of water now faced in most parts of the country. Almost all the projects implemented in the country provide water for domestic purpose although primarily some of the projects were not meant for this purpose. With 80-90 per cent precipitation accruing during monsoon only, it has become imperative to store water for domestic use. Water supply also has helped to keep populated areas clean and hygienic through better drainage and improved sanitation. Water supply has thus contributed in improvement of health

(c) Industrial use: A basic necessity of industrial development is adequate availability of water. The Second Irrigation Commission in their report of 1972 recommended a provision of 50 BCM. for industrial purpose for the country as a whole. However, a recent assessment indicates that requirement for industrial use will rise to 120 BCM by 2025 AD (MoWR, 2007).

5.2 Irrigation development

In an agrarian economy like India, irrigation has played a major role in the agricultural production process. Irrigation development in the country has been taken up in a big way through Major, Medium and Minor irrigation schemes since independence[10]. The irrigation potential has gone up from 22.6 Mha (9.76 Mha through Major and Medium and 12.84 Mha through Minor) prior to Plan period to 93.95 Mha by the end of IX Plan and further to 97.15 Mha (38.87 Mha through Major & Medium and 58.28 Mha through Minor) up to March 2004 against the Ultimate Irrigation Potential of 139.91 Mha (58.49 Mha through Major & Medium and 81.42 Mha through Minor). This development of irrigation facilities has largely contributed to country's self sufficiency in food grains which has gone up from 51 Million tons in 1950 to 210 million tons in 2000. A total number of about 1248 Major, Medium and ERM (Extension, Renovation and Modernisation) projects have been completed

[9] While water is essential for sustenance of human life, it can as well create problems concerning human health being a carrier of vectors for diseases such as typhoid, cholera, diarrhoea.

[10] Projects which have a Cultivable Command Area (CCA) of more than 10,000 ha. are termed as major projects, those which have a CCA of less than 10,000 ha but more than 2,000 ha are termed as medium projects and those which have a CCA of 2,000 ha or less are known as minor projects. Minor irrigation projects have both surface and ground water as their source, while major and medium projects mostly exploit surface water resources.

up to March 2004 and another 471 (169 Major, 219 Medium & 83 ERM) projects, which have spilled over from IX Plan with a balance cost of about Rupees One lakh crore, are on-going. In addition, 300 new projects (78 Major, 136 Medium & 86 ERM) are being taken up during the X Plan period. Additional Irrigation Potential of 10.50 Mha (6.5 through Major and Medium and 4.00 Mha. through Minor) is planned to be created during the X Plan (also see Table 2), totaling to 104.45 Mha by the end of the current Plan (MoWR, 2007).

Table 2. Status of projects under major and medium irrigation sector during X Plan.

	Major	**Medium**	**ERM**
Projects spilled into X Plan	171	233	86
New projects taken up in X Plan	49	84	46
Projects likely to be completed in X Plan	48	91	39
No. of projects deferred/merged/reclassified etc.	- 6	-4	- 4
Spillover projects into XI Plan	166	222	89

Source: MoWR, 2007

Potential creation: Expansion of Irrigation facilities, along with consolidation of the existing systems, has been the main part of the strategy for increasing production of food grains. With sustained and systematic development of irrigation, the irrigation potential through major, medium and minor irrigation projects has increased from 22.6 million hectares (mha.) in 1951, when the process of planning began in India, to about 98.84 mha. at the end of the year 2004-05. Plan-wise irrigation potential created and utilised through major, medium and minor irrigation projects in the country is shown in Table 5.2 in Annex.

A milestone in water resources development in India is creation of a huge storage capability. Because of these created storage works it has now become possible to provide assured irrigation in the command area, to ensure supply for hydropower and thermal power plants located at different places and to meet requirement for various other uses[11]. Flood moderation could be effected in flood prone basins, where storage has been provided. Besides, supply of drinking water in remote places throughout the year has become possible in different parts of the country.

Planned investments: The expenditure incurred on major and medium projects and the irrigation potential created during the various plan periods are shown in Annex Table 5.3. At the beginning of the Tenth Five Year Plan, there were 162 major projects with a spill over cost of Rs. 140968 crore, 221 medium projects with a spillover cost of Rs. 12786 crore, and 85 Extension, Renovation and Modernisation projects, with a spillover cost of Rs. 21256 crore.

Irrigation potential created and utilised under minor irrigation under various plan periods as per Minor Irrigation Development Report from state governments are shown in Annex Table 5.4 (also see Table 3). Since 1999-2000, Central loan assistance (loan/grant) of Rs. 607.83 crore has been released to different states for completion of 5519 minor irrigation projects. About 3480 schemes have been completed, creating an additional potential of 1.229 lakh hectares by the end of March 2006 (GoI,2006). .

[11] At the time of commencement of the First Five Year Plan in 1951, population of India was about 361 million and annual food grain production was 51 million tonnes which was not adequate. Import of food grains was then inevitable to cover up the shortage. Attaining self sufficiently in food was therefore given paramount importance in the plan period and in order to achieve the objective, various major, medium and minor irrigation and multi-purpose projects were formulated and implemented through successive Five Year Plans to create additional irrigation potential throughout the country. This drive compounded with green revolution in the agricultural sector, has enabled India to become marginally surplus country from a deficit one in food grains.

Table 3. Ultimate irrigation potential, potential created and potential utilized in mha

Sector	Ultimate Irrigation Potential	Potential Created		Potential Utilised	
		Till IX plan	Anticipated in X plan	Till IX plan	Anticipated in X plan
Major and Medium Irrigation	58.47	37.05	5.3	31.01	3.41
Minor Irrigation					
a) Groundwater	64.05	43.3			
b) Surface water	17.38	13.6			
Sub-total	81.43	56.9			
Total	139.9	93.95	8.82	81.00	6.23

Source: GoI, 2006.

5.3 Towards Better Management

5.3.1 Accelerated Irrigation Benefits Programme: The Accelerated Irrigation Benefits Programme (AIBP) was launched during 1996-97 to provide loan assistance to the states to complete some of the incomplete major/medium irrigation projects, which were in an advanced stage of completion. The criteria for AIBP was further relaxed from April 2005 to include minor irrigation schemes of non-special category States with potential of more than 100 ha with preference to Tribal Areas and drought-prone areas. Extension, renovation and modernisation schemes have also been included on a selective basis. Since inception of this programme, the State Governments have been provided an amount of Rs. 19,438 crore as grant under AIBP up to March 2006 for 200 major/medium irrigation projects and 5519 Surface Minor Irrigation Schemes. After commencement of this programme 50 major/medium and 3480 Surface minor irrigation schemes have been completed. An additional irrigation potential for 3.25 million hectare has been created through major/medium irrigation projects up to March 2005 and an irrigation potential of 123,000 hectare has been created through surface minor irrigation schemes up to March 2006 (GoI, 2006).

5.3.2 Hydrology Project: The Hydrology Project Phase-I was with the World Bank support in nine states. The project enabled establishment of functional Hydrological Information System (HIS) and an improved institutional capacity of implementing agencies to build, operate and utilise the HIS to the benefit of different user groups. Totally Rs. 605.28 crore was spent till the end of project in December 2003.

5.3.3 Water Quality Assessment Authority: In view of the multiplicity of agencies involved in water management in the country, with inadequate co-ordination among them, the problem of pollution of national water resources has become a matter of serious concern. To circumvent the situation, the Ministry of Environment and Forests, supported the formation of a "Water Quality Assessment Authority" from May 2001. The Ministry of Water Resources assists the Water Quality Assessment Authority in carrying out and coordinating its functions. The Water Quality Review Committees have also been constituted in states with an objective to improve coordination amongst the Central and State agencies with regard to reviewing schemes for improving quality of water resources on a sustainable basis and monitoring miscellaneous issues related to water quality (MoWR; GOI, 2006).

5.3.4 Command Area Development and Water Management Programme: The Centrally-sponsored Command Area Development (CAD) Programme was launched in 1974-75, with the main objectives of improving the utilisation of created irrigation potential and optimising agriculture production and productivity from irrigated agriculture through a multi-disciplinary team under an Area Development Authority**.** The core components of physical works under CAD program are construction of field channels and field drains and implementation of warabandi (rotational water supply). The

cumulative progress of works on these respective components up to the end of IX Plan is 15.75 M.ha, 1.124 M. ha. and 10.18 M. ha. The CAD programme was initiated with 60 major and medium irrigation projects. So far 310 irrigation projects with a Culturable Command Area (CCA) of about 28.45 mha have been included under the programme, out of which 133 projects are currently under implementation (GOI, 2005). However, there have been certain constraints which are: a) Unreliability of water supply at the government outlet mainly due to system deficiency, b) Waterlogging / drainage congestion, non availability of drainage system and unscientific water use, c) Gap between scientific technologies of efficient water use at farm level, d) Lack of participation of farmers in water management, e) Lack of conjunctive use of surface and groundwater, f) non inclusion of correction of system deficiencies and main drainage system g) Lack of matching budgetary support by State Governments to execute the programme,

The restructured Command Area Development and Water Management Program (CADWM) from 2002, considered almost all aspects of the water resources management[12]. The programme covers a great deal of activities responsible for bringing in greater efficiencies in land water and crop management. The success of the programme would, however, depend on the CADAs/State agencies that are implementing the programme through coordination of the concerned departments/ organizations and other related inputs.

*5.3.5 National project for repair, renovation and restoration of water bodies***:** This scheme was prepared to take up pilot projects in states for implementation by the State Governments for which funds are released to state. The pilot scheme envisaged a plan outlay of Rs. 300 crore to be shared by the Centre and State in the ratio of 3:1. This scheme was taken up for implementation during the last two years of the Xth Plan. The objectives of the scheme are: a) to restore and augment storage capacities of water bodies, and b) to recover and extend their lost irrigation potential. Once the pilot scheme is completed and validated, it will form the basis for launching of the ''National Water Resources Development Project'' at much larger scale and spread to be completed in 7 to 10 years (GOI, 2005).

5.3.6 Flood Management: Out of the country's total geographical area of 329 m.ha. about 40 m.ha. of area is prone to floods, out of which 32 million ha. can be provided with reasonable degree of protection. Till March 2004, an area of 16.46 m.ha has been provided with a reasonable degree of protection against floods by construction of embankments, drainage channels, town protection works and by raising platforms. Although flood management comes within the purview of the state governments, the union government is providing central assistance to the flood prone states to take up critical works. The central government is also providing special assistance to the border states and north eastern states in particular, for taking up certain special priority works.

In order to mitigate the damages from floods, a nation wide Flood Forecasting and Warning System was established by the Central Water Commission on interstate river basins and flood forecasts are being issued through 173 Stations, out of which 145 are river-level forecasting Stations and 28 are inflow forecasting stations on major dams/reservoirs, throughout the country. With

[12] Some of components of CADWM program, which aim at improving water resources management are: a) Survey, planning and designing of On-Farm Developments(OFD) works; b) Construction of field channels with a minimum 10% beneficiary contribution; c) Full package OFD works including construction of field channels, realignment of field boundaries, land leveling and shaping (also with a minimum 10% beneficiary contribution); d) Construction of field drains, intermediate and link drains for letting out surplus water; e) Correction of system deficiencies above the outlet up to distributaries of 150 Cusec capacity; f) Renovation and desilting of existing irrigation tanks including the irrigation system and control structures within the designated irrigation commands with a minimum 10% beneficiary contribution as maintenance fund, the interest from which has to be used for maintenance in future; g) Reclamation of waterlogged areas (with a minimum 10% beneficiary contribution) including use of location specific bio- drainage techniques to supplement conventional techniques for reclamation of waterlogged area; h) Warabandi; i) Trainings/ adaptive trials/ demonstrations through Water and Land Management Institutes (WALMI) and other institutions and monitoring & evaluation of the program with 75% funding from Government of India; j) Institutional support to Water Users' Associations; k) Establishment cost – 20 % of OFD works l) R & D Activities.

reliable advance information about impending floods, loss of human lives and immovable properties, human miseries is reduced to a considerable extent. These measures also benefit the authorities of concerned dams/reservoirs and barrages for systematic operation of the reservoirs for optimum utilisation of water resources and for the control of floods (MoWR; GOI, 2006).

5.3.7 River Water Disputes: The major rivers of the country are mostly inter-State rivers. There has been an increasing demand for water in all sectors, sometimes leading to inter-State disputes on sharing of water. Efforts are being made to resolve disputes through negotiations amongst the basin States with the assistance of the central government. Adjudication through the appointment of water dispute tribunal is also resorted when required. The mechanism for settlement of water disputes is already available in the form of ISRWD Act, 1956 which provides for settlement of disputes by negotiations failing of which refers such disputes to a tribunal for adjudication (also see Annex Table 5.5) (GOI, 2006).

6. Key issues

India is currently facing a daunting set of water-related challenges. The next two sections deals with key issues followed by strategic options to address them (also see Table 6 and 7 for the summary).

6.1 Access to and adequacy of safe water: The per capita water availability at national level has declined over the years. Deteriorating water quality, pollution problems and seasonal water shortages are increasingly making water unsuitable and inadequate for basic human needs. Key challenge is providing safe and adequate water to all. In rural areas burden of fetching water from distant sources falls on women and yet women (who are the providers and managers of water in the household) have little or no voice in 'water resources planning'. As for the urban areas, most large cities are chronically short of water. For example, Chennai has contributed large sums of money and depends for water from Krishna under the Telegu Ganga Project. However, the partial supplies that began quite late though have also stopped because of some difficulties. Bangalore depends for water from the Cauvery IV project, while Delhi is dependent on its neighbouring states for more water. Therefore, ensuring access to safe drinking water to all has not been among the successes of our water planning. In Noida, Ghaziabad, and Delhi, water rights were bought from Uttar Pradesh (UP) by financing the lining of canals in UP. In Chennai water rights were leased from the state's farmers or tank systems.

6.2 Institutional challenges: By far the most serious challenges are those of management of the existing infrastructure and of the water resource itself. Over the past few years several high-level commissions have been appointed to deal with water management issues and also new national/state policies have been promulgated[13]. However, not much of it has been implemented effectively. This divide between the problem and practice has led to extensive loss of credibility of the state apparatus for water development and management. Problem is balancing between service providers and users of all kind. For example, well-functioning water systems often separate the providers of services from the overall water resources management authority.

Other important changes at the state levels include the creation of autonomous corporations by Karnataka and Maharashtra for mobilizing public funds as well as the initiatives of Andhra Pradesh,

[13] At the national level, a number of national commissions have been constituted by the central government to review specific water policy issues as well as plan for a long-term development of the water sector. Among them, the notable ones are the Committee on Pricing Irrigation Water 1992 (for rationalization of water rates, volumetric water allocation, and system modification), Committee on Private Sector Participation in Major and Medium Irrigation Projects 1995 (documenting the rationale, feasibility, and actual state level initiatives for involving the private corporate sector, especially in the construction and modernization of irrigation schemes) and the National Commission of Integrated water Resources Development Plan 1997 (developing a national master plan for the water sector by synthesizing and updating similar plans prepared earlier by the CWC as well as investigating the economic, technical, and institutional issues in the water sector from a national perspective).

Gujarat, Madhya Pradesh, and Maharashtra for soliciting corporate investments in the water sector. In 1994, Karnataka formed the Krishna Bhagya Jal Nigam Limited (KBJNL) under the Companies Act with the specific purpose of mobilizing public funds for developing the Upper Krishna Project. Almost similar is the case with the Maharashtra Krishna Valley Development Corporation (MKVDC) floated by Maharashtra in 1996. But all these 'autonomous' organizations owing to their poor financial status depend on state budgetary support even for interest payments.

On the other hand, the government of Maharashtra is also trying to tap direct investment from the private corporate sector. For instance, in 1996, it has invited private bids for 52 irrigation projects worth Rs 150 billion. Along similar lines, the governments of Andhra Pradesh, Gujarat, and Madhya Pradesh have also tried to tap the private sector both for the construction and modernization of a few water projects (GoI, 1995). Growing financial crunch in water resources sector, particularly in irrigation projects development, is forcing several state governments to look for possible public-private partnerships. In recent years, Maharashtra government has invited tenders for Neera-Devagadh irrigation project in the year 2007, on Build-Own-Operate-Transfer basis, at a cost of Rs.1000 crores. Several private firms have shown interest in this venture. These private firms, are forming alliance with drip and sprinkler system providers on one side, and forward and backward linkages providers on the other side. They hope to reap rich dividends in the long term, by enhancing water use efficiency and higher crop productivity (including commercial crops), and thereby, boosting farmers willingness to pay for water to a higher side. A series of discussions, across various irrigation projects of Andhra Pradesh during 2005-06, had also indicated similar willingness from farmers, irrigation engineers and private firms.

6.3 Service Provision: The provision of formal irrigation and water supply services in India is the virtual exclusive monopoly of government agencies, which often do not provide services to many (especially the poor) or provide poor quality services to those who do have access. On the contrary, market competition could correctly be argued to improve efficiency. Absence of clear, enforceable water entitlements at all levels is also at the root of service shortcomings such as, water use inefficiency, corruption, financial problems and conflicts which plague the water sector in India currently.

Importantly, partnerships between public and private entities have proven a record for raising project financing and bringing in technical expertise for infrastructure projects, including water and sanitation. They can accelerate solutions and enhance operations and service. On February 7th in Chennai the Tamil Nadu Chief Minister inaugurated a public-private partnership that is now providing water and sewerage services to thousands of Tirupur area residents. The project was initiated in the mid-1990s when the Tirupur Exporters Association recognized the need to improve the area's infrastructure to remain competitive in the knitwear industry but did not have the resources to finance the project. The solution was to establish the New Tirupur Area Development Corporation, Limited, a group of private and public entities, which became the first public-private partnership in the water and sanitation sector in South Asia operating on a Build-Own-Operate-Transfer (BOOT) basis. With a focus on the poor from the outset, the public-private partnership in Tirupur covered the water and sanitation needs of the entire city population, including close to 80,000 slum residents. The Tirupur project is a great example of how private sector involvement in public service delivery can dramatically improve access to water and sanitation. It also illustrates that PPP can provide the necessary complement to government investments and that the private sector can provide important services to the poor - and at lower costs lower than those paid by so-called beneficiaries of government subsidies. Enlisting the private sector in the water sector brings finance, reduces waste and lowers costs when supported by effective governance and transparency.

6.4 Over-extraction of Groundwater and Quality Problems: Problems related to groundwater governance include high extraction rates, fluctuating water tables, groundwater pollution, and reduced agricultural production and equity issues. Complexities such as the existence

of millions of wells across the country, unhindered public access to groundwater and often poorly understood character of the system dependent on groundwater, pose a serious challenge to the groundwater managers. Although the CGWB has classified areas as safe, semi-critical, critical and unsafe based on units of groundwater availability for its development, there is general lack of vision about the development and recharge of groundwater resources. There are no legal and financial checks to ensure that the resource is developed only in safe and semi-critical areas. The over-extraction of groundwater in some coastal areas has led to the problem of saline water intrusion thereby resulting in quality deterioration of fresh water aquifers. Some natural geographical processes are also responsible for deterioration of groundwater quality (arsenic and iron concentration). Therefore, policy makers face a unique dilemma: how to ensure and preserve the benefits to farmers and the wider economy of rapid groundwater expansion; while attempting to control its excesses. Much of the problems related to groundwater management is owing to undefined property rights, which is conducive neither to equity nor to sustainability. Private landowners in India have absolute ownership of groundwater beneath their land and they can extract any amount of groundwater without regard to the impact on other adjacent landowners. Individual rights to groundwater are recognised only indirectly through land rights. Therefore, under conditions of unequal land, the practice of linking groundwater with land and the fact of *de facto* control by better endowed persons only accentuates rural inequality and water use inefficiency.

The main provisions of the 'Model Ground Water Bill' to regulate and control the development and management of groundwater are:

1. Constitution of a Groundwater Authority by each state to discharge the various functions under the legislation, comprising of a Chairman, a representative of the Central Groundwater Board, representatives of the concerned state government departments and knowledgeable persons in matters relating to groundwater. The authority should also be supported by technical persons and other staffs considered necessary for enforcing the legislation.
2. The State governments acquire power to restrict construction of groundwater abstraction structures by individuals or communities for all purposes including drinking and domestic use.
3. The Authority can declare any area to be a 'notified area' if it is of the opinion that controlling and regulating groundwater extraction and use of groundwater in that area is necessary.
4. Anyone (except small and marginal farmers) wishing to sink a well for any purpose within the notified area must obtain a permit from the authority. Such applications for permit are to be considered by the Authority keeping in view, the purpose for which water is to be used, availability of groundwater, existence of other competitive users, long-term groundwater level behaviour, and other relevant factors.
5. Every existing user of groundwater in the State should apply to the Authority for grant of a Certificate of Registration recognising its existing use and authorising the continued use of groundwater. The Authority is vested with the power to cancel any permits, registrations or licences if necessary
6. The Authority could take up steps to ensure that exploitation of groundwater resources does not exceed the natural replenishment to the aquifers. Wherever, there is a mismatch, steps could be taken to ensure augmentation of groundwater resources in addition to regulatory measures.
7. The Authority should upkeep the data-base on groundwater related information.
8. To improve groundwater situation, the Authority may identify the recharge worthy areas in the State and issue necessary guidelines for adoption of rain water harvesting for groundwater recharge in these areas.
9. The Authority should take steps for promotion of mass awareness and training programs on artificial recharging of groundwater through different government, non-governmental or educational institutions.
10. The Authority should be provided with complete legal support to enforce the various provisions of the legislations and the Civil Courts are barred from granting injunction on any decision taken by the Authority

***6.5 Growing Financial Crunch*:** Currently, India's water sector is in severe financial distress and there is enormous liability from deferred maintenance. There is shortage of substantial funds to deal with the needs for the development of water resources infrastructure, maintenance and management. Funds are required not only for annual maintenance and rehabilitation of the sector but also for providing services to those who do not have them. Distortion in pricing of water services has further induced substantial overall economic costs by enlarging the gulf between prices and costs. Some of the factors responsible for this financial crisis are; inadequate revenue generation, chronically under-funded operation and maintenance (O&M) costs[14], revenues not channeled directly to expenditure, inappropriate prioritization of government expenditures, etc. In short, inadequate cost recovery and lack of direct linkages between both revenue and expenditure are at the root of these problems.

National Water Policy, 2002 has emphasized that the management of water resources should incorporate a participatory approach by involving not only the Government agencies but also all stakeholders in various aspects of planning, design and management. Recognizing the need for legal framework for Participatory Irrigation Management (PIM), the Ministry of Water Resources (MoWR) has brought out a model act to be adopted by the States for this purpose. Presently more than 61,000 Water Users' Associations (WUAs) have been formed in 23 States covering an area of about 12.55 million hectares. Some of the remaining States have been encouraging participation of farmers in Irrigation Management at outlet level under cooperative/society acts. Despite this progress, PIM is not Working effectively in all States. The constraints in the implementation of PIM (like deficiencies in the irrigation supply system, lack of training and leadership, cooperation of Irrigation Departments, etc.) need to be addressed adequately.

In case of domestic water supplies, households have made huge personal investments owing to poor public services. These "sunk costs" often poses a challenge, because these users would actually benefit little in the short run from more reliable supplies and in the short run, they would oppose higher user charges, even if service quality is improved. They would only become supporters in the medium run when they understand that they did not need to replace their assets (their pump and overhead tanks and water filters) because they could now rely on the piped distribution system. Hence, this requires that information on improvements and savings that it brings in the short run (lower electricity costs) and medium run (no replacement of equipment for coping) needs to be communicated effectively. Time span for bringing tariffs in line with costs needs to be tailored to this reality. Therefore, there is an urgent need to formulate appropriate water policies, institutions, strategies and technologies to address these issues.

6.6 Expanding Water Conflicts: Allocation of water between users (agriculture, industry, domestic supplies, hydro-power, etc.) and between areas within river basins (e.g. catchment areas versus flood plains) is often uncontrolled, and inequitable. Severe water shortages have already led to a growing number of conflicts across the country. Some 90 percent of India's territory is drained by inter-state rivers. The lack of clear allocation rules and uncertainty about how much water each state has a right to, impose high economic and environmental costs. Such growing water conflicts between different users, areas and States (inter-state disputes on sharing of river water) and inequities in distribution of the available water resources are some of the crucial concerns currently faced by the country's water-sector.

The major rivers of the country are mostly inter-State rivers. There has been an increasing demand for water in all sectors, sometimes leading to inter-State disputes on sharing of water. Efforts

[14] Contribution from water users in many states is as low as 5% of O&M expenses (GOI, 2006). For example, Maharashtra seems to be attaining O&M cost recovery from revenues of industrial water users and irrigation water users, although the former appears to be cross subsidizing the latter.

are being made to resolve disputes through negotiations amongst the basin States with the assistance of the Central Government. Adjudication through the appointment of water disputes tribunals is also resorted to as and when warranted. The mechanism for settlement of water disputes is already available in the form of ISRWD Act, 1956 which provides for settlement of disputes by negotiations failing which referring such disputes to a tribunal for adjudication. As per the Inter-State River Water Disputes Act, 1956, (ISRWD Act, 1956) when the water dispute arises among two or more State Governments, the Central Government receives a request under Section 3 of the Act from any of the Basin States with regard to existence of water dispute. The details of such inter-state water disputes under ISRWD Act, 1956 are shown below.

Sl No.	River	Concerned States	Tribunal formed	Tribunal Decision Date
1	Krishna	Maharashtra, Andhra Pradesh, Karnataka	April 1969	May 1976
2	Godavari	Maharashtra, Andhra Pradesh, Karnataka, Madhya Pradesh, Orissa	April 1969	July 1980
3	Narmada	Rajasthanm, Madhya Pradesh, Gujarat, Maharashtra	October 1969	December 1979
4	Ravi and Beas	Punjab, Haryana, Rajasthan	April 1986	
5	Cauvery	Kerala, Karnataka, Tamil Nadu, Pondichery	June 1990 (originally in 1974)	
6	Krishna	Maharashtra, Andhra Pradesh, Karnataka	April 2004 (revised)	
7	Madhei/Mandovi,/ Mahadayi	Goa, Karnataka, Maharashtra		
8	Vamsadara	Andhra Pradesh, Orissa		

Note: In accordance with the said Act, the Central Government is required to refer a dispute to a Tribunal after it is satisfied that the dispute cannot be settled by negotiations. Accordingly, the water disputes related to Cauvery and Krishna were referred to the Tribunals for adjudication in 1990 and 2004 respectively. The Cauvery Water Disputes Tribunal (CWDT) passed an interim order on 25 June 1991. The water dispute related to Ravi & Beas was referred to the Ravi & Beas Water Tribunal (RBWT) in 1986 under Section 14 of the said Act. The RBWT submitted its report on 30 January 1987. Party States and the Central Government have sought explanation/guidance under Section 5(3) of the Act from the Tribunal. The Tribunal has not submitted its further report to the Government. In respect of Madei/Mandovi and Vamsadhara water disputes, the requests were received from States of Goa and Orissa in July 2002 and February 2006, the Central Government has not concluded so far that these disputes cannot be settled by negotiations.

6.7 Absence of Affected People's involvement **:** There are serious issues about how the affected people are dealt with in major water infrastructure projects. In coming decades planned infrastructure projects include hydropower that generates large revenues and involves substantial resettlement of people. Infrastructure developers need to see the economic and social development of local communities to be as important as the technical aspects. There are important issues of responsibility which need to be worked out between project developers and state governments (to whom non-state developers pay massive royalties of 12% of the gross value of the power generated).

6.8 Inadequate transparency: A central feature of modern water management in a liberalized economy and democratic environment is that of openness and transparency. In most countries now all relevant information – hydrological, performance, planning – is available publicly, on the web and in real time. Unfortunately, India has been slow in adapting to this changed information environment. However, recently there has been some modest progress. This change would undoubtedly stimulate a chain reaction of accountability, participation and demand for more and better data which would transform the culture of water management in the country. Importantly, there is a powerful feedback loop between data availability, quality and support for data collection activities. Global experience shows that hydrology data systems will be maintained only when there

are users who can get easy access to the information, who find the data they need in a user friendly way, and who then become a pressure group on government to commit the necessary funding to the data collection activities.

7. Strategic options

7.1 From 'Water resources development' to 'Water resources management': India need to shift its focus from 'water resources development' to 'water resources management' by restructuring and strengthening existing institutions for better service delivery and resource sustainability. Planning for big water resources projects should be interdisciplinary with all environmental, ecological and human concerns internalized and thereby assessing the impacts by a concrete statute. At the national level, a number of national commissions have been constituted by the central government to review specific water policy issues as well as plan for a long-term development of the water sector[15]. For the first time, across states, Andhra Pradesh has separated its water resources department into two departments in the year 2007: One, irrigation projects design and construction; second, project operation and maintenance. Maharashtra became the first state to form the Maharashtra Water Resources Regulatory Authority (MWRRA), through an Act in the year 2005, This Authority has powers to fix the rates for use of water for agriculture, industrial, drinking and other purposes and several related matters. It has three members, including a Chair, a Member Water Resource Engineering and a Member Water Resource Economy. It also has five invitees, one from each of the five major river basins in Maharashtra. As suggested by its name, the primary function of the Authority is to regulate the water sector in the state. The Authority has a wide range of powers for doing this. Encouraged by this, other states like Uttara Pradesh, Gujarat and Andhra Pradesh are also planning to set up similar authorities.

7.2 Promote River Basin Organizations: Despite the legal provisions[16], not a single River Board has been constituted under this Act (Iyer, 1994; Naqvi, 2006). None of the state governments has so far made any such "request" to establish River Basin Organisations[17]. In such circumstances, the co-existence of a River Board and a Water Tribunal seems questionable. Even if a River Board would have been set up it cannot be said that the riparian states would have waived their rights under the Inter-States Water Disputes Act of seeking the constitution of a Water Tribunal for the settlement of any disputes with respect to the very same inter-state river for which the Board is operating. Therefore, an element of "dispute" seems to be the primary reason for the government to act and not the "regulation and development of the river". The origin of River Basin Boards in India can be seen from two perspectives: a) functions vested upon the board by certain policies, b) legal considerations for its formation.

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[15] Among them, the notable are: a) Committee on Pricing Irrigation Water 1992 (for rationalization of water rates, volumetric water allocation, and system modification), b) Committee on Private Sector Participation in Major and Medium Irrigation Projects 1995 (documenting the rationale, feasibility, and actual state level initiatives for involving the private corporate sector, especially in the construction and modernization of irrigation schemes) and, c) National Commission of Integrated water Resources Development Plan 1997 (developing a national master plan for the water sector by synthesizing and updating similar plans prepared earlier by the CWC as well as investigating the economic, technical, and institutional issues in the water sector from a national perspective).

[16] The legal framework for constituting an Inter-State River Basin Organization is contained within the Constitution of India itself, which in turn has vested powers on the Parliament of India for the "Regulation and development of Inter-State rivers and river valleys to the extent to which such regulation and development under the control of Union is declared by the Parliament by law to be expedient in the public interest" (Entry No. 56, List I, Seventh Schedule to Article 246). The parliament of India within six years of adopting the Constitution of independent India, enacted a specific law for the constitution of the River Basin Authority, namely the River Boards Act, 1956 (Act 49 of 1956).

[17] Another reason for the failure of this Act might be the Inter-State Water Disputes Act, which was also enacted in 1956 (Act 36 of 1956). Under the Inter-State Disputes Act the Central Government is bound to constitute a Water Tribunal when there is a complaint even by any one of the riparian states, whereas in case of the River Boards Act there should be a collective request for the constitution of an inter-State River Board.

River Basin Organizations in India are typically either headed by the Ministry of Water Resources or Power or a Chairman appointed by the GOI (who may be a chief engineer of that particular basin or in certain cases may be the Chairman of the Central Water Commission). The structure of the RBOs is generally highly bureaucratic, with no participation of the stakeholders. A few water users or water-using sector are generally represented on these boards. Over the past 50 years several River Basin Authorities have been constituted. A few noteworthy RBOs are; the Damodar Valley Corporation, the Tungabhadra Board, Bhakra-Beas Management Board, Cauvery river authority, Ganga Flood Control Board, Brahmaputra Board, etc. Despite this, the National Commission for Integrated Water Resources Development Plan admits in one of its reports submitted in 1999 that India does not have a successful model of RBO and it is in this report it recommended for a model RBO. Till date such a model RBO has not yet been constituted. There is a need to promote a few pilot RBOs as models to refine and replicate later. These RBOs can also embark on IWRM in the process.

However, there are impediments to the formation of River Basin Organizations based on formal rules, laws and procedures. Leaving those aside there are also other impediments originating from the political, economic, and institutional environment.

a) Political Impediments:-Political reasons might have led to the enactment of the River Boards Act in 1956, but might also have stopped the Central Government in constituting any River Boards for the inter-state rivers. The political compulsions may be due to multi-party political structure of the country where there may not be the same political party ruling at the Centre and the State simultaneously. This prevents the Central Government from imposing upon a State, a decision, which a state is unwilling to accept.

b) Economic Impediments:- Insufficient funds for the large projects may also be one of the reasons to create River Boards and Organizations.

c) Institutional Impediments:- Over the past 50 years several River Basin Authorities have been constituted. Despite this, the National Commission for Integrated Water Resources Development Plan admits in one of its reports submitted in 1999 that India does not have a successful model of RBO and it is in this report it recommended a model RBO. Till date such a model RBO has not yet been constituted.

Effective IRBM exists for similar situations in Australia (Murray-Darling) and Europe (International Rhine Commission). While Indian subsidies for water-intensive crops like rice and electricity for irrigation hamper water savings and efficient and environmentally friendly use of water resources, IRBM can a) still help conserve some water resources through enhanced planning and allocation of water among water-using sectors, and b) can help increase awareness of wastage of water as a result of the subsidy economy. Some of the water shortages in India are artificial; large-scale rice and sugarcane irrigation in the Cauvery basin are a sign of relative water abundance rather than scarcity. Similarly, drip irrigation for sugarcane in the Bhavani basin of Tamil Nadu is now slowly getting adopted not because of water scarcity but because of labor shortages (personal communication, Bhavani basin). This situation reinforces the need for enhanced data and information exchange, and improved management of scarce water resources.

7.3 Ensure Integrated Water Resource Management: Coordinated and conjunctive use of all water - by location (surface, ground), by users (rural, urban, peri-urban), or by use (domestic, irrigation, industrial and institutional) - is a working definition of integrated water resource management (IWRM). In the absence of demand management (inducing water conservation through prices or other incentives) in urban as well as rural India, supply augmentation alone is not likely to bring supply in line with demand. Another major conundrum is how to make 'demand-responsive' water development in rural India match with the technical requirements of watershed-wide management under IWRM. Different institutional arrangements are needed for water resources

planning (example: Department Water Resources Planning in Rajasthan and District Water Management Agencies in Andhra Pradesh).

Since water is a political issue and most river basins are inter-state (water is a state subject), improvement in water resources management is not easy. More than any other country India depends on groundwater (in absolute terms) for agricultural production, which necessitates careful planning for integrated water resources management. India provides free electricity and subsidizes highly water intensive crops. Wasteful and distorting subsidies need to be gradually controlled to move towards IWRM. This (IWRM) would also help to follow up recovery of cost for water services and the 'user pays' and the 'polluter pays' principle.

While Indian subsidies for water-intensive crops like rice and electricity for irrigation hamper water savings and efficient and environmentally friendly use of water resources, IRBM can a) still help conserve some water resources through enhanced planning and allocation of water among water-using sectors, and b) can help increase awareness of wastage of water as a result of the subsidy economy. Furthermore, India depends to a large extent on groundwater resources, which are an intrinsic component of basin hydrologic units. The increased focus on integrated surface and groundwater management, which has been advancing significantly in India, will likely reduce the perception of India's groundwater dependence as an obstacle to IRBM.

7.4 Support Groundwater Governance: The issue of regulation is important in groundwater management. Introducing a groundwater management system that ensures balance between abstractions and recharge is a rather difficult. Also, command and control type of approaches to prohibit more abstractions simply do not work. Groundwater management essentially requires a legal framework which constrains the rights of people to pump as much water as they wish from their land; the separation of land rights and water entitlements, with the latter usually based on historical use; strong government presence to give legal backing for the development of participatory aquifer management associations and to provide the decision-support systems which enable aquifer associations to monitor their resource; and, above all, clarity that the primary responsibility for the maintenance of the resource on which they depend is with those who have entitlements to use water from a particular aquifer.

Currently, there is a need for a paradigm shift from groundwater management mode (in terms of purely technical management of an aquifer as viewed by hydro geologists or purely legal management of groundwater as viewed by policy makers) to a broader and holistic concept of groundwater governance mode which has to be multi-level, multi-actor and multi-instrumental. The proposed strategies for groundwater development for the XI plan[18] are; undertaking schemes on artificial recharge in rural areas and rainwater harvesting in urban areas of the over-exploited/critical areas; augmenting groundwater through restoration of old groundwater structures in safe and semi-critical blocks. Since groundwater and lift irrigation schemes are largely dependent on power, changes in energy policy status have a direct bearing on irrigation potential. India needs to think to utilize more of solar energy and other alternative sources to bail out from inadequacies of power supplies.

A core legislation aiming to regulate groundwater use is the creation of Central Groundwater Authority under the Environmental Protection Act 1986 (Government of India, 1986), which acts as a technical body to monitor and regulate groundwater withdrawals in different states. However, it has

[18] Two schemes of CGWB are proposed to be taken up during the XI Five Year Plan are: a) Scheme for groundwater survey, investigation and exploration including component of artificial recharge and CGWA, and b) setting up of Rajiv Gandhi National Groundwater Training and Research Institute with proposed outlay of Rs 460 crore and Rs 30 crore respectively. Besides, there is CGWB component in Scheme for Capital outlay and Hydrology Project with proposed outlay of Rs 25 crore and Rs 26 crore respectively. Thus total plan outlay for all these schemes is proposed at Rs 541 crore (GOI, 2006).

failed to set withdrawal limits (GOI, 1992). The Authority has been conferred with the powers for issuing directions and taking measures to regulate and control development of groundwater resources and to resort to penal action where needed. The Model Groundwater (Control and Regulation) Bill, which has also been formulated and circulated by the centre for the consideration of the states, postulates a kind of groundwater permit system. As per the Bill, the State monitors and regulates the level of groundwater extraction through constitution of the Groundwater Authority, which in turn exercises power to restrict construction of groundwater abstraction structures in any area, if considered necessary.

However, it is important to note that these conventional regulatory approaches to manage groundwater in India are not making much headway because it is rather difficult to centrally manage an economy in which millions of independent well users are scattered over a vast countryside. Also, efforts to regulate groundwater withdrawals through licensing, credit or electricity restrictions for wells or spacing norms have sought only to regulate the establishment of groundwater structures rather than the quantum of water extracted. Besides these regulations also tend to be regressive as well-off farmers can self-finance their structures and restore to diesel use in the event of electricity restrictions. For instance, in Gujarat, for wells of a depth more than 150 ft a 'No Objection Certificate' is required to obtain loan from the government. However, ever since the introduction of this regulation in 1967, the rules have tended to become less stringent over the years. More recently, indirect management of groundwater are being increasingly advocated. Interestingly, the levers of impacting groundwater demand are often not controlled by groundwater managers but by decision makers in other sectors. For example, it has been estimated annual groundwater withdrawal could be reduced by almost 12-20 km^3 in the overexploited areas by eliminating perverse electricity subsidies, the key to which lies with the state electricity utilities and not with the groundwater authorities. Therefore, in recent years indirect mechanisms of governing groundwater through high quality but rationed electricity supply at a flat rate tariff is being favoured. Similarly the rice-wheat system responsible for much groundwater depletion in Punjab and Haryana could be reconfigured within 5 years by reorienting India's foodgrain production policies towards eastern India, while north-western India shifts to cropping patterns that offer more cash per drop of groundwater. Thus the Food Corporation of India may be able to do more for groundwater governance in India than the Central Groundwater Authority.

7.5 Scale-up Community-based Tanks Rejuvenation: India has some 580,000 tanks of various sizes spread over across the country. Most of them were managed by local communities for several centuries. In the post-independence era, they collapsed owing to poor maintenance and lack of interest from the government. Community based tank rejuvenation is of critical importance for a country like India. With growing water scarcity, tank rejuvenation is an important way in which water can be conserved for both surface and groundwater irrigation. With limited water resources, vagaries of monsoon and looming water scarcity in many parts of India, water conservation and use by medium and micro water retaining structures have assumed greater significance. 'Empowerment' of local communities will take transaction costs away from the states and simultaneously achieve efficiency of resource allocation. Community ownership over the natural resource will then ensure long-term sustainability of the systems. Encouraged by positive results by community-based tank rejuvenation project in nine districts of Karnataka state, now other states (like Rajasthan, Andhra Pradesh) have also initiated such projects. With more refinements India needs to scale up this programme in several states. Experience from Karnataka and Tamil Nadu indicates that a separate legislation for tank management is required. The PIM Act does not fit well with tank management and its multiple water and non-water resources and multiple users – farmers and non-farmers.

High performing tank institutions have well-defined norms, evolved over a long period of time, about allocation of water to various segments and special rules in times of scarcity. Tanks are common property of the village, and whether the institution makes provisions during a scarcity

situation to enable economically weaker sections and the landless to sustain their livelihood, is an important factor in obtaining cooperation from all villagers. Though based on custom and tradition, they are clear, specific, detailed and accepted by all command area farmers as fair. There are a wide range of allocating rules, which focus on ensuring livelihood to the marginal and poor.

The direct involvement of tank users in major collective decisions is important to ensure that the decisions reflect their interest and needs. One way to achieve this is to allow all the tank users to get involved in major decisions concerning the tank and its water resources. The decision-making process in the best performing institutions is characterised by transparency, involvement of all, accountability, fairness and equity, and avoidance of conflicts. Even the election process of the office bearers ensures the participation of all members. Wherever transparency, involvement of all in decision-making and accountability are absent, the performance of the tank is poor. After making decisions it must be ensured that they are fully implemented and that free riding is prevented. But, individuals would have little incentive to comply with rules unless they believe their non- compliance will result in substantial penalty. In many tank systems, specialised monitors have been appointed to enforce rules. The tank institutions that have a mechanism of enforcing the rules and who penalise the violators create confidence among members. There may be some special cases where the rules have to be flexible, but agreed upon unanimously.

7.6 Provide Water for All: The National Water Policy – 2002, has assigned the highest priority to drinking water. However, it is important to note that despite five decades of planning and over a decade of 'Drinking Water Missions' there are large numbers of 'no source' villages, i.e., those with no identified source of safe drinking water. Interestingly, although the targets for covering such 'no source' villages are repeatedly achieved, their numbers grow, which in turn mean that some 'covered' villages are lapsing back into the uncovered category, and that newer villages are being added to this class.

India needs to revamp its model of drinking water provision. The country needs to tap assured sources and link them within the river basin, if required. This would enable within a river basin, guaranteed domestic supplies both in terms of quantity and quality. For this, investments have to be focused on creating effective infrastructure and mechanisms to operate them efficiently. If required, supply links need to be provided across the basins. Since, provision of drinking water is prime concern, both states and central governments and all stakeholders would support such venture. All this would enable to provision of adequate safe drinking water for all in the country.

Promote Extensive Use of Water Treatment technologies to Reclaim Water: In recent years, various technologies have proven, across the country – both in rural and urban areas[19]. Several agencies have demonstrated on a larger scale in hundreds of villages and small towns, that poor quality of water (sea water, groundwater, and sewage water) can be converted to provide safe and adequate water to local people, at a low cost. Such programmes need to be scaled up on a large scale to make dent in demand management. This would enable a) sustainable supplies, b) provision of safe and adequate water to both domestic and industrial supplies, c) low capital cost, d) self supporting system, e) user pay principle comes into practice (if required, cross-subsidies may be introduced, for weaker sections). Experiences of NGOs and corporate agencies indicate that, both in rural and urban areas, people are more worried about safe and adequate water than its price. Several models may be introduced across the country:

- water-on-call may be provided by BOOT based private agencies on procure-treat-supply on cost basis through mobile vans, as demonstrated in different places;

[19] Several urban water supply agencies (e.g. water supply and sewerage boards of Bangalore, Hyderabad, Chennai), corporate agencies (e.g, Byrraju foundation, Naandi Foundation), NGOs (e.g, AKRASP, Pravah, Gram Vikas), and technology providers (e.g, Doshion, DEWATS).

- Regional water supply schemes with modern technologies to procure –treat-distribute on cost basis, on long-term BOOT basis.
- River basin level integrated system on BOOT basis to augment sources from all sources and after treatment, distribute to both urban and rural settlements on cost basis.

Key dimensions are: a) Priority, in any of the above model, should be given to rain water harvesting (RWH), with low capital cost and low O&M costs for user group; b) If RWH and source are constrained, then preference should be given to BOOT system (on Swiss package basis) for technology-centric interventions. Here, options may be river osmosis to use sea water (to most of the coastal areas), UV and sand screen filter, different membrane technologies (all this preferably for ground water), waste water treatment; c) Being in semi-arid zone, stress should be on solar energy based water treatment plants; d) Dual water providing systems need to be explored. Important to consider is single agency responsibility for procure-treat-distribute-recover cost on long term basis, at river basin level. If required inter-basin and inter-state transfer may be promoted for domestic and industrial supplies.

7.7 Promote Public-Private-Panchayat-Partnership (4P): Considering the financial constraints and managerial limitations of governments, part of the water resources development and management activities may be shared under 4P (PPPP) model. The interest to mobilize financial resources from the private sector was first considered in 1995 by the Government of India, when it was realized that such involvement could provide better and efficient services to the water sector. This issue was also examined by the National Commission for Integrated Water Resources Development Plan set up by the Ministry of Water Resources in 1996. Later in 2000, a Working group on 'Private Sector and Beneficiaries participation for the formulation of X Five Year Plan (2002-2007)' was set up by the Planning Commission to deliberate upon various aspects of private sector participation[20]. The National Water Policy 2002 also encourages private sector participation in planning, development and management of water resources project for diverse uses, which might help in generating financial resources and introducing corporate management and improving service efficiency and accountability to users. As per the recommendations deliberated by a Group of Experts constituted by the MoWR, a State Water Regulatory Authority should be established in those states where 4P is to be taken up, which should include representatives of all concerned government organizations dealing with water resources and stakeholders (Water Users' Association/local body/gram panchayat) to ensure transparency. It also recommends some incentives to promote 4P either in the form of tax holidays, floating tax-free revenue bonds/loans at concession rates, etc.

The public sector should play an expanded role in financing and provision of public services (such as flood control and sewage treatment) and the government should develop a set of laws, policies, capacities and organizations for defining and delivering an enabling environment, with special emphasis on the establishment and management of water entitlements, and the regulation of services and resources. In the historically-public business of wastewater treatment, there is much innovation taking place. However, in recent years, several private corporate agencies have expressed keen interest in Maharashtra state, to 'take over' the major irrigation projects and willing to ensure assured supplies to existing irrigators and still make more money by enhancing water use efficiency levels and by adopting crop diversification. It would be fruitful to promote a few pilot irrigation projects across the country on 4P model with clear outcomes. This model may also be extended to provision of drinking water, wastewater recycling in urban areas and at river or sub-basin level.

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[20] The group recommends formation of WUAs under PIM Act. WUAs should be involved in planning, budgeting, implementation and management of irrigation systems to be transferred to them. There is a need to enforce a regime whereby farmers pay the water rates to meet the O&M expenditure rates. Conditions of reforms should be imposed before handing over the projects to WUAs. Also, volumetric supply of irrigation water to WUAs should be introduced. Reputed NGOs with requisite skills may be involved for promotion of WUAs, Autonomy of WUAs should be maintained in regard to Water Management. However, there may be linkages with Panchayati Raj Institutions through cross representation.

7.8 Irrigation Management Transfer

a) Promote Project Level Pilots: Based on consolidation of all learning, initiate a few pilot schemes at the project level for full scale irrigation management transfer. These pilots, at the rate of one/two per state, in selected states (Orissa, Chattisgarh, Rajasthan, Gujarat, Madhya Pradesh, Andhra Pradesh, Karnataka and Maharashtra) would be a good bet to invest. However, a series of public consultations need to be organized to streamline stakeholder involvement and their roles and responsibilities. Support organizations, with good field experience (which have already soiled their hands in this field) have to be involved from the designing stage. A clear monitoring and periodical evaluation and learning process should be in place from the beginning. Some of the measurable indicators (at WUA, DC, and PC level) are: additional area irrigated, water use efficiency, amount spent on operation, maintenance, repairs and establishment by WUA and the irrigation department, water deliveries at regulation points, and resource mobilization by WUA/DC/PC. This would demonstrate for all other projects to get convinced of the possibilities and potential benefits of irrigation management transfer. The whole exercise at each project level can move in phases on hydraulic boundary basis. Good documentation should be an essential part of this scheme. Crop-season wise and annual performance measurement would indicate the benefits of irrigation management transfer.

b) Try Alternate Models: Irrigation management transfer need not to be only through user organizations. However, they are the first priority. Alternative models also seem to be more attractive. Initial discussions indicate that private channels play an important role.

a. A financial company with the support of irrigation infrastructure providing company is planning to take over an irrigation project, including drinking water and industrial water supplies in western India on as is where is basis and then rejuvenate and operate it for the next 20 years with massive investment. The initial exercise indicates that the payback period is around eight years and in the process landholders would be major beneficiaries owing to crop diversification, and high returns. An added advantage is enhancement in water use efficiency and assured supplies on time.

b. A few open house discussions with leading WUA presidents across Andhra Pradesh indicated their willingness to take over the entire irrigation project. The bidding level went up from Rs.5000 crore (for a partially complete project) to Rs.40,000 crore (for a completed million acre plus project)[21]. These biddings were made by a group of engineers those who have worked for several years on those projects and leading WUA presidents. They are willing to take over the project on as is where basis, with a guarantee of supplies to all existing landholdings. On any additional savings in the supplies, tourism, and other related activities, the future operating companies would like to have full control.

c. A few years ago, the federation of the Lower Bhavani project in Tamil Nadu was willing to take over the entire project with a command area of 250,000 ha and agreed to pay Rs.2.5 crore per year to the government, when the government was finding it difficult to collect even Rs.25 lakh as water fees.

[21] These biddings are appears to be on a higher side. These are based on quick estimates and generated in the public meetings, largely based on local engineers and contractors' perceptions and guess estimates. Bidders feel that adequate revenue may be generated from industrial supplies, efficient use of irrigation water by installing drip and sprinkler irrigation gadgets and by promoting more commercial crops, with adequate infrastructure for backward and forward linkages, which will boost up good market linkages.

7.9 Set up and Strengthen Water Regulatory Authorities at State Level: Currently, Maharashtra and Uttara Pradesh (and proposed in Andhra Pradesh) have water regulatory authorities. The lessons from these authorities need to be learnt and replicated in other states, including successful experiment of the water auditing system implemented in Maharashtra. These authorities need to be oriented to focus on: a) effective water allocation and entitlement mechanisms at each river basin level to take care of both lean and flush season supplies across competing water uses; b) Evolve locally suitable approaches to promote effective irrigation management transfer at various levels; c) design models to promote public-private partnerships at sub-basin levels for effective operation and maintenance activities, and also to provide adequate infrastructure facilities to boost up both backward and forward linkages to all farmers; and d) introduce and refine methods for performance measurement at all levels of the irrigation project.

Table: 6 Water sector issues and key features	
Issues	**Key features**
1. Institutional challenges	a) Crumbling water infrastructure and its poor maintenance b) Imbalance of management power between State and users (farmers, citizens, industries) c) Water reforms focusing mostly on organizational issues rather than instruments that govern the relationship between regulator and user d) Public private partnership (private sector participation) required in water resources development
2. Water stress and pollution problems (environmental concerns)	a) Decline in per capita water availability b) Inadequate water availability to meet basic human needs including agriculture c) Unavailability of safe drinking water d) Deteriorating water quality and pollution problems e) Seasonal water shortages f) Increasing droughts and flooding g) Wasteful water use in agriculture and urban areas
3. Lack of competition in service provision	a) Public monopoly in provision of formal irrigation and water supply services b) Poor quality service provision c) Inefficient and inequitable provision of services
4. Service shortcomings and water use inefficiency	a) Unclear water entitlements b) Water rights linked to land rights c) Inadequate human resource development
5. Groundwater overexploitation and pollution problems	a) Declining water tables b) Sea water intrusion in coastal areas c) Deterioration of groundwater quality (arsenic and iron concentration) d) Undefined property rights e) Power subsidy triggering extraction of the resource and the related equity issues
6. Growing financial crunch	a) Waived or reduced water charges enlarging the gulf between prices and costs b) Liability from deferred maintenance c) Resistance against increasing charges for poor quality service provision d) 'Sunk costs' incurred by households to cope with poor public services
7. Growing water conflicts	a) Inter-state disputes on sharing of river water b) Conflicts between different users (domestic, agriculture, industrial) c) Conflicts between different areas (rural, urban, peri-urban)
8. Lack of openness in water management programs and absence of beneficiaries participation	a) Inadequate public accessibility to relevant information on water management b) Lack of accountability, participation and transparency in rule c) Insufficient involvement of beneficiaries in water resources management authority

Table: 7 Strategic options and key features	
Strategic Options	**Key features**
1.1 Shifting focus from 'water resource development' to 'water resource management'	a) Integrated Water Resource Management - coordinated and conjunctive use of all water, by location or by use (involves large scale planning and implementation) b) Ensuring that there is sufficient water in the entire system to support all the various uses of water and also that it is distributed equitably across space and users – technically complex c) Restructuring and strengthening existing institutions for better service delivery and resource sustainability d) Make the planning of big water resources projects interdisciplinary with all environmental, ecological and human concerns internalized e) Assessing the impact of such projects backed by concrete statue f) Developing set of laws, policies, capacities and organizations for water management by government g) Involving service providers in the overall water resources management authority – sustainability of local governance
1.2 Public Private Partnership	a) Considering the financial constraints and managerial limitations of governments, private sector involvement should be encouraged in water resources development and management projects b) Characterizing service sector by contracts between providers (public and private)and users with the description of the rights and responsibilities of both parties c) Mix of public and private financing for the provision of services based on the type of infrastructure – a partnership mode of relationship between public and private sector
2. Demand management and increasing resource use efficiency; rejuvenating tanks	a) Storing water in reservoirs to transfer it from the season/region of abundance to that of scarcity b) Minimizing the need for supply-side solutions through demand-management (restraining demand within availability) and using water resources efficiently c) Fostering consciousness of scarcity and promoting conservation and minimizing waste d) Modernizing the systems for allocating and monitoring surface and groundwater resources e) Efficiently managing water resources by implementing water entitlements, water pricing, accountable institutions and effective regulations f) Shifting government focus from traditional areas (of constructing and operating water supply infrastructure) and encouraging investments in environmental quality g) Tank rehabilitation and restoration to conserve both surface and groundwater h) Ensuring access to safe drinking water to all – providing water for all
3. Encouraging market for services	a) Encouraging private sector to compete for the right to supply water and irrigation services (service can be privatized but not the resource) b) Unbundling distribution functions in large irrigation systems and then providing distribution services to farmers through cooperatives and private sector c) Advocacy of privatization of water services (competition in provision of public services could improve efficiency)
4. Empowering users and Human Resource Development	a) Empowering users groups and gram panchayats b) Establishing formal water entitlement system and clarifying that water is publicly owned and water entitlement is usufructory, i.e, it is a right to use not a right to own water c) Encouraging community and local government to plan, implement, operate and manage water service schemes d) Interdisciplinary team work in water sector - investment in improving the quality and diversity of professionals engaged
5. Groundwater governance	a) Holistic concept which has to ve multi-level, multi-actor and multi-instrumental b) Participation of state, people and even markets depending on the nature of the problem c) Energization of pumps and administration of its distribution and setting tariff for energy consumption d) Constitution of Central Groundwater Authority to monitor and regulate groundwater withdrawals

	e) Regulatory approaches viz., regulating withdrawals through licensing, credit or electricity restrictions, spacing norms
6. Taxes and user charges	a) Pricing of water services by introducing taxes or water user charges to bring tariffs into balance with costs b) Accompanying increased charges by improvement in services and provision of these services in an efficient and accountable manner c) Rationalizing irrigation water rates or prices d) Ensuring budget support (taxpayers' money) for irrigation e) Generation of funds for annual maintenance and rehabilitation of the sector and also providing services to those who do not have them g) Improvements in the quality of service provided so as to avoid resistance against the increased charges
7. River Basin Organizations	a) Preparation of basin level and regional plans for optimum water usage b) Maintenance of allocation and distribution of water supplies for different uses c) Promoting integrated water resources management and building multi-level statkeholder plarforms d) Controlling flood, soil erosion e) Socio-economic development of people living in the valley
8. Transparency in rule and local Beneficiaries' involvement	a) Making relevant water sector related information (hydrological, performance, planning) publicly available b) Encouraging accountability, participation and demand for better data c) Giving primacy to the affected people, involving them in the planning and decision making process and giving them first rights over the benefits of the project – Water users' Asociation d) Working out important issues of responsibility between project developers and state governments e) Considering the economic and social development of local communities to be as important as the technical aspects of the project

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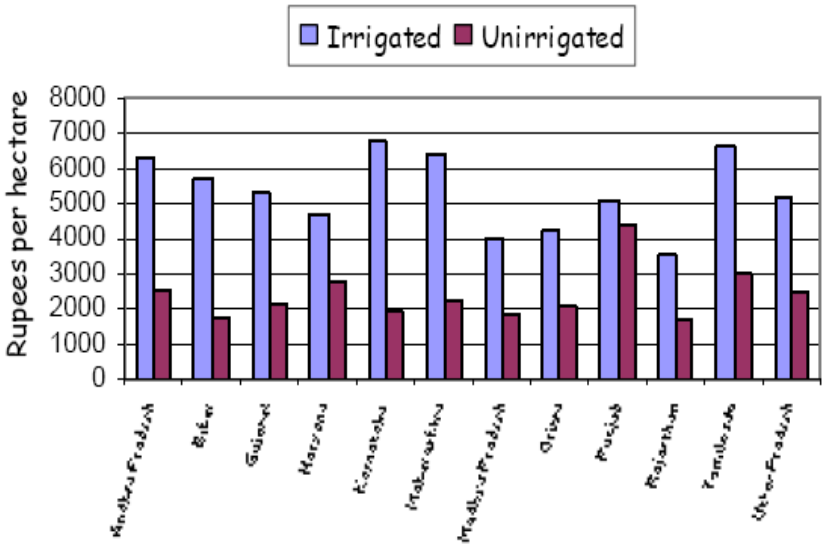
http://wrmin.nic.in/index2.asp?sublinkid=290&langid=1&slid=412

http://wrmin.nic.in/index2.asp?sublinkid=289&langid=1&slid=332

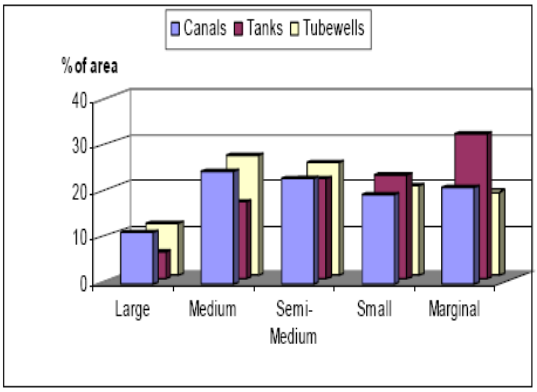
Annexure

Figure:1 Output on irrigated and unirrigated farmland



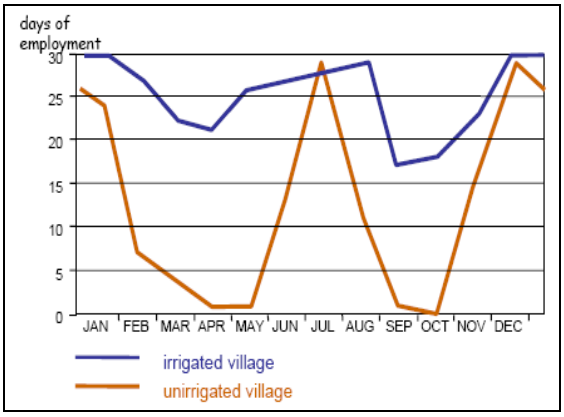
Source: Bhatia, 2005

Figure: 2 % of irrigated area by farm size



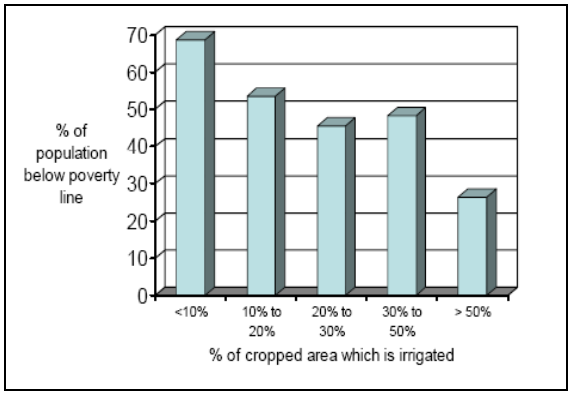
Source: World Bank, 2005

Figure 3: Avg no. of days of employment for adult casual Laborers each month



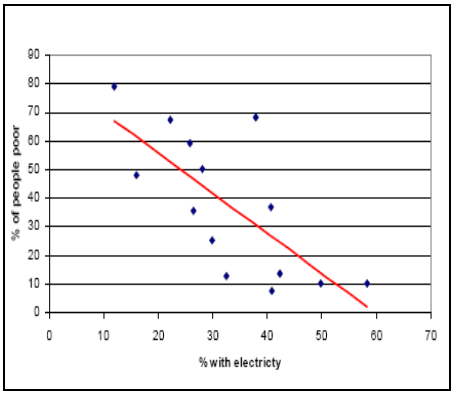
Source: Chambers, 1998

Figure: 4 How irrigation reduces poverty in India



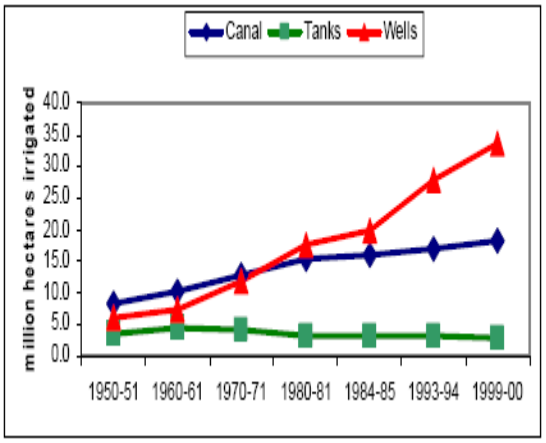
Source: World Bank, 1991

Figure:5 Electrification and rural poverty by state



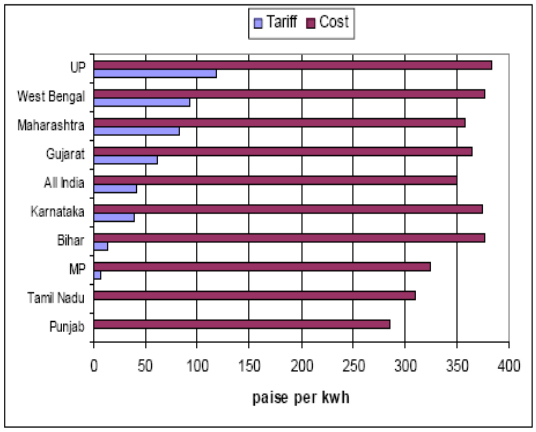
Source: World Bank, 1995

Fig: 6 The evolution of forms of irrigation in India (1950-2000)



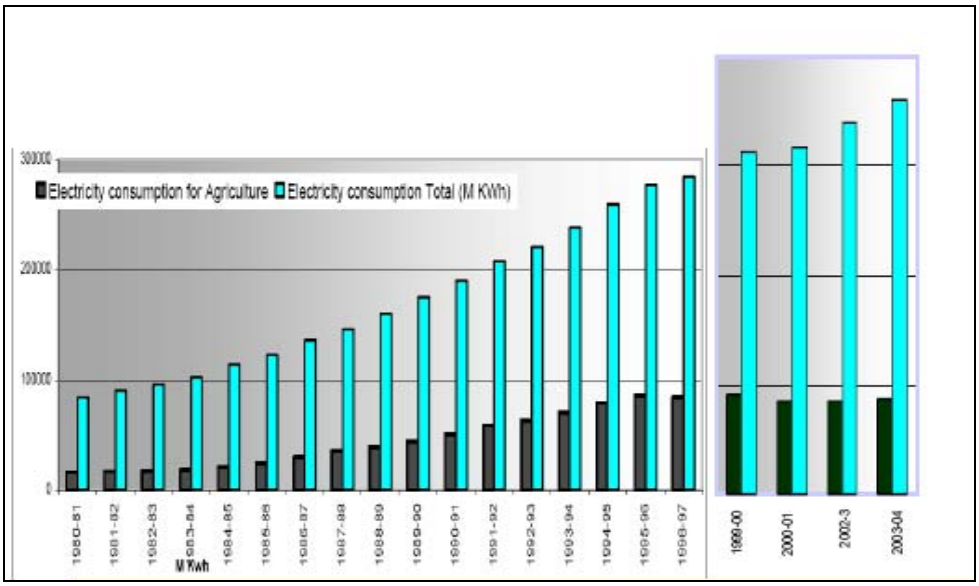
Source: Bhatia, 2005

Fig: 7 State-wise electricity tariffs and generation costs



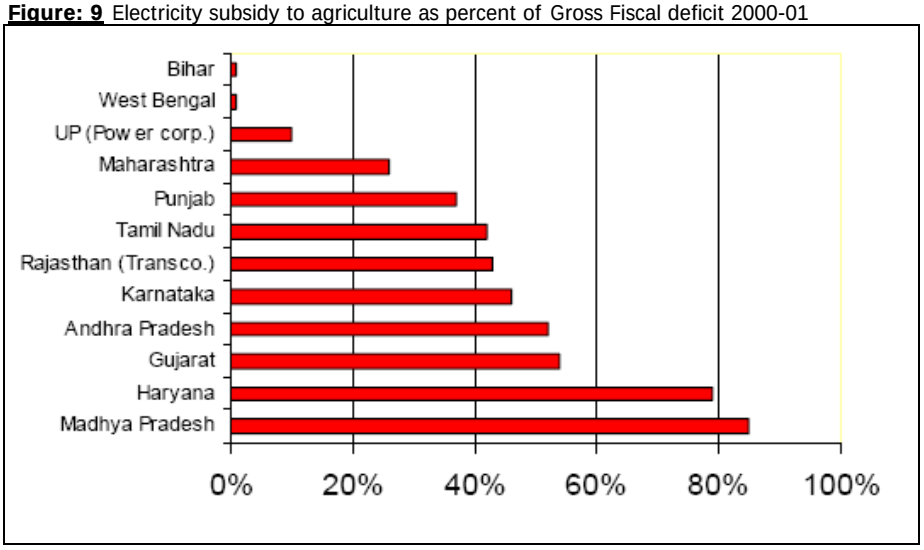
Source: Bhatia, 2005

Figure: 8 **Increase in electricity consumption for agriculture**



Source: World Bank, 2005

Figure: 9 Electricity subsidy to agriculture as percent of Gross Fiscal deficit 2000-01



Source: Bhatia, 2005

Table 1: Availability of Water Resources in India

S. No	Particulars		Quantity (Billion Cubic Meter)
1.	Annual Precipitation (Including snowfall)		4000
2.	Average Annual Availability		1869
3.	Per Capita Water Availability (2001) in cubic meter		1820
4.	Estimated Utilizable Water Resources		1123
	(i) Surface Water Resources	690 Cu.Km.	
	(ii) Ground Water Resources	433 Cu.Km.	

Source: Website of Ministry of Water Resources, GOI www.wrmin.nic.in

Annex Table 5.2: Irrigation potential created and utilized during Plan periods in India

Plan Period	Potential (cumulative) created (Mha)	Potential (cumulative) utilized (Mha)
Pre-Plan period	22.60	22.60
First Plan (1951-56)	26.26	25.04
Second Plan (1956-61)	29.08	27.80
Third Plan (1961-66)	33.57	32.17
Annual Plans (1966-69)	37.10	35.75
Fourth Plan (1969-74)	44.20	42.19
Fifth Plan (1974-78)	52.02	48.46
Annual Plans (1978-80)	56.61	52.64
Sixth Plan (1980-85)	65.22	58.82
Seventh Plan (1985-90)	76.53	68.59
Annual Plans (1990-92)	81.09	72.86
Eighth Plan (1992-97)	86.26	77.24
Ninth Plan (1997-2002)	93.95	80.06
Tenth Plan (upto 2004-05)	98.84	83.56

Source: www.wrmin.nic.in

Annex Table 5.3: Major and Medium Irrigation Projects (Expenditure Incurred and Potential Created)

Period	Outlay/expenditure (Rs crore)	Potential created (mha)	Cumulative (mha)
Pre-Plan period	Not available	9.70	9.70
First Plan (1951-56)	376	2.50	12.20
Second Plan (1956-61)	380	2.13	14.33
Third Plan (1961-66)	576	2.24	16.57
Annual Plans (1966-69)	430	1.53	18.10
Fourth Plan (1969-74)	1,242	2.60	20.70
Fifth Plan (1974-78)	2,516	4.02	24.72
Annual Plans (1978-80)	2,079	1.89	26.61
Sixth Plan (1980-85)	7,369	1.09	27.70
Seventh Plan (1985-90)	11,107	2.22	29.92
Annual Plans (1990-92)	5,459	0.82	30.74
Eighth Plan (1992-97)	21,669	2.22	32.96
Ninth Plan (1997-2002)	42,968	4.10	37.06
Tenth Plan outlay (2002-2007)	71,213	6.50(Target)*	43.56

* Provisional and are subject to change.
Source: www.wrmin.nic.in

Annex Table 5.4: Irrigation potential created and utilized under minor irrigation

Period	Potential created (mha)	Potential utilized (mha)
Up to 1951 (Pre-Plan Period)	12.90	12.90
First Plan	14.06	14.06
Second Plan	14.75	14.75
Third Plan	17.00	17.00
Annual Plans (1966-69)	19.00	19.00
Fourth Plan	23.50	23.50
Fifth Plan	27.30	27.30
Annual Plans (1978-80)	30.00	30.00
Sixth Plan	37.52	35.25
Seventh Plan	46.61	43.12
Annual Plans (1990-92)	50.35	46.54
Eighth Plan	53.31	48.77
Ninth Plan (1997-2002)	56.90	49.05
Tenth Plan (2002-2007) Target	63.71	54.49

Source: www.wrmin.nic.in

Annex Table 5.5: Inter-state river disputes

S.No.	River(s)	States concerned	Date of Reference to the Tribunal	Decision of the Tribunal
1.	Krishna	Maharashtra, Andhra Pradesh, Karnataka	April 1969	May 1976
2.	Godavari	Maharashtra, Andhra Pradesh, Karnataka, Madhya Pradesh and Orissa	April 1969	July 1980
3.	Narmada	Rajasthan, Madhya Pradesh, Gujarat, Maharashtra	October 1969	December 1979
4.	Ravi & Beas	Punjab, Haryana and Rajasthan	April 1986	
5.	Cauvery	Kerala, Karnataka, Tamil Nadu and Union Territory of Pondicherry	June 1990	
6.	Krishna	Karnataka, Andhra Pradesh and Maharashtra	April 2004	
7.	Madei/Mandovi/ Mahadayi	Goa, Karnataka and Maharashtra		
8.	Vamsadhara	Andhra Pradesh & Orissa		