11 Management of freshwater resources

Introduction

Fresh water as a commodity generates concern being an exhaustible resource and due to the environmental issues related to its degradation. With a phenomenal development of water resources since independence, India has successfully met water requirements for different usages. Preserving the quality and availability of freshwater resources however, is becoming the most pressing of many environmental challenges on the national horizon. Perhaps, because water is considered a cheap readily available resource, people fail to realise just how much stress human demands for water are placing on natural ecosystems. The stress on water resources is from multiple sources and the impact can take diverse forms. The growth of urban megalopolises, increased industrial activity and dependence of the agricultural sector on chemicals and fertilisers has led to the overcharging of the carrying capacity of our water bodies to assimilate and decompose wastes. A deterioration in water quality and contamination of lakes, rivers and ground water aquifers has therefore resulted.

The need is to bring about a perceivable shift in our philosophy and address water problems. Water resource managers and professionals are beginning to focus on the use of existing infrastructure to meet the demands of a growing population by improving efficiency, reallocating of water for different uses, prioritising the water demand sector-wise and adopting policies and practices that check resource degradation.

Pressure

Uneven resource distribution

India receives an average annual rainfall equivalent of about 4,000 billion cubic metres (BCM). This only source of water is unevenly distributed both spatially as well as temporally. Most of the rainfall is confined to the monsoon season, from June to September, and levels of precipitation vary from 100 mm a year in western Rajasthan to over 9,000 mm a year in the northeastern state of Meghalaya (Engleman and Roy 1993). With 3,000 BCM of rainfall concentrated over the four monsoon months and the other 1,000 BCM spread over the remaining eight months, our rivers carry 90% of the water during the period from June-November. Thus, only 10% of the river flow is available during the other six months.

National level statistics for water availability mask huge disparities from basin-to-basin and region to region. Spatially, the utilisable resource availability in the country varies from 18,417 cubic meters in the Brahmaputra valley to as low as 180 cubic metres in the Sabarmati basin (Chitale 1992). Even within the Ganga basin, water availability varies from 740 cubic meters in Yamuna to 3,379 cubic meters in the Gandak. Rajasthan, for instance, with 8% of the country's population has only 1% of the country's water resources while Bihar with 10% of population has just 5% of the water resources. Thus, while India is considered rich in terms of annual rainfall and total water resources, its uneven geographical distribution causes severe regional and temporal shortages.

Declining resource availability

Surface water

Of 4,000 BCM of available water from precipitation, the mean flow in the country's rivers is about 1,900 BCM. Out of this, only 690 BCM is utilisable. With 177 BCM of live storage created by the existing major and medium projects and another 75 BCM of storage from projects under construction, there is still a gap of 440 BCM of water, which is utilised (CWC 1997).

Groundwater

The latest assessment of replenishable ground water resources has been made at 431.9 BCM by the Central Ground Water Board through a large volume of hydrologic and related data (CGWB 1996). This is the sum total of potential due to natural recharge from rainfall and due to recharge contributions from canal irrigation. The utilisable ground water resources have been assessed at 395.6 BCM (70.0 BCM for domestic and industrial uses and 325.6 BCM for irrigation). The CGWB has also assessed the quantum of static ground water resources (one time available) at 10,812 BCM.

Water availability from other sources and through desalinisation of sea and ground waters is considered negligible in view of the high cost. The basin-wise details of various water resources and their utilisable components are shown in Table 11.1. The assessed gross available and utilisable water resources of the country, based on conventional technology, are therefore 2,384 BCM (billion cubic metres) and 1,086 BCM, respectively. With an estimated population of one billion in 2000, the available and utilisable water resources per capita per year are 2,384 m^3 and 1,086 m^3 respectively against an estimated availability of 6008 m^3 in 1947. This itself, gives a broad indication of the growing resource scarcity in India in the fifty three years since independence. The status of per capita resource availability in different basins of the country is show in as Map 11.1.

Increasing resource demand

Since independence, India has witnessed an unprecedented increase in population. From a population of about 343 million in 1947, the population has grown at a rate of 2.04% to cross the 1,000 million mark in 2000. With an increasing number of mouths to feed, there has been an additional pressure on agriculture resulting in an increase in net sown area from 119 million hectares in 1951 to 142 million hectares in 1997; high cropping intensity has also resulted in an increased demand for water resources. Domestic water need in the urban areas has also grown notably with the current urban population at 4.5 times the population level in 1950s (TERI 1998). The water requirement of the manufacturing sector has increased in proportion to the increase in the sector's share in GDP from about 12% in 1950s to 20% in 1990s.

Further, there is a substantial variance in the different user sectors—agriculture, domestic and industry, vis-à-vis their share of water demand, resource pricing structure and usage efficiencies, which creates inter-sectoral competitions and conflicts. The agriculture sector, for instance, accounts for about 95% of the total water demand with the subsidised and free regime of supply of power and water resulting in the over-exploitation and inefficient usage of water. The high resource cost for industries, on the other hand, cross- subsidises the water consumed by the other sectors (TERI 2001).

The demand for fresh water has been identified, as the quantity of water required to be supplied for specific use and includes consumptive as well as necessary non-consumptive water requirements for the user sector. The total water withdrawal/utilisation for all uses in 1990 was about 518 BCM or 609 m^3/capita/year. Estimates for total national level water requirements, through an iterative and building block approach, have been made for the years 2010, 2025 and 2050 (Table 11.2) based on a 4.5% growth in expenditure and median variant population

Table 11.1 Mean flow utilisable surface and ground water resource—basin-wise (**in BCM**)

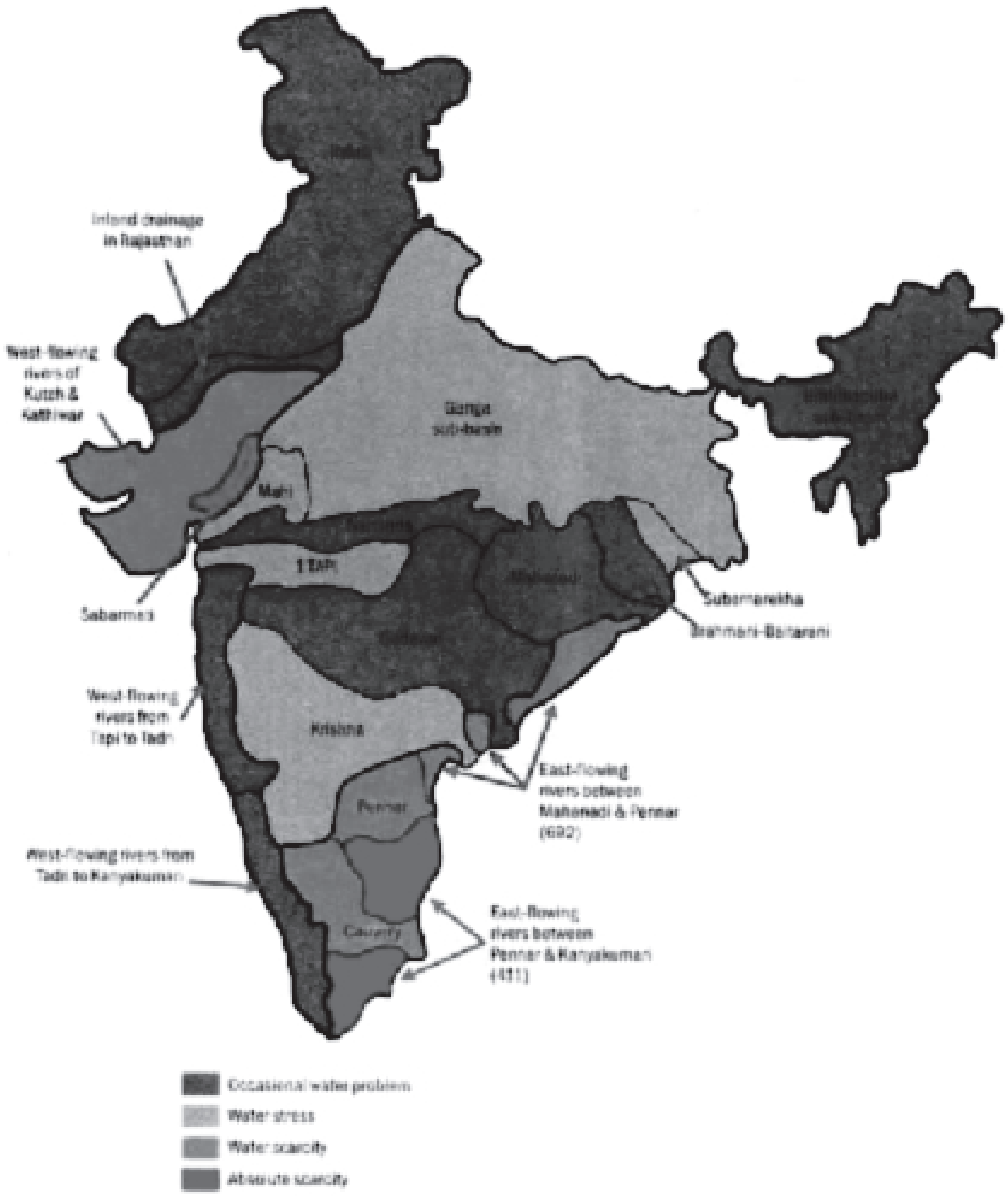
River Basin	*Surface water*		*Ground water*	
	Mean flow	*Utilisable*	*Replenishable*	*Utilisable*[c]
Indus	73.31	46.00	26.50	24.3
Ganga	525.02	250.00	171.00	156.80
Brahmaputra	629.05[a]	24.00	26.55	24.40
Barak	48.36	-	8.52	7.80
Godavari	110.54	76.30	40.64	37.20
Krishna	69.81[b]	58.00	26.40	24.20
Cauvery	21.36	19.00	12.30	11.30
Subernarekha	12.37	6.80	1.82	1.70
Brahmani-Baitarni	28.48	18.30	4.05	3.70
Mahanadi	66.88	50.00	16.50	15.10
Pennar	6.32	6.90	4.93	4.50
Mahi	11.02	3.10	7.20	6.60
Sabarmati	3.81	1.90	-	-
Narmada	45.64	34.50	10.80	9.90
Tapi	14.88	14.50	8.27	7.60
West flowing rivers between Tapi and Tadri	87.41	11.90	17.70	16.20
West flowing between Tadri and Kanyakumari	113.53	24.30	-	-
East flowing rivers between Mahanadi and Pennar	22.52	13.10	11.22	10.30
East flowing rivers between Pennar and Kanyakumari	16.46	16.70	18.80	17.20
West flowing rivers of Kachchh, Saurashtra and Luni	15.10	15.00	0.00	0.00
Area of inland drainage in Rajasthan	0.00	-	-	-
Minor rivers draining into Bangladesh and Myanmar	31.00	-	18.12	16.80
Total	1952.87	690.30	431.32	395.60

Source National Commission for Integrated Water Resources Development Plan, 1999
[a] includes additional contribution of 91.81 BCM being flow of 9 tributaries joining Brahmaputra; [b] assessment is based on mean flow of the yield series accepted by KWDT award; [c] The figure of the CWC assessed from run-off data at Vijaywada is 78.12 BCM computed on proportionate basis from annual replenishment

projections of the United Nations. The country's total water requirement by the year 2050 will become 1,422 BCM, which will be much in excess of the total utilisable average water resources of 1,086 BCM. At the national level, it would be a very difficult task to increase the availability of water for use from the 1990 level of approximately 520 BCM to the desired level of 1,422 BCM by the year 2050 as most of the undeveloped utilisable water resources are concentrated in a few river basins such as the Brahmaputra, Ganga, Godavari, and Mahanadi.

Inequitable water supply

Although about 88% of the population, on average, has been covered with organised drinking water supply in class I cities and class II towns of the country, there is a huge disparity in quantity of water supplied. Of the 299 class I cities, only 77 cities have cent percent water supply coverage. The per capita water supply also ranges from as low as 9 litres per capita per day (lpcd) in Tuticorin to as high as 584 lpcd in Triuvannamalai (CPCB 2000a). Similarly, 203 of the 345 class II towns have low per capita supplies of less than 100 lpcd (CPCB 2000b). Table 11.3 highlights the wide disparity that exists in the per capita



Map 11.1 Per capita resource availability in the country's river basins (Chitale 1992)

water supply in different urban areas of the country. Besides an inequitable distribution of water in a given city, the supplies are erratic with water quality degrading continuously over time.

Efforts have been made to provide safe drinking water in rural areas by providing funds in the state budgets from the First Five Year Plan onwards. The Central Government assists the states through programmes such as

Table 11.2 Water requirement for different uses **(in BCM)**

Category	*2010*	*2025*	*2050*
Irrigation	536	688	1008
Domestic	41.6	52	67
Industries	37	67	81
Energy	4.4	13	40
Inland navigation	-	4	7
Flood control	-	-	-
Afforestation	33	67	134
Ecology	5	10	20
Evaporation	36	42	65
Total	693	942	1422

Source National Commission for Integrated Water Resources Development Plan, 1999

the Accelerated Rural Water Supply Programme (ARWSP) and Rajiv Gandhi National Drinking Water Mission (RGNDWM). The status of coverage of habitations as on 1 April 1999, shows that about 267 347 habitations (18.6% of total) are still either not covered or partially covered. Cent percent rural habitation coverage was only in Uttar Pradesh, Delhi, Pondicherry and Chandigarh. Percentage habitations fully covered in Assam, Punjab and Kerala are only 57.4%, 33.3% and 22.2% respectively (MoRD 1999).

Table 11.3 Disparity in per capita water supply in class I cities and class II towns

Type	*Number of cities/ towns*	*Number of cities/ towns with per capita supply* (litres per capita demand)				*Average supply*	*Minimum supply*	*Maximum supply*
		Low (<100)	*Normal (100-200)*	*High (200-300)*	*Very high (>300)*			
Class-I	299	109	138	36	16	183	9	584
Class-II	345	203	120	18	4	103	7	776

Source CPCB 2000a

Resource degradation

Discharge of untreated domestic wastewater is a predominant source of pollution of aquatic resources in India. Urban centres contribute more than 25% of the sewage generated in the country. The smaller towns and rural areas do not contribute significant amounts of sewage due to the low per capita water supply. Wastewater generated normally percolates into the soil or evaporates.

The CPCB conducted a survey in 1994-95 (CPCB 2000a, CPCB 2000b) on water supply and wastewater generation, collection, treatment and disposal in 299 class I cities and 345 class II towns of the country. The survey findings indicated that, most cities did not have organised wastewater collection and treatment facilities. The status of wastewater generation, collection, and treatment in urban areas is as given in Table 11.4.

It also emerged that the class I cities and class II towns of Maharashtra, Delhi, Uttar Pradesh, West Bengal, and Gujarat contribute 59% of the total wastewater generated in the country. The infrastructure to collect and treat wastewater in these states is as given in Table 11.5. Furthermore, the facilities constructed to treat wastewater do not function properly and remain closed most of the time due to improper design and poor maintenance, together with a non-technical and unskilled approach. Photo 11.1 depicts one such drain in Delhi carrying a mix of industrial and domestic wastewaters.

Rural sanitation is a state subject, and is looked after by the state governments under the MNP (minimum needs programme) and supplemented by the CRSP (Centrally Sponsored Rural Sanitation Programme) aiming at increased coverage and eradicating manual scavenging. It has been targeted to achieve at least 50% coverage by the end of Ninth Plan period.

Inefficient resource utilisation

With government policies that provide hardly any incentive to encourage efficient usage, water has conventionally been considered as a free commodity. Distribution losses of treated water range between 25% and 40%; losses in irrigation are even to the extent of 45% due to seepage and excess application and storage losses are estimated to be about 15% (MoWR 1999). Photo 11.2 shows such a case of resource loss due to water overflow. Industrial output per unit of water withdrawal in India is only $5 per cubic metre as against output at $25 and $32 for such developed countries as Japan and Sweden. Even in the domestic sector, areas with high per capita water availability are known for poor water utilisation. The subsidy regime in the domestic sector further leaves the service providers with insufficient funds for proper upkeep of the system and finally affects the quality of service and its efficiency.

Table 11.4 Status of wastewater generation (w/w), collection, and treatment in class I cities and class II towns **(million litres per day)**

Type	*Number of cities/towns*	*w/w generated* (mld)*	*w/w collected* (mld)	*%age of w/w collected*	*w/w treated* (mld)	*%age of w/w treated (of collected)*	*%age of w/w treated (of total)*
Class I cities	299	16662.5	11938.2	72	4037.2	33.8	24
Class II towns	345	1649.6	1090.3	66	61.5	5.6	3.7
Total	644	18312.1	13028.5	71	4098.7	31.5	22.4

* Also includes information gathered on industrial wastewater
Source CPCB 2000a

Table 11.5 Status of wastewater (w/w) generation, collection, and treatment in major contributing states **(million litres per day)**

State	*Number of Type*	*w/w generated cities/towns*	*w/w collected* (mld)*	*%age w/w* (mld)	*w/w treated collected*	*%age w/w* (mld)	*treated*
Gujarat	Class-I	21	1175.8	936.7	78.6	676	51.3
	Class-II	27	191.2	137.8		25	
Maharashtra	Class-I	27	3593.4	3139	85.6	481.4	13.3
	Class-II	28	160.4	73.8		18	
Uttar Pradesh	Class-I	41	1557.7	1048.9	66.7	246.2	13.4
	Class-II	45	275.5	174		-	
West Bengal	Class-I	23	1623.1	1183	72.2	-	-
	Class-II	18	66.9	36.7		-	
Delhi	Class-I	1	2160	1270	58.8	1270	58.8
Total		231	10804	8000	74.04	2716.6	25.14

* Also includes information gathered on industrial wastewater
Source CPCB 2000a

Photo 11.1 Delhi's Viswas Nagar Drain carrying a mix of domestic and industrial wastewater to the Trans-Yamuna drain

State

Resource quantity

Comparing water availability in the country's basins with the standard definition[1] by Engleman and Roy, only four of the twenty basins had more than 1,700 m^3 per capita per year renewable fresh water resources, nine basins had between 1,000 to 1,700 m^3, five basins had between 500 to 1,000 m^3, and two basins had less than 500 m^3 in 1991. In 1997, at an agro-ecological zone[2] (AEZ) level, availability exceeded requirements throughout the country with the exception of AEZ 2 (western plains and Kachchh) and AEZ 9 (northern plains) where it is less than the demand (Map 11.1). By 2047 it is anticipated that demand will exceed availability in five of the twenty AEZs and of these, the situation will be particularly critical in AEZs 2, 9, and 15 (Bengal and Assam plains) where availability is less than 75% of the total demand (TERI 2001). Despite the fact that the National Water Policy accords top priority to drinking water, the coverage of population for safe water supplies is still less than 100 % in most urban and rural areas. Though maximising water availability, water pricing and water zoning for proper management of resources have all been addressed in this national document, poor execution presents a diametrically opposite picture on ground. Further, with water being a state subject and with the absence of water policies at the state level, resource management and conflict resolution ultimately affect resource availability. Inadequate legal framework for withdrawals also affects resource accessibility due to overexploitation.

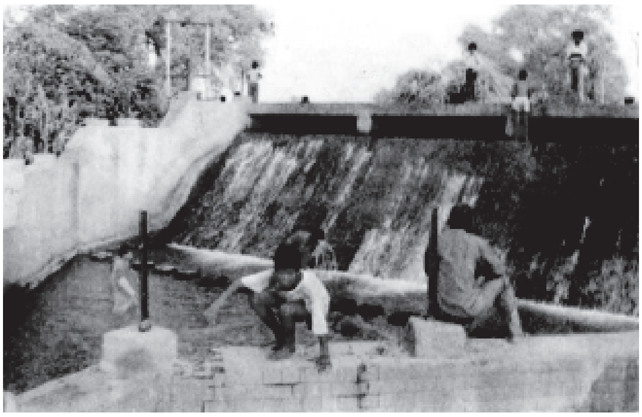


Photo 11.2 Water overflow from the conduit carrying freshwater to the Bhagirathi Water Treatment Plant

Resource quality

The major rivers of the country have generally retained pristine water quality in the less densely populated upper stretches where the likelihood of getting affected by man's interference is minimal. As the rivers enter the plains, these start getting exploited for irrigation and receiving pollution discharges due to human activities such as intensive agriculture,

[1] According to a standard definition, for water availability from 1000 m^3/capita/year to 1700 m^3/capita/year, shortage will be local and rare. Below 1000m^3 per capita per year, water supply begins to hamper health, economic development and human well-being. At less than 500m^3 per capita per year, water supply is primary constraint to life (Engleman R and Roy P 1993).

[2] Twenty zones into which the country has been divided on the basis of physiological features, soil type, climate etc to facilitate easy accounting of natural resources

use of fertilisers and insecticides, domestic sewage, industrial effluents etc. Thus in the middle stretches, the rivers are most affected both, due to increased water requirement for various consumptive and non-consumptive uses, and degraded water quality. Increased quantity of wastes of a more complex nature finds way into the river and tends to deteriorate the water quality. This makes the situation grave especially during the lean flow season when the amount of dilution water available is less.

The Central Pollution Control has been monitoring water quality of national aquatic resources in collaboration with concerned State Pollution Control Boards at 507 locations (CPCB 1999a), of which 430 stations are under MINARS (Monitoring of Indian National Aquatic Resources), 50 stations are under GEMS (Global Environmental Monitoring Systems) and 27 stations under the YAP (Yamuna Action Plan). The polluted stretches identified in some of the major rivers (Table 11.6) are based on regular monitoring. The water quality and desired water quality have been classified as A, B, C, D, and E, which reflect the best use of the water.

The water quality monitoring results obtained during 1998 indicate that organic and bacterial contamination still continue to be critical sources of pollution in Indian aquatic resources. Table 11.7 lists the number of observations in different broad ranges of observed values for BOD, total coliform and faecal coliform at different locations. The results show that BOD concentrations below 3 mg/l were observed in 61% of the samples as against 65% in 1997. BOD between 3 to 6 mg/l was observed in 24% of the samples as against 28% in 1997 and BOD exceeding 6 mg/l was observed in 14% of the samples, which is the same as in 1997. The number of observations having high coliform density increased in 1998 against 1997. The Yamuna river is the most polluted in the country having high BOD and coliform in the stretch between Delhi and Etawah. Other severely-polluted rivers are the Sabarmati at Ahmedabad, Gomti at Lucknow, Kali, Adyar, Cooum (entire stretches), Veghai at Madurai, and Musi d/s of Hyderabad.

A profile of water quality of major Indian rivers is shown in Map 11.2 (CPCB 1999a).

In an effort to assess the health of a water body, the CPCB is developing a bio-monitoring methodology under the Indo-Dutch Collaboration Programme on the Environment. Intensive exercises have been carried out for the Yamuna River and the methodology has been developed and tested for other rivers. In the first phase, 215 locations have been selected for the introduction of bio-monitoring on the basis of the interpretation of physico-chemical data at different locations (CPCB 1999b).

CPCB has also carried out limited water quality monitoring of the wells in different states and calculated percent violations over the desired levels of water quality in terms of pH, dissolved oxygen, BOD and total coliform. Certain locations in these states reported 100% violation over the desired levels for dissolved oxygen and total coliform (CPCB 1999a). CWC's studies on chemical composition of groundwater in phreatic zones have revealed that in many cases anomalously high concentrations of nitrates, potassium and even phosphates are present in contrast to their virtual absence or low concentration (nitrate and potassium < 10 mg/l) in semi-confined and confined aquifers. The unsystematic use of synthetic fertilisers coupled with improper water management has affected the groundwater quality in many parts of the country. The statewise brief account of the incidence of groundwater pollution also reflects the occurrence of high concentrations of heavy/toxic metals, fluoride and nitrates at different locations around the country. The presence of zinc in shallow aquifers of Delhi is reported at

Table 11.6 List of polluted river stretches[a]

River	*Polluted stretch*	*Desired class*	*Existing class*	*Critical parameters*[b]	*Possible source of pollution*
Sabarmati	Immediate upstream of Ahmedabad up to Sabarmati Ashram	B	E	DO, BOD, Coliform	Domestic and industrial waste from Ahmedabad
	Sabarmati Ashram to Vautha	D	E	DO, BOD, Coliform	Domestic and industrial waste from Ahmedabad
Subarnarekha	Hatia dam to Bharagora	C	D/E	-do-	Domestic and industrial waste from Ranchi and Jamshedpur
Godavari	Downstream of Nasik and Nanded	C	D/E	BOD	Wastes from sugar industries, distilleries and food processing industries
Krishna	Karad to Sangli	C	D/E	BOD	Wastes from sugar industries and distilleries
Sutlej	Downstream of Ludhiana to Haike	C	D/E	DO, BOD	Industrial wastes from hosieries, tanneries, electro-plating and engineering industries and domestic waste from Ludhiana and Jalandhar
	Downstream of Nangal	C	D/E	Ammonia	Wastes from fertiliser and chloralkali mills from Nangal
Yamuna	Delhi to confluence with Chambal	C	D/E	DO, BOD, Coliform	Domestic and industrial wastes from Delhi, Mathura and Agra
	In the city limits of Delhi, Mathura and Agra	B	D/E	DO, BOD, Coliform	Domestic and industrial wastes from Delhi, Mathura and Agra
Hindon	Saharanpur to confluence with Yamuna	C	D	DO, BOD, Toxicity	Industrial and domestic wastes from Saharanpur and Ghaziabad
Chambal	Downstream of Nagda and downstream of Kota	C	D/E	BOD, DO	Domestic and industrial waste from Nagda and Kota
Damodar	Downstream of Dhanbad	C	D/E	BOD, Toxicity	Industrial wastes from Dhanbad, Durgapur, Asansol, Haldia and Burnpur
Gomti	Lucknow to confluence with Ganges	C	D/E	DO, BOD, Coliform	Industrial wastes from distilleries and domestic wastes from Lucknow
Kali	Downstream of Modinagar to confluence with Ganges	C	D/E	BOD, Coliform	Industrial and domestic wastes from Modinagar

[a] Class A stands for drinking water without conventional treatment but after disinfection, Class B water is suitable for outdoor bathing, while Class C stands for water suitable for drinking after conventional treatment. Class D water is suitable for propagation of wildlife and fisheries. Class E water can be used for irrigation, industrial cooling and controlled waste disposal
[b] DO is Dissolved Oxygen, BOD is Biochemical Oxygen demand
Source CPCB 1999a

places located close to areas of intensive agricultural practices coupled with extensive use of chemical fertilisers (CGWB 1997). Even with strong legislative provisions such as the Water (Prevention and Control of Pollution) Act and the Environment Protection Act, since 1974 and 1986 respectively, 851 defaulting industries were located along the rivers and lakes in 1997. The Water Cess Act, 1977 has also failed to act as a market based instrument in reducing the quantity of polluted discharges.

Table 11.7 Water quality status in India (1998)

State	*BOD* (mg/l)			*Total Coliform* (MPN/100 ml)			*Faecal Coliform* (MPN/100 ml)		
	< 3	*3-6*	*>6*	*<500*	*500-5000*	*> 5000*	*< 500*	*500-5000*	*> 5000*
Andhra Pradesh	202	56	19	16	25	0	37	0	0
Assam	113	4	9	15	49	23	22	21	0
Bihar	146	3	1	15	48	82	35	106	2
Daman & Diu	28	0	0	11	13	0	12	9	0
D & N Haveli	16	0	0	3	11	0	6	7	0
Delhi	11	4	14	0	6	14	10	5	5
Gujarat	224	82	125	200	63	164	214	90	116
Goa	33	15	0	48	0	0	44	0	0
Himachal Pradesh	88	1	0	61	27	1	83	6	0
Haryana	28	4	9	0	0	0	0	0	0
Karnataka	247	49	52	94	283	0	113	136	1
Kerala	275	1	0	10	238	24	71	192	12
Lakshdweep	6	2	0	3	5	0	6	2	0
Maharashtra	0	326	123	375	73	0	391	0	0
Manipur	30	2	0	27	5	0	0	0	0
Meghalaya	0	4	16	12	6	2	9	8	0
Madhya Pradesh	345	114	48	373	124	0	209	0	0
Orissa	22	298	57	234	143	0	299	78	0
Punjab	26	26	20	72	0	0	71	1	0
Pondicherry	15	1	3	0	0	0	0	0	0
Rajasthan	71	5	2	36	42	0	78	0	0
Tamil Nadu	260	38	6	168	72	63	219	53	31
Tripura	30	1	1	4	17	0	18	3	0
Uttar Pradesh	210	165	176	29	123	161	114	123	49
West Bengal	110	24	0	89	0	0	89	0	0
Total	2536	1225	681	1895	1373	534	2150	840	216

Source CPCB 1999a

Response

Existing response

Water has been included in India's Constitution as Entry 17 of the state list. The current institutional arrangement for managing water resources in India involves various government agencies. At the central level, the Ministry of Water Resources (MoWR) is responsible for developing, conserving and managing water as a national resource covering areas as diverse as irrigation, ground water exploitation, drainage and flood control. The MoWR functions through the Central Water Commission, National Water Development Agency and Central Ground Water Board. The Ministry of Environment and Forests (MoEF) is the nodal agency for water quality and environmental matters. Water supply in urban and rural areas is co-ordinated by the Ministries of Urban Affairs and Rural Development, respectively. Besides, water is also a subject of several other ministries and departments such as the Ministry of Agriculture, Power, Health and Family welfare, Surface Transport and the Inland Waterways Authority. Major policies and legislations guiding the management of water resources and its quality and initiatives taken have been discussed.

Map 11.2 Water quality profile of major Indian rivers

- The National Water Policy, 1987, formulated by the Government of India accords top priority to drinking water supply in the allocation of water resources for various beneficial uses. After drinking water, the list includes irrigation, hydropower, navigation and industrial and other uses. The policy also addresses issues such as planning of water resource development projects, maximising water availability, water pricing, water quality, water zoning for proper management of resources and other issues.

- The government explicitly enacted the *Water (Prevention and Control of Pollution) Act, 1974,* with the primary objective of preventing and controlling of water pollution. The Water Act established the Central Pollution Control Board and the state pollution control boards for its implementation. The Water Act empowers the state pollution control boards to lay down and maintain location and source specific standards for discharge of wastewater. The actual provisions for enforcement such as penalties, imprisonment etc. are confined to source-specific standards for individual polluters.
- *The Environment Protection Act, 1986,* is an umbrella act providing for the protection and improvement of environment and for matters connected therewith. It authorises the central government to intervene directly in order to protect the environment and also allows public interest litigation for the same purpose. The nature of penalties under this act is similar to those authorised under the Water Act.
- The government has also introduced, as a supplementary measure, major economic incentives for pollution abatement, besides the 'command and control' regulatory mechanism. The *Water Cess Act* was introduced in 1977, empowering the state pollution control boards to levy a cess on local authorities supplying water to consumers and on consumption of water for certain specified activities. The Act also provides for a rebate on the cess payable if the local authority or industry concerned installs a plant to treat sewage or trade effluent. The cess rates were increased three fold in February 1992. A rebate of 25% on the cess payable has been provided to those industries whose wastewater discharge does not exceed the quantity declared by them and which also comply with the effluent standards prescribed under the Water Act and the Environment Protection Act.
- Under the 1994 EIA notification, an *Environmental Impact Assessment* has been made mandatory for 30 categories of development activities involving investments of more than Rs 500 million and above and environmental clearance for activities is given by the MoEF.
- Under the *National River Action Plan (NRAP),* certain stretches of major rivers with high or intermediate levels of pollution were identified by the CPCB. Sewage collection and treatment works being created to reduce the pollution load to these rivers include schemes for better sewage interception and diversion, construction of sewage treatment plants, provisions for low cost sanitation and other schemes. In the first phase, in the GAP (Ganga action plan), 29 towns were selected along the river and 261 schemes of pollution abatement sanctioned. At present, 156 towns are being considered under the NRAP, out of which about 74 towns are located on the river Ganga, 21 on the river Yamuna, 12 on the Damodar, 6 on the Godavari, 9 on the Cauvery, 4 each on Tungbhadra and Satlej, 3 each on the Subarnarekha, Betwa, Wainganga, Brahmini, Chambal, Gomti, 2 on the Krishna and one each on the Sabarmati, Khan, Kshipra, Narmada, and Mahanadi (MoEF 1999) (Photo 11.3).
- To focus on urban lakes subjected to anthropogenic pressures, the *National Lake Conservation Plan (NLCP), 1993* was prepared. Bhoj Lake of Madhya Pradesh is already getting assistance under funds provided by OECF, Japan.
- Under the World Bank aided Industrial Pollution Control project there is a provision of loan and grant assistance to proposals of construction of Common Effluent Treatment Plants (CETP) for the treatment of effluents from a cluster of industries particularly of small scale (CPCB 1999c).

Besides, there are other acts that have a bearing on the water policy. The Easement Act, 1882 allows rights to use the groundwater by viewing it as an attachment to land. It also provides that all surface water is to be treated as state property. The Transfer of Property Act, 1994 provides that ownership in groundwater can be given to one only if ownership in land overlying is also transferred. Thus groundwater is viewed essentially as an attachment to land (Pachauri and Sridharan 1998).

Policy gaps

- The major bottleneck in an effective policy formulation and implementation is the current institutional set-up involving various government agencies. Further, there is a separation of responsibilities on the basis of water quality and quantity. As many as eight agencies are involved in collecting data on the following water-related parameters: quality of surface water, ground water quality, monitoring of drinking water quality, sanitation and drinking water supply. Such a fragmentary approach, both at the central and state levels, results in duplication and ambiguity of functions and discourages unitary analysis of this scarce resource. For instance, the CPCB monitors the water quality at 507 locations and the CWC separately measures water quality at another 300 locations (TERI 1998). However, co-ordination between the two agencies in fixing the monitoring locations and defining monitoring protocols is missing.
- Water being a state subject, the states are empowered to enact laws or frame policies related to water. Even then, only some of the states have set up organisations for planning and allocating water for various purposes. Though water policy for the country has been prepared by the Ministry of Water Resources (MoWR), only four of the states have their own respective state water policies.
- A proper legal framework for regulating withdrawals of groundwater is not in place. Though efforts have been made to check the overexploitation of groundwater through licensing, credit or electricity restrictions, these restrictions are directed only at the creation of wells. Even the licenses do not monitor or regulate the quantum of water extracted.

Photo 11.3 45 MLD capacity sewage treatment plant under Yamuna Action Plan at Faridabad, Haryana
Source MoEF Annual report 1997-98

- The water cess in industries, is potentially an effective instrument for inducing abatement, but the rates of raw water are so low that the rebate has been as much of an incentive so far. Market-based instruments to encourage resource conservation mainly in the agriculture and domestic sector have not been really tried. This accompanied with the subsidy regime in these sectors has resulted in poor resource usage efficiency.
- It was realised during the later stages of implementation of the Ganga Action Plan, that the local authorities were not able to operate and maintain these assets due to inadequate resources and skills. The level of commitment required from the state agencies was also missing. The pollution arose from a number of diffused sources either urban or rural.

Knowledge/information/data gaps

- Water quality monitoring by CPCB is at present being carried out at 507 locations, as against 77 stations in 1977. The 476 stations at which monitoring was carried out in 1996 and 1997 comprised 407 stations on rivers, 20 on wells, 33 on lakes, 9 on canals, 2 on ponds, 3 on creeks, and 2 on tanks. Water quality monitoring at 383 locations is conducted on a monthly basis, on a quarterly basis at 121 stations and annually for 3 locations through the involvement of several agencies. The maximum, minimum, and mean values of the parameters and the percentage violations for select parameters are reported. However, specific information is not available for water quality in these water bodies for seasons with lean flow. The frequency of monitoring and number of monitoring stations also is not representative of the quality of the water body specifically in the non-monsoon period.
- The CWC also monitors the water quality for 47 parameters at about 300 locations. Though there is a dedicated staff for monitoring the water quality at these three times in a month, published data are not available. Information is available only at the regional office level and that too, on request.
- Information on the availability of groundwater and its quality is limited. Though groundwater availability maps have been prepared for certain locations, extraction rates have not been defined.
- Much of the information—quantitative as well as qualitative, on water supplied, coverage of population, quality of service and sanitation both in the urban and rural areas is not available. Besides, information gaps on water consumption and effluent discharge patterns for industries also exist.

Recommendations

River basin approach

With water being a subject under the state list, the present approach to water-related matters restricts the issue only to political boundaries, involving a number of agencies and ministries with overlapping responsibilities. Instead a river basin or sub-basin-based approach to water management is called for. This would ensure that aspects such as water allocation, pollution control, protection of water resources, and mobilisation of financial resources are not dealt in isolation and decisions on the overall development process and land-use planning flow from this. The administrative mechanisms of these authorities need to be defined and operationalised in coordination with relevant state government departments, the central government, and representatives from the community, ensuring that the delegation of authority from the existing departments is consistent and avoids any overlapping.

Further, for effective co-ordination, apex level bodies need to be created, as in other countries, to coordinate the functioning of different agencies. For instance, the National Water Commission (NWC) in Mexico was established in 1989 as the sole authority with offices in all 31 states and coordinates with the river basin organisations for each of the six basins.

Plug weaknesses in the current policy and legal framework

State-specific water policies need to be prepared for all issues concerning a state. Various individual development projects and proposals, water allocation priorities and guidelines for resource management need to be area-specific and formulated by the states within the framework of such an overall plan. Revision in the National Water Policy, 1987 also needs to be finalised at the earliest. Similarly, weaknesses in the current legal framework, specifically with regard to groundwater regulations, arise from the absence of certain laws and inadequate provisions. Groundwater legislation aiming at equity and sustainability in access to groundwater and its development needs to be enacted in all states. It is important to assess the effectiveness of the various legislative acts and work out measures that improve their applicability and outcomes. Incentives under the Water Cess Act, for instance, have to be made more attractive to make the industries undertake pollution control measures.

Increasing resource availability

The need is to develop surface irrigation sources and undertake measures for rainwater harvesting and preventing water run-offs. With the rivers of the country carrying about 80% of the flow during the monsoon months of June-September and generally in excess of 90% during the period of June-November, the run-off can be tapped by building appropriate water harvesting structures in the lower reaches to trap the water. However constraints associated with rainwater harvesting in terms of the capacity of soil to absorb large quantities of water in a short time frame, quality of the harvested water for drinking water purpose, and the cost involved with building such harvesting structures, need to be looked into, as well.

The concept of watershed development has also to be adopted more rigorously, which will effectively contribute to the revival of local level traditional water control works. Micro-watershed development provides a medium for revival and integration of traditional water control measures. This type of integrated planning helps to make investments far more effective, functionally and economically. But it is also more demanding on both the government and the affected people. Obviously a major effort in public education and training of local people to impart the basic understanding and skills necessary for eliciting such participation is imperative. The government should also consider providing technical and financial support for harvesting rainwater, especially in the rural areas. Photos 11.4 and 11.5 highlight watershed development efforts in the country.

Pricing the resource

Water being a state subject, pricing is done by the state governments and water prices vary from state to state. With water demand in the agricultural sector as high as 95% of total demand and no proportions between the water rates and consumption patterns, water usage efficiency is only 30%–35%. Such poorly targeted subsidies send the wrong signals to users causing a wasteful use of resources and suboptimal choices by consumers. An appropriate tariff structure for water services will encourage wise usage of the resource and generate additional support for the fund-starved service providers as well.

Resource conservation

Together with the measures towards pollution abatement it is imperative to further intensify efforts for conservation of water to prevent overexploitation of existing resources and reduce the quantity of wastewater generated. As water tariffs are very low, the consumer has little incentive to conserve water. There is a need to take a fresh look at the existing water pricing structure. Additionally, there is a need to develop and implement cost-effective water appliances such as low-flow cisterns and faucets and formulate citizen forum groups to encourage and raise awareness on water conservation. Besides the Water Cess Act, efforts have to be made to introduce and implement the Zero discharge concepts, which would enhance recycle and reuse of effluent discharge.

Resource degradation

In order to enhance effective treatment of wastewater, there is a need for better collection and interception of sewage. The existing large number of scattered sources of pollution from high-density low-income communities need to be converted into concentrated point-sources that are easier to monitor and intercept for any further treatment. Many low-cost and effective technologies for waste water treatment, e.g. UASB, duckweed ponds, and horizontal filters have been developed in other parts of the world but are applied to a limited extent in India. There is a need to explore the associated advantages in terms of the negligible amount of energy required, beneficial uses of by-products (sludge as manure and biogas), lower operation and maintenance costs, etc. Adoption of cleaner technologies by the industry would go a long way in safeguarding the quality scarce resources. Policy initiatives can aid the diffusion and implementation of clean technologies by encouraging their procurement by the public sector and other government owned organisations leading to development of a domestic market demand for the product.

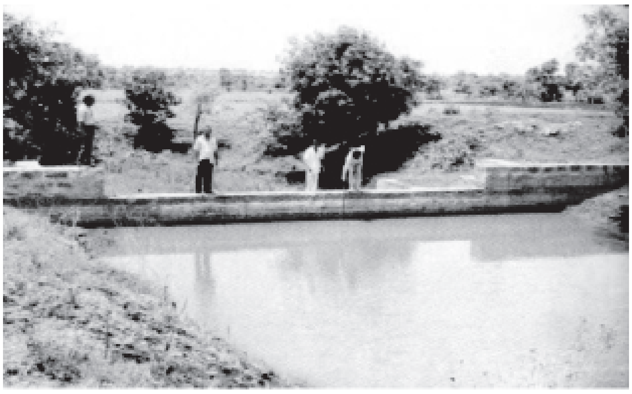


Photo 11.5 Masonry gully control structure having harvested water in Parua Nala watershed

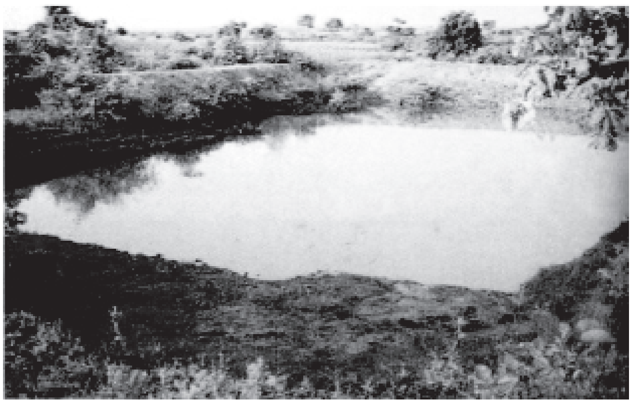


Photo 11.4 Farm pond created in a farmer field in Manoli watershed

Plugging information gaps

Baseline information—quantitative as well as qualitative—needs to be collected for water supply and sanitation both in the urban and rural areas and then used for formulating strategies to address these and prioritising the action plan. Exercises such as performance measurement of the service provider, specifically in the urban areas need to be undertaken to benchmark operational efficiencies related to water treatment and distribution. This will also help in critically reviewing the various water and wastewater treatment processes and then coming out with some best practice guidelines for operation and maintenance of different types of systems. Similarly, information on water consumption and effluent discharge patterns for industries could be used to benchmark resource consumption and increase the productivity levels per unit of water consumed.

A basin-wise analysis of the availability of utilisable resources, demand levels and consumption patterns needs to be made. This will help in identifying pockets or states over-using water, basins that have poor water utilisation rates and prioritise an action plan for implementing projects like watershed management to increase the resource availability. Such an analysis would also assist in developing a Water Zoning Atlas to guide decisions related to the siting of industries and other economic activities.

Community management

Community management is the key to the successful overall performance of the water sector. It has been amply demonstrated that projects with community inputs are more successful in reaching the greatest number of affected people with long lasting services. Other benefits include lower costs, greater acceptance of the technology, and better maintenance of the facilities by the users. In order to regulate pollution, changes in government policies are required and community participation is also necessary to ensure the success of NRAP.

However, one needs to maintain some degree of caution while adopting either ‘community participation’ or ‘community management’ approaches. Community-based management goes one step beyond just simple involvement of the people in the process—it empowers the community to control its systems. This would require a number of committed volunteers and trained staff to carry out the tasks. At the micro-level, the delegation of integrated water resources development and management procedures to the lowest appropriate levels would lead to redressal of the problems of the affected people within their own social and regional domains. The NGOs can provide a very important link between the community and government institutions. The NGOs can offer their services in capacity building of the relevant stakeholders, R&D for low-cost and effective water supply and sanitation facilities, and timely enforcement of policies.

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