



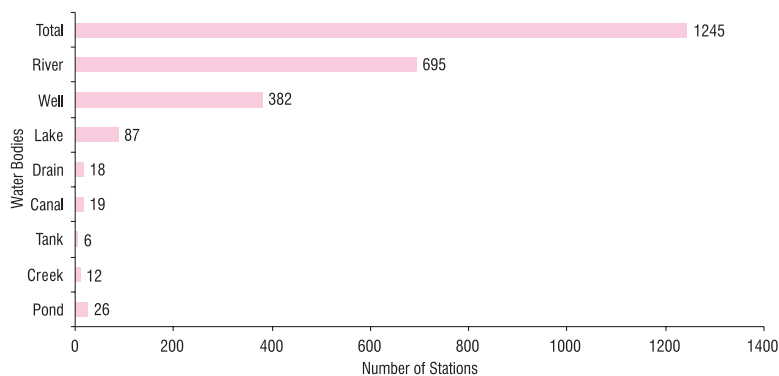
Water Quality Assessment

1.1 National Water Quality Monitoring Programme (NWQMP)

Water quality monitoring facilitates evaluation of nature and extent of pollution and effectiveness of pollution control measures, water quality trends and prioritisation of pollution control efforts. Central Pollution Control Board (CPCB) had established a network of monitoring stations across the country under NWQMP. The network comprises of 1245 water quality monitoring stations in 27 States and 6 Union Territories.

Water quality monitoring facilitates evaluation of nature and extent of pollution

Figure 1.1 Water Quality Monitoring Network



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. The monitoring is done on monthly or quarterly basis in surface waters and on half yearly basis in case of ground water. Water samples are analyzed for physico-chemical, bacteriological parameters apart from the field observations. Besides 9 trace metals and (28 Parameters) pesticides. Biomonitoring is also carried out on specific locations. Limited numbers of organic pollution related parameters are analyzed monthly or quarterly while major cations, anions, other inorganic ions and micro pollutants (Toxic Metals & POP's) are analyzed once a year. The water quality data and trends in Indian water bodies are compiled and published as Water Quality Status Year Book.



1.2 'Designated Best Use' (DBU) based Water Quality Criterion for River Waters

The water quality management is performed under the provision of the Water (Prevention and Control of Pollution) Act, 1974. The Act emphasizes to maintain and restore the wholesomeness of national aquatic resources by prevention and control of pollution. It was considered ambitious to maintain or restore all natural water bodies at pristine level. Planning pollution control activities to attain such a goal is not only deterrent to developmental activities but cost prohibitive also. The natural water bodies are liable to be used for various competing as well as conflicting water demands, the objective of DBU Concept is aimed at restoring and/or maintaining natural water bodies or their parts to such a quality as needed for their best uses. According to this concept, out of several uses water body is put to, the use which demands highest quality of water is termed as "DBU", and accordingly the water body is designated. Primary water quality criteria for different uses have been identified.

The entire water resources of the country were classified according to their designated best uses and a "Water Use Map" was prepared. For identification of the water bodies or their parts where water quality is at variance with water quality criteria, it was felt important to measure water quality of that water body or its part to facilitate preparation of "Water Quality Map" of the Country. The idea was to superimpose "Water Quality Map" on "Water Use Map" to identify the water bodies or their parts, which are in need of water quality improvement (restoration). Subsequently through water quality monitoring network, water quality data are generated to identify the polluted stretches for initiating appropriate measures to restore their water quality. All policies and programmes on water quality management are based presently on this concept including the Ganga Action Plan and National River Action Plans.

1.3 Polluted River Stretches

During 1988-89, CPCB had identified 10 problem areas and 10 polluted river stretch to concentrate the pollution control efforts. The identified polluted stretches formed the basis for formulation of River Action Plans of National River Conservation Directorate. The polluted river stretches were further extended based on increasing pollution problem in the country. Those water bodies having BOD more than 6 mg/l are identified as polluted water bodies. The water quality data up to the year 2000 was analysed and 86 polluted water bodies are identified. Among them 71 are rivers while 15 are lakes and tanks. The water quality data for seven years from 2000 to 2006 has been analysed and polluted water bodies are identified. The State Pollution Control Boards (SPCBs)/ Pollution Control Committees (PCCs) have been advised to formulate action plans to restore the water quality in the water bodies in their respective States/ Union Territories.

1.4 Water Quality Trends

The water quality monitoring results derived from Water Quality Monitoring Network during 1995 to 2006 indicate that the organic and bacterial contamination are continued to be critical. The discharge of domestic wastewater mostly in untreated form from the urban centres of the country has been identified as prime source for this contaminates. The municipal corporations at large are not able to treat the increasing load of municipal sewage flowing into water bodies and it is often discharged without treatment. Further, the receiving water bodies do not have adequate water for dilution. Therefore, the oxygen demand and bacterial pollution is on increase which is mainly responsible for water borne diseases.

The water quality monitoring data have also been analysed with respect to indicator of oxygen consuming substances (Bio-chemical demand-BOD) and indicator of pathogenic bacteria (total coliform and faecal coliform). The result of analysis indicates that the number of observations having BOD and coliform density has increased between 1995 to 2006. The water quality status and trend for the period 1995 to 2006 are depicted ahead.

Analysis indicates that the number of observations having BOD and coliform density has increased between 1995 to 2006

Figure 1.4a Water Quality Trend of BOD (mg/l)

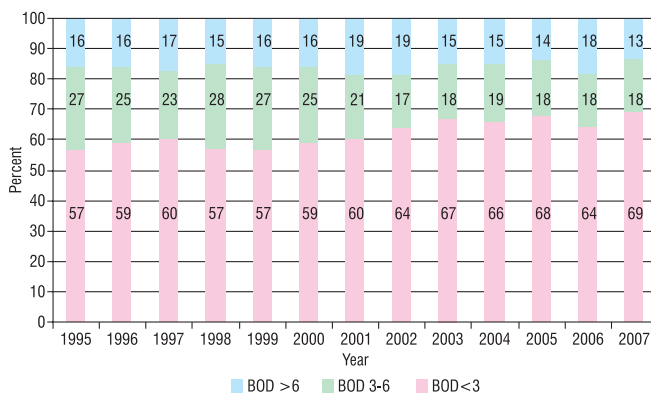


Figure 1.4b Water Quality Trend of Total Coliform (MPN/100 ml)

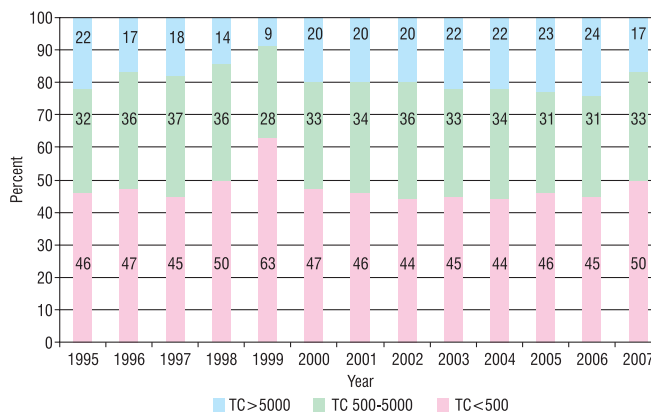
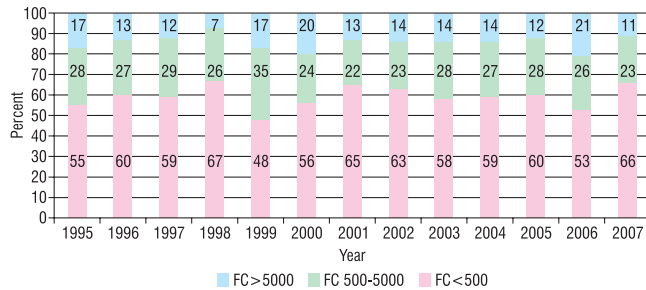




Figure 1.4c Water Quality Trend of Faecal Coliform (MPN/100ml)



1.5 Surveillance of Water Quality Monitoring Stations and Associated Laboratory Facilities for Quality Assurance

West Zone: In Gujarat state, there are total 52 water quality monitoring stations operating either monthly or quarterly while 23 stations are being operated half yearly. In Maharashtra 48 water quality monitoring stations are operational on monthly and quarterly basis while 25 stations are operated on half yearly basis. The CPCB Zonal Office visited 22 NWQMP stations in Gujarat and 14 stations in Maharashtra for quality assurance.

It was observed during the surveillance visits that Gujarat and Maharashtra Pollution Control Boards were following the guidelines stipulated by CPCB with respect to sample collection, preservation, transportation, analysis and data reporting for data quality assurance.

Central Zone: The CPCB Zonal Office, Bhopal has undertaken surveillance of 46 NWQMP stations and related laboratory facilities at the SPCB's regional offices at Ajmer, Bhiwadi, Udaipur, Jabalpur, Ujjain, Raipur and Raigarh during the year. The SPCB has been communicated regarding observations during surveillance visit.

1.6 Monitoring of River Water Quality at Interstate Boundaries

West Zone: In the Western Zone, there are 14 River Water Quality Monitoring stations located at the Interstate boundaries of Gujarat, Maharashtra, Rajasthan and Madhya Pradesh. The CPCB West Zonal Office has undertaken the river monitoring at Interstate Boundaries at 11 locations (7 locations in Maharashtra and 4 locations in Gujarat) on the rivers Krishna, Bhima, Wainganga, Wardha, Narmada, Tapi, Mahi. Two new locations on river Damanganga have been included in the interstate river monitoring at Vapi (Gujarat) and Daman (UT). The water quality has been assessed for Physico-chemical and bacteriological characteristics.

Based on the rationale for the monitoring of rivers at interstate boundaries, it has been decided that the following stations will only be monitored henceforth at inter state boundaries of Gujarat, Maharashtra and UT of Daman.

River	Sampling Location	Frequency
Tapi	Nizhar	Half Yearly
Bhima	Takli	Half Yearly
Krishna	Kurundwad	Half Yearly
Wainganga	Bapera village	Half Yearly
Damanganga	GIDC Weir, Vapi	Quarterly/Yearly
Damanganga	Jarry Causeway, Daman	Quarterly/Yearly

The Lucknow CPCB monitors River Ganga twice a month from u/s Allahabad upto Tarighat

Central Zone: The first phase of monitoring of River water quality at interstate boundaries was initiated during April 2006 at four selected stations on three rivers, namely Wardha (tributary to Godavari) at Bangoan (near Pandhurna) (MP – Maharashtra), Mahi at Bajna (MP – Rajasthan), Mahi at Bajaj Mahi Sagar Dam (MP- Rajasthan) and Chambal at Fish farm, Rawatbhata (MP-Rajsthan).

The water quality trend in these rivers has been found conforming to water quality criteria with respect to pH and Dissolved Oxygen (DO). The DO varied from 6.7 to 9.2 mg/l. The total and faecal coliform count are considerably high and do not meet the DBU Class ‘A’ criteria.

1.7 Water Quality Status of River Ganga

The CPCB Zonal Office, Lucknow is regularly monitoring Ganga under NRCD project twice a month from u/s Allahabad upto Tarighat i.e. Ganga after confluence of River Gomti. With reference to DBU classification, the entire stretch of Ganga from Haridwar to Tarighat has been designated as conforming to category B, which implies that water quality is fit for uses like bathing, swimming, water contact sport. In case of Yamuna, the water quality is monitored at Allahabad, also conform to Category B for these uses.

Figure 1.7a Water Quality of River Ganga -Dissolved Oxygen (DO)

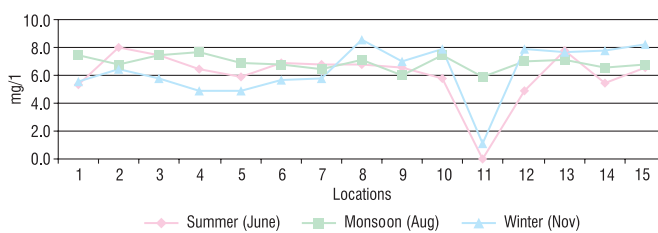
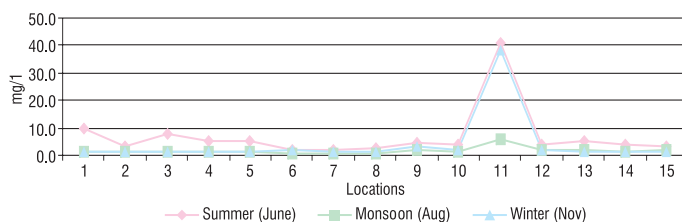
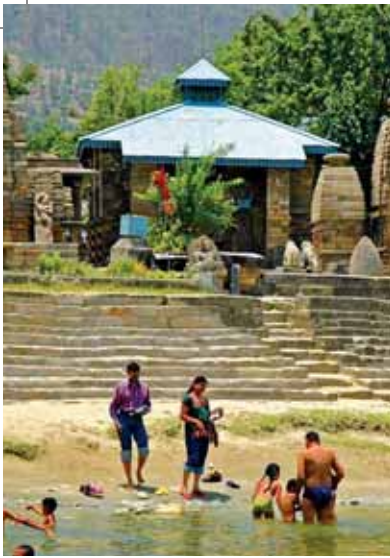


Figure 1.7b Water Quality of River Ganga - Biochemical Oxygen Demand (BOD)





Monitoring locations legends

1. River Ganga u/s Allahabad
2. River Yamuna b/c with River Ganga
3. Bathing Ghat at Sangam
4. River Ganga d/s Allahabad ¼ width
5. River Ganga d/s Allahabad ½ width
6. River Tons b/c with River Ganga
7. River Ganga at Pakka Ghat Vindhyachal
8. River Ganga u/s Varanasi
9. River Ganga at Dashashwamegh Ghat
10. River Ganga near Malviya Bridge at Varanasi
11. River Varuna b/c with River Ganga
12. River Ganga d/s Varanasi ¼ width
13. River Ganga d/s Varanasi ½ width
14. River Gomti b/c with River Ganga
15. River Ganga at Tarighat

1.8 Water Quality Status of River Yamuna

The CPCB is regularly monitoring the entire stretch of Yamuna (1376 km) for its water quality under National River Conservation Directorate (NRCD/MoEF) sponsored project and NWQMP. There are 21 sampling locations from the origin of Yamuna at Yamunotri to its confluence with Ganga at Allahabad. The Yamuna River water quality status in terms of Dissolved Oxygen (DO), Bio-chemical Oxygen Demand (BOD), Total Coliforms (TC) and Faecal Coliforms (FC) is presented below.

Figure 1.8a Dissolved Oxygen Profile of River Yamuna (2007)

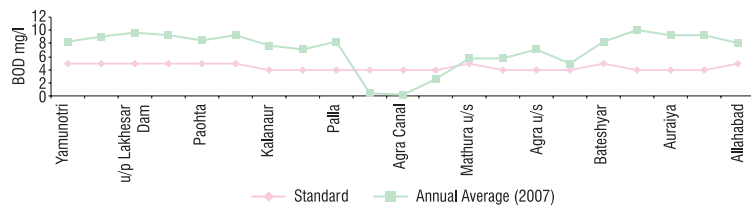


Figure 1.8b Biochemical Oxygen Demand Profile of River Yamuna (2007)

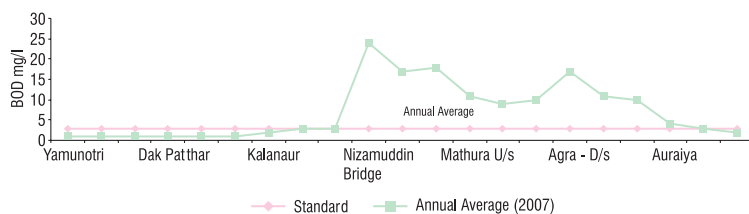
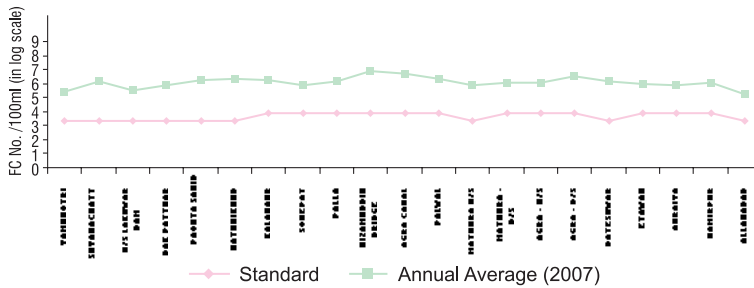
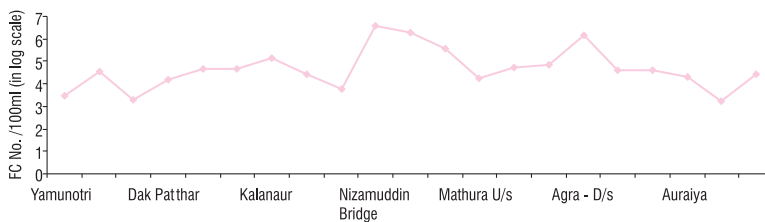


Figure 1.8c Total Coliform Profile of River Yamuna (2007)



Results show that before the confluence of River Sarayan, water quality of River Gomti conforms to the designated best use category B except for faecal coliform

Figure 1.8d Faecal Coliform Profile of River Yamuna (2007)



1.9 Water Quality status of River Gomti

Gomti, a tributary of Ganga is also facing problem of pollution due to discharge of sewage and industrial effluent. CPCB has taken up a project to assess the water quality of Gomti in its entire stretch and identify its major polluting sources during 2007-08. The results show that before the confluence of River Sarayan, the water quality of Gomti conforms to the designated best use category B except for faecal coliform. Presence of faecal coliform can be attributed to open defecation all along the bank of river. Yet the river maintains the pristine water quality and it was observed that river water is directly used by the local villagers in that area.

Water quality of Gomti gets affected after confluence of Sarayan. Sarayan was observed having COD level of 35 mg/l and BOD of 5.6 mg/l while its DO level was observed as 2.7 mg/l. Sarayan receives the sewage and industrial effluent from Sitapur city. Discharge of industrial waste water and untreated sewage into the river is the main cause of poor water quality of Sarayan. DO level of Gomti depletes to 6.9 mg/l from 8.0mg/l after meeting Sarayan. The COD level increases to 18 mg/l and BOD to 3.0 mg/l while the fecal coliform concentration increases about 100%. Water quality of Gomti d/s confluence of Sarayan upto u/s Lucknow does not indicate any appreciable change, as there is no other polluting source in this stretch of the river.

Water quality in Gomti deteriorates in its Lucknow stretch. COD and BOD, the indicator of organic pollution increase from 20 to 37 mg/l and from 2.16 to 5.5 mg/l ,respectively, between Gau ghat to Pipraghat.



With the increase in organic pollution load the DO level reduces to as low as 2.0 mg/l, while the faecal coliforms phenomenally increase to 1.3×10^4 MPN/100ml. Reason for deterioration of water quality may be attributed to direct disposal of untreated sewage from Lucknow city and dumping of garbage along the river bed.

Water quality of Gomti which deteriorates due to mixing of untreated sewage and industrial effluent up to Lucknow improves as a result of self purification process between Pipraghat to u/s of confluence of River Reth as the River meanders through a stretch of about 30 kms, the DO level improves up to 3.89 mg/l, while COD level decreases to 15 mg/l and BOD to 2.4 mg/l. Reth carrying the waste water from Barabanki city further deteriorates the water quality of Gomti. After meeting Reth, COD level of Gomti increases to 27mg/l and BOD to 2.9 mg/l and DO level becomes 4.1 mg/l. Increase in DO level is due to mixing of high DO water of Reth and Loni. Self purification process of river reduces its organic pollution level and increases its DO level as it meanders up to d/s of Jagdishpur where Kandu Nallah carrying wastewater from Jagdishpur industrial area joins Gomti. Kandu Nallah does not have much impact on water quality of Gomti because of its little flow as compared to Gomti. Water quality of Gomti does not fluctuate much up to Sultanpur. However, the bacteriological pollution remains high at all locations.

Impact of Sultanpur city is clearly visible on water quality of River Gomti. Untreated sewage of city meeting with River Gomti deteriorates water quality as the river traverses through the city. Dumping of garbage along river bank and disposal of other filthy material into the river also affect the water quality of river. As the River leaves Sultanpur city, COD level increases to 20 mg/l, BOD to 3.7 mg/l with DO level of 6.0 mg/l.

Due to self purification process between d/s Sultanpur to u/s Jaunpur city, COD level comes down to 13 mg/l, BOD to 2.8 and DO level increases to 57 mg/l, while the coliform increases. This reflects, significant contribution from village areas in terms of coliform count. Jaunpur city also contributes pollution to Gomti as there is no sewage treatment scheme for the city sewage. Most of the city sewage is discharged to Gomti although it does not have noticeable impact on water quality of Gomti due to its small volume.

1.10 Bio Mapping of River Kosi

Kosi is the major tributary of River Ramganga and originates from village Budapeenath, Kasauni in District Almora. After traveling a distance of about 100 km through hilly areas of lower Himalayas it emerges at Ramganga in Indo-Gangetic plain and passes through small towns of Dadiyal and Lalpur before it reaches Rampur. From Rampur the river further traverses a distance of about 50 kms, and joins Ramganga at village Chamraul of Tahsil Shahbad in District Rampur.

During its course of travel in lower Himalayas the River serves as the lifeline since it is the main source of water for drinking, irrigation and other

Table 1.9 Status of Water quality of River Gomti and its Tributaries

Location	COD mg/l	BOD mg/l	TDS mg/l	DO mg/l	Cl mg/l	Total Coliform MPN/100	Faecal Coliform MPN/ 100	pH	Conductivity mmhos/cm
R. Gomti b/c of R. Sarayan (Koda vill. Distt. Hardoi)	6	1	194	7.95	3.8	1.7x10 ⁴	1.4x10 ⁴	8.12	367
R. Sarayan b/c with R. Gomti (Koda vill. Distt. Hardoi)	35	5.6	218	2.68	5.7	-	-	8.32	510
R. Gomti a/o of R. Sarayan	18	2.5	272	6.93	3.8	2.7x10 ⁴	2.2x10 ⁴	8.15	407
R. Gomti u/s at Lucknow	19	3.1	264	6.69	5.7	3.4x10 ⁴	2.7x10 ⁴	8.06	410
R. Gomti u/s Lucknow at water intake (Gaughat)	20	2.2	312	6.02	4.7	5x10 ³	3x10 ³	8.02	441
R. Gomti d/s at University Bridge	18	2.6	342	3.00	7.6	3x10 ³	2.3x10 ³	7.91	470
R. Gomti d/s at Pipraghat Lucknow	37	5.5	358	2.06	6.0	2.3x10 ⁴	1.3x10 ⁴	7.70	522
R. Gomti b/c of R. Reth at Tirgaon	15	2.4	274	3.89	7	8x10 ⁴	5x10 ⁴	7.75	378
R. Gomti a/c of R. Reth & R. Loni (at Salempur)	27	2.9	246	4.11	12	5x10 ⁴	3x10 ⁴	7.77	399
Kadu Nala b/c with R. Gomti at Bahadur - Dadar	14	1.4	322	10.65	24	---	----	8.30	480
R. Gomti b/c of Kadu Nala at Bahadur -Dadar	11	2.3	260	5.34	8	1.1x10 ⁵	8x10 ⁴	7.10	352
R. Gomti a/c of Kadu Nala	11	2.2	242	5.70	9	8x10 ⁴	5x10 ⁴	7.37	355
R. Gomti u/s Sultanpur (Kunwar bridge)	12	2.6	280	5.97	9	1.3x10 ⁵	8x10 ⁴	8.05	366
R. Gomti d/s Sultanpur (Kunwar bridge)	20	3.7	297	6.04	9	7x10 ⁴	5x10 ⁴	8.17	359
R. Gomti u/s Jaunpur (Badalpur)	13	2.8	254	7.57	10	1.3x10 ⁵	8x10 ⁴	8.30	380
R. Gomti d/s Jaunpur (at Railway bridge)	14	1.2	300	7.83	10	8x10 ⁴	3x10 ⁴	8.10	370
R. Gomti b/c of R. Sai (Raje pur)	13	1	285	8.47	12	2.3x10 ⁴	1.3x10 ⁴	8.25	401
R. Gomti a/c of R. Sai (Sirkoni)	17	1	285	8.01	11	5x10 ⁴	2.3x10 ⁴	8.12	396
R. Sai b/c with R. Gomti (Sirkoni)	12	1	242	8.46	5	--	--	8.37	301
R. Gomtib/c with R. Ganga (Gajipur road)	13	1.4	254	7.80	8.7	5X10 ³	3X10 ³	8.46	351



purposes . The area lying in the river basin i.e. from Ramnagar to Rampur, is known as the rice belt and is amongst the most prosperous agricultural region. Considering that the River has its economic importance and to protect rare and endangered biotic species, the ecological effects on the river system by indiscriminate discharge of city sewage (mostly untreated) and industrial effluent have been assessed through biomapping.

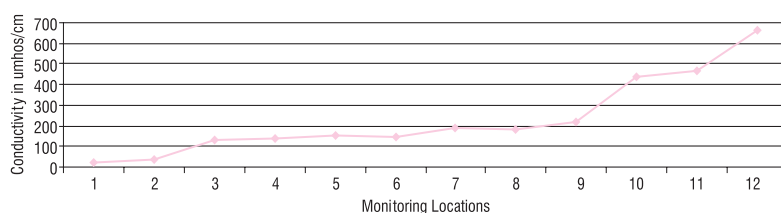
Biomapping is the technique for presenting the biological water quality information of the river basin in the form of a coloured map. Different colours on a river basin map, such as blue, light blue, green, orange and red, indicate various water quality classes in terms of clean, slight pollution, moderate pollution, heavy pollution and severe pollution of a water body, respectively. In the Biomapping methodology bio-monitoring parameters are included to enhance the quality evaluation in a cost effective manner. Amongst all the biotic component of the river, the benthic macro-invertebrates have been considered as the most suitable biological parameters for various reasons.

To assess the water quality of Kosi throughout its stretch, 12 monitoring were selected from origin to confluence keeping in consideration the impact of confluence of its major tributaries and the water quality was monitored for biomonitoring parameters as well as physico-chemical parameters at 8 major tributaries viz. River Sai, River Khajuri, River Chhoti Kosi, River Suyal, River Ramgarh Gadhera, River Kushgarh, River Bahella, and Kachhya drain.

The taxonomic identification of the benthic invertebrates has been undertaken and inference has been drawn from water quality data.

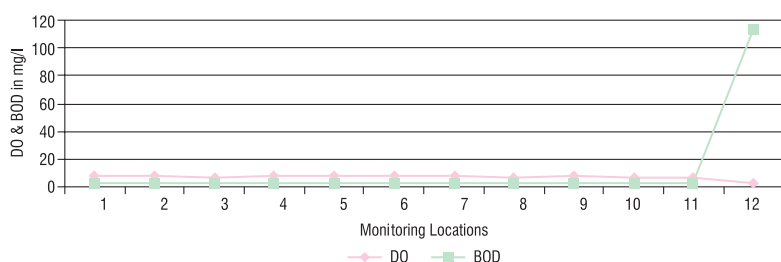
- › The water quality gradually deteriorates from origin to the confluence point.
- › In terms of organic pollution the river water quality was found to be good upto Ramnagar. After the untreated sewage of Ramnagar city is discharged into the River the water quality starts deteriorating from Lalpurdam.
- › The coliform contamination was found throughout the stretch because of open defecation.
- › Some of the pulp & paper units and distilleries located at Kashipur, are discharging their effluent into the Kosi and River of Bahella (tributary of Kosi).

Figure 1.10a Conductivity Profile of River Kosi



The water quality in Loktak Lake, Manipur, was found deteriorated in terms of BOD

Figure 1.10b Dissolved Oxygen & BOD Profiles of River Kosi



1.11 Water Quality Monitoring in Loktak Lake, Manipur

The CPCB Zonal Office, Shillong monitored Loktak Lake, an important wetland in Manipur, in association with the Manipur State Pollution Control Board (MSPCB).

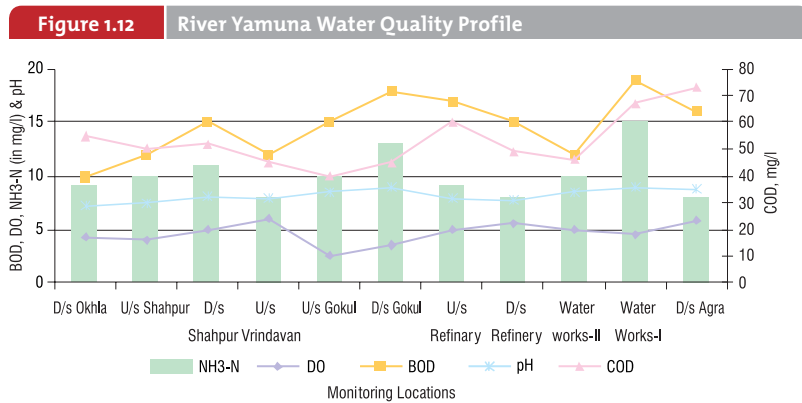
Water samples from six monitoring locations viz. inlet point of the Nambul-Nambol River falling to the Lake; outlet of Manipur River from the Lake; outlet point of the Lake water to the Hydel Project (NHPC Project); and three locations within the Loktal Lake have been collected. The water quality was found deteriorated in terms of BOD within the lake areas.

Table 1.11 Water Quality of Loktak Lake (September 2007)

Parameters	Monitoring Locations					
	Toubul	Ningthou khong	Sendra	Thanga	Karang	Ithai
pH	7.3	7.02	7.61	7.74	7.49	7.36
Temperature °C	27.9	28.0	28.5	28.0	28.0	28.0
Dissolved oxygen mg/l	0.71	2.23	7.91	6.90	7.91	7.71
Biochemical Oxygen Demand mg/l	--	1	4.8	3.8	4.8	4.3
Total Coliforms NOz/100 ml	215	64	560	415	315	220
Chlorides mg/l	7.1	10.1	11.4	11.4	10	9.2
Hardness mg/l	33	50	37	54	44	40
Calcium mg/l	17	25	19	28	23	22
Magnesium mg/l	16	24	18	26	22	20
Alkalinity mg/l	60	70	60	80	57.5	70

1.12 River Yamuna Water Quality Monitoring from Okhla to Agra

Yamuna is the life line for the city of Agra, however due to restricted flow at the Okhla barrages, inflow of untreated sewage from Delhi (East), Ghaziabad, Noida, part of Haryana, discharge of untreated sewage in Vrindavan, Mathura, restricted flow at the Gokul barrage and discharge of effluents even in Agra, the water quality remains adverse. This results in enormous increase in the chlorine requirements for its purification. CPCB carried out monitoring of river water quality in this stretch. The results are graphically presented below.



It may be seen that there is a direct correlation between Ammonia-Nitrogen and pH. The main contributor for Ammonia-Nitrogen was noted to be untreated sewage discharge. The following are the suggestions based on the study:

- (1) There should be regular release of water from Okhla barrage as this water is acting as dilution water in the down stream river,
- (2) The Gokul barrage shall release its water regularly to the tune of 1500 cusec through Gate 21 (farthest gate from Mathura wastewater outfalls) and shall not discharge settled bottom sludge from the barrage once in sudden go (they may keep open Gate 0 and Gate 2 at a constant pace with minimum flow so as to avoid excess loading of sludge in lean season),
- (3) SPCB should prepare inventories and pollution load (including list of industries & characterization of metal finishing effluents) of all the drains between U/s Vrindavan to Water Works-I at Agra and initiate necessary action towards pollution prevention from identified locations.

