WATER QUALITY MONITORING IN INDIA-ACHIEVEMENTS AND CONSTRAINTS

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Abstract India is rich in water resources, being endowed with a network of rivers and blessed with snow cover in the Himalayan range that can meet a variety of water requirements of the country. However, with the rapid increase in the population of the country and the need to meet the increasing demands of irrigation, human and industrial consumption, the available water resources in many parts of the country are getting depleted and the water quality has deteriorated. Indian rivers are polluted due to the discharge of untreated sewage and industrial effluents. The Central Pollution Control Board (CPCB) has established a network of monitoring stations on rivers across the country. The present network is comprising of 870 stations in 26 States and 5 Union Territories spread over the country. The monitoring is done on monthly or quarterly basis in surface waters and on half yearly basis in case of ground water. The monitoring network covers 189 Rivers, 53 Lakes, 4 Tanks, 2 Ponds, 3 Creeks, 3 Canals, 9 Drains and 218 Wells. Among the 870 stations, 567 are on rivers, 55 on lakes, 9 on drains,12 on canals, 4 on tank, 3 on and creeks,2 on pond and 218 are groundwater stations. The monitoring of water quality at 257 stations is being done on monthly basis, 393 stations on quarterly basis, 216 on half yearly basis and 4 stations on yearly basis. Presently the inland water quality-monitoring network is operated under a three-tier programme i.e. GEMS, Monitoring of Indian National Aquatic Resources System and Yamuna Action Plan. Water samples are being analysed for 28 parameters consisting of physico-chemical and bacteriological parameters for ambient water samples apart from the field observations. Besides this, 9 trace metals and 15 pesticides are analysed in selected samples. Biomonitoring is also carried out on specific locations. In view of limited resources, limited numbers of organic pollution related parameters are chosen for frequent monitoring i.e. monthly or quarterly and major cations, anions, other inorganic ions and micro pollutants (Toxic Metals & POP's) are analysed once in a year to keep a track of water quality over large period of time. The water quality data are reported in Water Quality Statistics yearbooks. The water quality monitoring of major rivers indicates that organic pollution is predominant and almost all the surface water sources are contaminated to some extent by Coliform Group of Bacteria that make them unfit for human consumption unless disinfected. The grossly polluted rivers on specific stretches are Sabarmati, Godavari, Satluj, Yamuna, Cauvery, Ganga, Krishna, Tapi, Mahanadi and Brahmani whereas relatively clean rivers are Mahi, Narmada, Brahmaputra and Beas with respect to organic and bacterial pollution.

1. Background

The Central Pollution Control Board (CPCB) is responsible for restoration and maintaining the wholesomeness of aquatic resources under Water (Prevention & Control Of Pollution) Act 1974 passed by Indian Parliament. To ensure that the water quality is being maintained or restored at desired level it is important that it is monitored on regular basis. Water quality monitoring helps in evaluating the nature and extent of pollution control required, and effectiveness of pollution control measures already in existence. It also helps in drawing the water quality trends and prioritising pollution control efforts.

2. Water Resources in India at a Glance

The geographical area of India is 3,287,590 sq km. The length of its Coastline is about 7500 km. The climate of India varies from tropical monsoon in south to temperate in north. Its terrain have upland plain (Deccan Plateau) in south, flat to rolling plain along the Ganges, deserts in west, Himalayas in north. India is enviably endowed in respect of water resources. The country is literally criss-crossed with rivers and blessed with high precipitation mainly due to the southwest monsoon, which accounts for 75% of the annual rainfall. There are thirteen major river basins (area more than 20,000 square kilometre) in the country, which occupy 82.4% of total drainage basins, contribute eighty five percent of total surface flow and house eighty percent of the country's population. Major river basins are Brahmaputra, Ganga (including Yamuna Sub Basin), Indus (including Satluj and Beas Sub Basin), Godavari, Krishna, Mahanadi, Narmada, Cauvery, Brahmini (including Baitarni Sub Basin), Tapi, Mahi, Pennar and Sabarmati. The classification of river basin based on catchment area is given in Table 1. There are few desert rivers, which flow for some distance and get lost in deserts. There are complete arid areas where evaporation equals rainfall and hence no surface-flow. The medium and minor river basins are mainly in coastal area. On the east coast and part of Kerala State, the width of land between mountain and sea is about 100 km, and hence the riverine length is also about 100 km. whereas, the rivers in the west coast are much shorter as the width of the land between sea and mountains is less than 10 to 40 km. Yet, in spite of the nature's bounty, paucity of water is an issue of national concern resulting in deterioration of water quality in aquatic resources.

Table 1: Classification of river Basin in India

River Basin	Catchment Area -Sq.km (%)	No.of Basin
Major	More than 20,000 (82.4)	13
Medium	Between 2000 – 20,000 (8)	48
Minor	Less than 2,000 (9.6)	52

3 Objective

To address water-related environmental problems, it is must to have accurate information and to know precisely what the problem is, where it is occurring, how serious it is, and what is causing it. Such information is necessary for determining cost-effective and last-

ing solutions to water-related problems. The goal is to provide appropriate picture of current water-quality conditions and trends in water quality and water uses, and to facilitate the identification of emerging issues and future priorities. The water quality monitoring is performed with following objectives.

- For rational planning of pollution control strategies and their prioritisation;
- To assess nature and extent of pollution control needed in different water bodies or their part;
- To evaluate effectiveness of pollution control measures already is existence;
- To evaluate water quality trend over a period of time;
- To assess assimilative capacity of a water body thereby reducing cost on pollution control;
- To understand the environmental fate of different pollutants.
- To assess the fitness of water for different uses.

4. Approach to Monitoring

The monitoring activities under national network serve various assessment goals. These goals are determination of natural freshwater qualities in the absence of significant direct human impact, determination of long term trends in the levels of critical water quality indicators in freshwater resources and determination of the fluxes of organic matter, suspended solids, nutrients, toxic chemicals and other pollutants from major river basins to the seawater/coastal water interfaces. To meet the objectives and goals, highly selective network of strategically located monitoring stations is created and operated in the major, medium and minor watersheds of rivers, lakes, ponds, tanks, creeks, drains, canals and subsurface aquifers in the country. Three types of monitoring stations are set up for monitoring i.e. baseline, trend and impact or flux stations

Groundwater quality problems have reached to a cause of concern throughout the country. Salinisation and use of agrochemicals mandate the monitoring of trends in important aquifers, particularly of the arid and semi-arid climate belt. Trace contaminants, Fluoride and Nitrates, by levels and trends, are the primary monitoring concerns for aquifers in agriculture, industrialized and grossly polluted areas. Monitoring of groundwater quality needs to be strengthened for parameters from pollution point of view.

5   Water Quality Monitoring Network

Central Pollution Control Board started national water quality monitoring in 1978 under Global Environmental Monitoring System (GEMS), Water Programme. Monitoring Programme was started with 24 surface water and 11 groundwater stations. Parallel to GEMS, a National Programme of Monitoring of Indian National Aquatic Resources (MINARS), was started in 1984, with a total of 113 stations spread over 10 river basins. The present network comprises of 870 stations on rivers, lentic water bodies and subsurface waters is elaborated in Table 2.The number of locations on mainstream of the major

river and their tributaries, medium and minor rivers, lakes, ponds, tanks and other water bodies is given in parenthesis.

Water samples are being analysed for 28 parameters consisting of physico-chemical and bacteriological parameters for ambient water samples apart from the field observations. Besides this, 9 trace metals Mercury (Hg), Arsenic (As), Chromium (Cr), Cadmium (Cd), Lead (Pb), Copper (Cu), Nickel (Ni), Zinc (Zn) and Iron (Fe) and 15 pesticides (Alpha BHC, Beta BHC, Gama BHC (Lindane), OP DDT,PP DDT, Alpha Endosulphan, Beta Endosulphan, Dieldrin, Aldrin, Carboryl (Carbamat), 2-4 D, Malathion, Methyl parathion, Anilophos and Choropyriphos are analysed in selected samples. Bio-monitoring is also carried out on specific locations. In view of limited resources, limited numbers of organic pollution related parameters are chosen for frequent monitoring i.e. monthly or quarterly and major cations, anions, other inorganic ions and micro pollutants (Toxic Metals & POP's) are analysed once in a year to keep a track of water quality over large period of time. The water quality data are reported in Water Quality Statistics year-books.

Table 2 : Water bodywise distribution of Monitoring Stations

River (main stream), Tributaries and Sub-Tributaries, Lake, Ponds, Tanks, Canals, Creeks and Groundwater Stations	Total Stations
Baitarni (5)	5
Brahmani (11) **Tributaries**-Karo (1), Koel (2), Sankh (2)	16
Brahmaputra (6) **Tributaries**-Burhidihing (1), Dhansiri (6), Disang (1), Jhanji (1),Subansiri (1), Bhogdoi (1),Bharalu (1),Borak (1),Deepar Bill (1), Digboi (1),Mora Bharali(1),Teesta (4),Dickhu(1), Maney(2),Ranchu(2)	31
Cauvery (20) **Tributaries**-Arkavati (1), Amravati (1), Bhawani (5), Kabini (4), Laxmantirtha (1), Shimsa (2), Hemavati (1),Yagichi(1)	36
Ganga (39) **Tributaries**-Barakar (1),, Betwa (3), Chambal (7), Damodar (5), Gandak (1), Saryu-Ghaghra (3), Gomti (5), Hindon (3), Kali (West) (2), Kali Nadi (2), Khan (1), Kshipra (2), Mandakini (Madhya Pradesh) (1) , Parvati (3), Ramganga (1), Rapti (1), Rihand (2), Rupanarayan (1), Sai (1), Sone (5), Tons (Madhya Pradesh) (2), Yamuna (23),Sind (1), Johila (1),Sankh(1), Gohad (1), Kolar (1), Sai(1), Churni (1), Tons (Himachal Pradesh) (1),Sikrana (1),Daha (1), Sirsa (1), Dhous (1), Farmer (1)	127
Godavari (11) **Tributaries**- Manjira (2), Maner (2), Nira (I),), Wainganga (4), Wardha (1),Kolar (1), Kanhan(1), Purna(1),Karanja (1), Indravati (2), Shankhani (1)	28
Indus **Tributaries**-Beas (18), Chenab (1), Jhelum (3), Larji (1), Parvati (1), Ravi (3), Sutlej (21), Tawi (1), Gawkadal (1), Chuntkol (1), Sirsa (3), Swan (1)	55
Krishna (19) **Tributaries**- Bhadra (3), Bhima (10), (Ghataprabha (2), Malprabha (3), Muneru (1), Musi (2), Nira (1), Paleru (1), Tunga (1), Tungabhadra (6), Panchganga (3), Chandrabhaga (2)	54
Mahi (9) (2G, 7) **Tributaries**-Anas (1), Panam (1)	11
Mahanadi (18) **Tributaries**-Ib (4), Hasdeo (2), Kathajodi (1), Kharoon (4), Kuakhai (2), Sheonath (3), Birupa (1),Arpa (1), Kelo (2)	38
Narmada (14) (3G,11) **Tributaries**-Chhota Tawa (1)	15
Pennar (1G, 4)	5
Sabarmati (2G, 4) **Tributaries**-Shedhi (1), Khari (1)	8
Subarnerekha (4G,2)	6
Tapi (11) (3G, 8) **Tributaries**-Girna (2M), Rangavali (1)	14

River (main stream), Tributaries and Sub-Tributaries, Lake, Ponds, Tanks, Canals, Creeks and Groundwater Stations	Total Stations
Medium & Minor Rivers Ambika (1), Ulhas(2),Ulhas-Bhatsa (1)Ulhas-Kalu(1), Imphal (4), Mandovi (2), Palar (1), Pamba (3), Pariyar (3), Rushikulya (2), Tambiraparani (7), Achankoil (2), Chalakudy (1), Damanganga (6), Ghaggar (21), Kallada (1) , Kali-Karnataka (1), Manimala (2), Mindhola (3), Nagavalli (3), Amlakhadi (1), Chaliyar (2), Iril (2), Kharkhala (1), Karmana (1),Kolak(2),Kundalika(1),Meenachil(1),Muvattupuza(1),Patalganga(2),Umtrew(1),Vamanpuram(1),Zuari(2),Gumti(2),Kalna(1),Valvant(1),Madai(1),Khandepar(1),Asanora(1),Neyyar(1),Ithikkara(1),Kadalundy(1),Kuttiyady(1),Mahe(1),Kuppum(1),Neelsvaram(1),Karingoda(1),Chandergiri(1),Chitrapuzha(1),Nambul(2),Ganol(1),Simsang(1),Myntdu(1),Arasalar(1),Kodra(1),Haora(1), Markanda (2), Sukhna (1), Baleshwar Khadi (1), Netravati (1), Kumardhara (1),Purna (1), Kaveri (1), Dhadar (1)	117
Lakes (55) Hussaingar(1), Saroornagar(1), Himayatsagar(1), Pulicate(1) ,Salaulim(1), Kankoria(1), Ajwah(1), Sursagar(1), Brahamsarovar(1), Govindsgar(1), Pongdam(1), Renuka(1), Wuller(1), Dal(1), Ulsoor(1), HebbalaValley(1),. Oruvathikotta(1), Sasthamcotta(1), Ashthamudi(1), Paravur(1), Vembanad(1) ,Periyar(1), Kodumgallor(1), Kayamkula(1), Punnamadakayal(1), Pookotekayal(1), UpperLake(1), LowerLake(1), MultaiLake(1), Loktak(4), Umiam(1), Ward(1), Thadlaskena(1), Osteri(1), Bahour(1), Harike(2), Pichola(1), Udaisgar(1), RamgarhJaipur(1), Pushkar(1), Fatehsagar(1), Kalyana(1), Nakki(1), Udhagamadalam(1), Kodaikanal(1), Yercaud(1) ,Lakshminarayan Baridigh(1), Rudrasagar(1), Ramgarh-UttarPradesh (1), Naini(1), Rabindrasarovar (1) **Tanks (4)** Dharamsagar(1),Bibinagar(1),Kistrapetrareddy(1),,Goysagar(1), **Ponds (2)** Elangabeel System(1), Lakshadweep(1),	61
Creeks, Canals, Tanks, Ponds, Drains Creeks (3M), Agra Canal (1M), Gurgaon Canal (1M), Western Yamuna Canal (9M), Agartala Canal (1),Drains (10M)	25
Groundwater	218
Total	**870**

6   Analytical Quality Control (AQC)

AQC is introduced as a regular component of water quality monitoring among the laboratories analysing the water samples under National Water Quality Monitoring Programme. CPCB laboratory is also regularly participating in the AQC programme conducted by Global Environmental Monitoring System (GEMS).

7   Water Quality Criteria

The Central Pollution Control Board has classified water resources of the country according to their uses for setting water quality objectives for different water bodies. The classification system is presented in Table 3.

Table 3: Primary water quality criteria for various uses of fresh water

Designated best use	Class	Criteria
Drinking water source without conventional treatment but after disinfections	A	*Total coliform organisms MPN/100mL shall be 50 or less. *pH between 6.5 and 8.5 *Dissolved oxygen 6 mg/l or more *Biochemical oxygen demand 2 mg/l or Less
Outdoor bathing (organised)	B	*Total coliform organisms MPN/100ml shall be 500 or less *pH between 6.5 and 8.5 *Dissolved oxygen 5 mg/l or more

		*Biochemical oxygen demand 3 mg/l or Less
Drinking water source with conventional treatment followed by disinfection	C	*Total coliform organisms MPN/ 100ml shall be 5000 or less *pH between 6 and 9 *Dissolved oxygen 4 mg/l or more *Biochemical oxygen demand 3 mg/l or Less
Propagation of wild life, fisheries	D	*pH between 6.5 and 8.5 *Dissolved oxygen 4 mg/l or more *Free ammonia (as N) 1.2 mg/l or less
Irrigation, industrial cooling, controlled waste disposal	E	*pH between 6.0 and 8.5 *Electrical conductivity less than 2250 micro mhos/cm *Sodium absorption ratio less than 26 *Boron less than 2mg/l

8   Findings/Monitoring Results

8.1   Surface Water- Organic and Bacteriological Parameters

The monitoring results obtained under the programme indicate that organic pollution continues to be the predominant pollution of aquatic resources. The organic pollution measured in terms of bio-chemical oxygen demand (BOD) & coliform count gives the indication of extent of water quality degradation in different parts of India. It is observed that nearly 66% of the observations recorded during 2004 are having BOD less than 3 mg/l, 19% between 3-6 mg/l & 15% above 6 mg/l. Similarly, Total & Faecal coliform, which indicate presence of pathogens in water are also a major concern. About 44% observations are having Total Coliforms and 59% observations are having Faecal Coliform less than MPN 500/100 ml.

The trends of % of observations obtained during 1994-2004 for last 11 years in different levels of pollution with respect to BOD & Total Coliform and Faecal Coliform are shown in bar diagram (Fig. 1) indicating different ranges of BOD and Coliform organisms. It is clear from the Fig.1 that there is an increasing trend in percentage of observations having BOD below 3 mg/l. This indicates that there is a gradual improvement in water quality with respect to organic pollution.
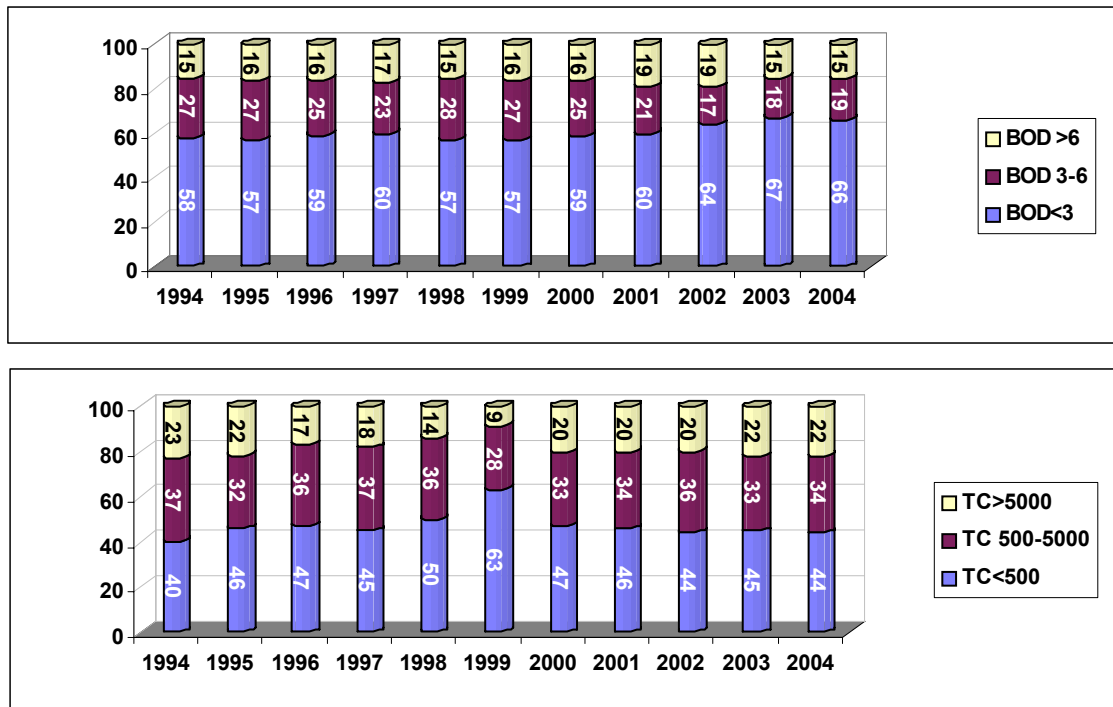
Figure 1: Water Quality Status & Trend from 1994 to 2004

Taking BOD as indicator of organic pollution, an attempt is made to estimate the riverine length under different level of pollution i.e grossly polluted having BOD > 6 mg/l, moderately polluted having BOD between 3and 6 mg/l and Relatively clean having BOD < 3 mg/l. Total length of perennial rivers, streams and their tributaries in India is estimated as 45,000 km. On the basis of water quality monitoring results, the estimated riverine length having different level of pollution is presented in Fig 2.
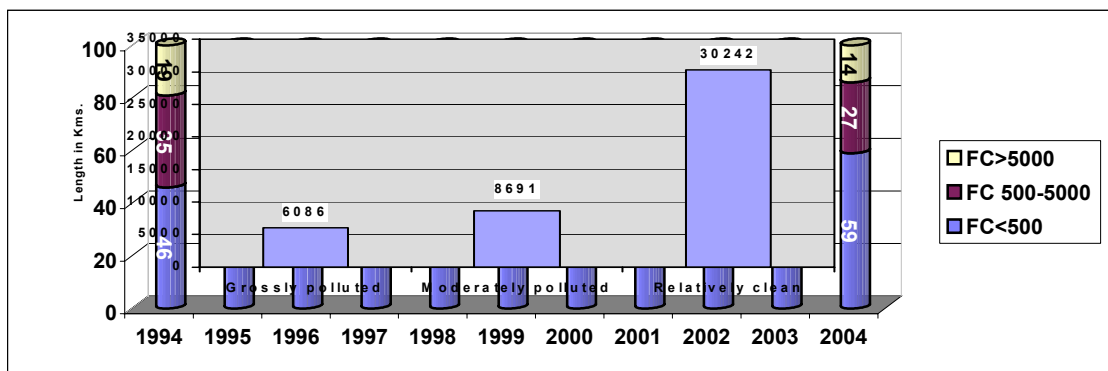

Figure 2 : Length of polluted River Stretches

The water quality data is processed to observe the water bodies meeting the desired water quality classes. The water bodies (Rivers and lentic water bodies) not meeting the desired water quality standards and having BOD level more than 6 mg/l are identified as polluted water bodies/stretches. The numbers of water bodies (river stretches and lentic water bodies) exceeding the level of 6 mg/l BOD are 86 and among them 71 are river stretches and 15 are lentic water bodies (lakes/tanks and ponds).

8.1.1 River Specific Findings

The water quality data of rivers Ganga, Yamuna, Sabarmati, Mahi, Tapi, Narmada, Godavari, Krishna, Cauvery, Mahanadi, Brahmani, Baitarni, Subarnrekha, Brahmaputra, Satluj and Beas is computed statistically to obtain information on polluted stretches.

The water quality of major rivers varied widely with respect to DO,BOD,TC and FC. The level of DO is observed more than 4 mg/l in river Tapi, Narmada, Brahmini, Brahmaputra, Subarnrekha and Beas throughout the year, whereas the lowest values (0.1 mg/l) are observed in river Yamuna at downstream of National Capital city of Delhi , Krishna at Vijaywada and Cauvery at Mohanur respectively; Sabarmati (0.8 mg/l) at downstream of Ahmedabad city, Mahanadi (1.4 mg/l) at Sheorinarayan due to discharge of untreated municipal wastewater that is responsible for high oxygen demand.

The very high values of Biochemical Oxygen Demand (BOD) are observed in river(s) Sabarmati (475 mg/l) downstream of Ahmedabad followed by   Godavari (78mg/l) downstream of Nanded city, Satluj (45mg/l) downstream of Ludhiana city, Yamuna (36 mg/l) downstream of Delhi, Cauvery (27mg/l) downstream of Tiruchirapalli, Ganga (17mg/l) downstream of Varanasi, Krishna and Tapi (10 mg/l each) downstream of Sangli and Uphad respectively, Mahanadi (8mg/l) and Brahmani (6mg/l) after meeting river Mand and Panposh downstream respectively. The relatively low values of BOD (less than 6 mg/l) are measured in river(s) Mahi, Narmada, Brahmaputra and Beas throughout the length of the river.

In respect of Total Coliform Numbers and Faecal Coliform Numbers, river Yamuna is leading with highest count of 2.6 billion MPN/100 ml and 1.7 million MPN/100 ml respectively, which is followed by Sabarmati (2.8 million), Ganga (2.5 million and 1.1 million), Brahmaputra (240,000 and 24,000), Cauvery (160,000 and 28,000), Brahmani(90,000 and 60,000),Satluj (35,000 and 3500),Krishna (33,300 and 10,000), Mahanadi (30,000 and 17,000),Baitarni (22,000 and 11,000) and Godavari (5260 and 3640).The river Mahi, Tapi, Narmada, Subernrekha and Beas are relatively clean rivers as the number of Total Coliform and Faecal Coliform count are quite less as compared to other rivers and are meeting the criteria. Water quality of major Indian rivers and some of their tributaries for the year 2002 is presented in Table 4.

Table 4 : Water Quality in Indian Rivers - 2002

River Name	Length (km)	No. of Monitoring locations	Observed Range of Water Quality Parameters							
			Temperature ^0C	pH	Conductivity (μmhos/cm)	DO (mg/l)	BOD (mg/l)	COD (mg/l)	Total Coliform (MPN/100 ml)	Faecal Coliform (MPN/100 ml)
Ganga	2525	34	3-34	6.4-9.0	19-2720	2.7-11.5	0.5 – 16.8	1-30	300-25x10^5	20-11x10^5
Yamuna	1376	23	3-34	6.7-9.8	56-1959	0.1-22.7	1.0 – 36	1-112	27-26.3x10^6	11-17.2x10^5
Sabarmati	371	8	12-32	2.9-8.6	269-13530	0.6-7.9	0.8 – 475	4-1794	210-28x10^5	28-28x10^5
Mahi	583	7	19-34	7.1-9.2	175-5720	0.2-8.5	0.1 – 3.0	9-163	3-2400	3-75
Tapi	724	10	20-40	7.4-9.0	76-700	4.8-8.8	0.6 – 10.0	8-40	40-2100	2-210
Narmada	1312	14		6.9-9.3	102-1341	5.8-9.8	0.1 – 3.8	6-47	9-2400	2-64
Godavari	1465	11	22-35	7.0-9.0	118-1400	3.1-10.9	0.5 – 78.0	3-96	8-5260	2-3640
Krishna	1401	17	18-33	6.8-9.5	28-11050	2.9-10.9	0.2 – 10.0	3-88	17-33300	3-10000
Cauvery	800	20	21-37	2.0-9.2	31-53100	0.1-12.6	0.1 – 26.6	**30**	39-160000	2-28000
Mahanadi	851	16	18-38	7.3-8.9	114-15940	1.3-10.4	1.0 – 7.6	7-39	15-30000	50-17000
Brahmani	799	11	20-38	7.0-8.4	81-376	5.2-9.8	1.5 – 6.0	8-13	80-90000	40-60000
Baitarni		5	24-36	7.3-8.3	54-78400	6.8-9.3	2.0 – 6.8	7	900-22000	700-11000
Subarnrekha	395	6	18-36	6.5-8.0	113-355	5.2-8.5	0.2 – 12.0	4-96	150-1800	70-540
Brahmaputra	916	6	15-32	6.5-9.0	104-684	1.1-10.5	0.1 – 3.9	6-11	360-240000	300-24000
Pennar	597	4	-	7.5-8.7	364-978	6.0-9.3	1.0 – 2.9	14-16	-	-
Satluj	1078	20	9-32	6.8-8.8	131-819	3.8-11.4	0.1 – 45.0	1-80	8-35000	2-3500
Beas	460	19	3-32	7.1-8.7	53-517	5.2-11.5	0.3 – 5.0	1-13	2-2400	2-1600

8.1.2 Surface Water -Major Ions and other Inorganics

The major ions are measured to assess the fitness of water for various beneficial uses other than drinking and to validate the monitoring results. The monitoring results indicate that the ionic concentration in groundwater is generally higher than the surface water if not affected by waste water discharges. Similarly the water bodies receiving return flow from the irrigated areas usually have high salt concentration.

8.1.3 Toxic Metals and POP's

Of late, it has been realised that the parameters measured under National Programme are not adequate to provide complete information on water quality. Also there is a growing concern about pesticide residues and heavy metals in ambient water which is responsible for the presence of these micro pollutants in aerated drinks, bottled water, vegetables and crops. It has now been decided that micro pollutants in water and sediment samples have to be measured at all the monitoring locations under National Water Quality Monitoring Programme at least once before monsoon. The data generated to limited extent during 2004 is under scrutiny and validation as the detection limits of instruments vary from laboratory to laboratory and reference standards has low shelf life.

8.2 Subsurface Water

The subsurface Water Quality is degraded mainly due to natural reasons along with over withdrawal of water, insanitary conditions in rural and urban areas and increased application of fertilisers and POP's. The parameters of concern in subsurface water are higher level of Fluoride in several pockets of the country (about 200 districts are being affected); Arsenic problem in parts of West Bengal, specially in 24 paragna's of West Bengal; Nitrate problems observed in many parts of the country especially in intensively irrigated and high productivity regions from agriculture point of view; and in urban areas due to improper and inadequate sewage collection; Salinity problems in intensive irrigated (command areas) and coastal areas of the country; Micro pollutants, especially pesticides due to their intensive applications in certain parts of the country; and Pathogenic pollution in urban areas, due to in-sanitary conditions.

9.   Outcome of National Programme and Achievements

- Every year a compendium of water quality statistics is published and circulated to various scientific institutes and processed data is put on the web site for easy access.
- Basin sub basin Inventory of water pollution is prepared and published for all the major river basins in the country.
- Water quality atlas is prepared to assess the fitness of river water for desired uses in the country.
- Water quality data is used for Identification of Polluted Water Bodies based on violation of desired water quality criteria for designated uses
- Water quality data formed the basis for Formulation of River Action Plan and Identification of Pollution Sources. 157 cities are identified for interception   and diversion of municipal wastewater and stricter survillance of industrial sources discharging effluents in rivers.
- Water quality data is used for Query Response i.e. to reply Parliament Questions, VIP reference, Public Queries, Public Interest Litigation filed in Supreme Court and Various High Courts and to fulfill the requirement of Non Governmental Organisation, Students, and Researchers.
- Providing data to GEMS Programme on Water on annual basis for 72 stations for global data base.

10. Constraints

- Sustainability of infrastructure.
- The resources in terms of financial as well as manpower are inadequate.
- Travel to long distances for monitoring and preservation of samples in warm weather conditions adversely affect the results.
- Analysis results needs in-depth validation.
- Low flow and no flow conditions prevail during summer months at number of locations.
- Improper reporting of units, variation in analysis methods and quality control of chemicals are cause of concern.
- Lack of training for data management and statistical tools.
- Lack of software to analyse the data for trend analyses and data validation.

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