RIVER WATER QUALITY IN MAHARASHTRA

Report prepared for

Maharashtra Pollution Control Board

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January 2005

Acknowledgement

We are grateful to Mr. Mushtaq Antulay, Ex- Chairman MPCB, Shri B.P. Pandey, Chairman MPCB and Dr. Dilip Boralkar, Member Secretary, MPCB for their interest to prepare the status report and support.

Our sincere thanks many researchers for their support and providing the data of their work. Dr. Jayashree Deshpande, Dr. Salunke, Dr. A. D. Sawant, Dr. S.B. Chaphekar, Dr. R.K. Trivedy, Dr. P.K. Goel, Dr. V.B Gaikwad, Scientists from NEERI, Dr. Gandhe, Dr. Ghate, Dr. Anil Kulkarni, Dr. (Mrs.) Kanhere, Prof. Yedekar, Dr. S.N. Nandan, Dr. Ghosh, Dr. N.J. Pawar, Dr. Thanedar, and many more.

We must put our gratitude for the support we got from authorities of University of Pune and Dr. Rajendra Jagdale, Director General Science and Technology Park and his team for facilities and support in completing this report.

We also thank Dr. V. S. Kale, Dr. A. Gadgil, Dr. G. Kewlramani, Dr. A. Wakhare, Dr. M Paprikar and Dr. K.R. Dikshit, Dr. J. Diddee and Dr. J. Dikshit and many individuals for their data and maps used in preparation of this report which is evident from the large number of cited references.

Our thanks to Ms. Mayura Arya and Ms. Shalaka Desai for their hard work and completion of the report.

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January 2005

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Executive Summary

A meeting was called by Dr. D.B. Boralkar, Member Secretary, MPCB in February 2004 to take a review of river pollution in Maharashtra and to take long term River Water Quality Monitoring Program with the help of various Universities and Institutions.

It was decided to prepare the status report on water pollution based on the work done by various Institutions and Universities. The work was assigned to Prof. Venkat Gunale, University of Pune to prepare the status report.

The present report covers general information, developmental activities and status of river water pollution of Maharashtra state.

Maharashtra is the third largest state in India both in area and population. Maharashtra state has area of 307,690 sq. km. There are total 35 districts, capital being Mumbai. The language spoken is Marathi. The population is 96,752,247 and the literacy is 77.3

There are 7 Industrial Regions of Maharashtra. The Annual Survey of Industries reveals that the composition of the organized industrial sector in Maharashtra has changed in last four decades. In 1960, the consumer goods industries contributed 52 percent of the total value added by all industries followed by capital goods industries 28.3% and the intermediate goods industries 19.7%. In 1997-1998 their respective shares were 15.5%, 42.8 % and 41.7 %.

The State of Maharashtra has major rivers such as the Krishna, Bhima, Godavari, Tapi-Purna and Wardha-Wainganga river. Major cities have developed along the river banks and due to increase in industrialization and urbanization, these natural resources have been deteriorated but human activities tremendously. Though studies on the physical chemical and biological parameters have been studied by various agencies – institutional, governmental and non-governmental, serious measures should be taken for the improvement of the river water quality status.

The Godavari Basin: River Godavari and many of its tributaries showed moderate to heavy pollution load depending on urbanization and industrialization.

Extensive work has been done by Dr. V.B. Gaikwad, KTHM College, Nashik as a part of his Ph.D. he has used Pollution Pool Index so as to co- relate the influencing parameters for the period of 10 months. Dr. K. K. Deshmukh and N. J. Pawar worked in Sangamner area on the Pravara river which is the tributary of the Godavari river.

Tile in 1998 analysed the water quality of the Godavari river from Someshwar to Panchak covering 12 km area and the Nandini river from Kamblewadi to Dwaraka covering 8 km area of Nashik city. Aher HR, Zinjad DG, Gunjal PS, Kuchekar SR (2002), collected water from Bhandara to Babhaleshwar for analysis. The results show that the physico-chemical characteristic of water changes to downstream from Bhandara to Babhaleshwar due to human activities. Islam SR (2002) and Gyananath G. (2002) from Swami Ramanand Teerth Marathwada University (SRTMU) worked on contamination of chemical fertilizers in ground water and seasonal variations. Sulphate and nitrate levels were within permissible limits but phosphate levels higher than the permissible limits. Prof Yedekar, SRTMU, has started work on Godavari near Nanded to assess the sources and types of pollution.

The Wardha and Wainganga Basin: Much studies have not been done on the Wardha and Wainganga rivers though MPCB studied the physico-chemical parameters of Penganga river which is a tributary of Wardha.

The Krishna Basin: The Krishna system occupies 258,948 sq. km of the area within Maharashtra. It drains different districts such as Satara, Kolhapur, Sangli, Solapur and small part of Ahemdnagar. These areas have many sugar plants which use large quantities of water for their operations and discharges of effluents. The utilization of large amounts of fertilizers and pesticides ultimately find its way into natural water body and contaminate it. The first report on Krishna river was of Dr. Boralkar (1980). He analysed water samples from the Krishna River Ecosystem between the Karad- Sangli area covering 120 km. High levels of nitrates were due to large quantities of nitrogenous fertilizers, which were used for agricultural purpose and from liberal discharge of organic wastes. Another group Dr. Triverdy and Goel working over last two decades in water pollution both lentic and lotic ecosystem from western Maharashtra. The studies done by S. K. Soam and J.P. Singh (1997) on the Krishna river using Spatial modeling approach to water pollution monitoring in the sugar belt of Maharashtra, The stretch-I, has been identified by CPCB and MPCB (Maharashtra Pollution Control Board) for the restoration of water quality under the National River Action Plan (NRAP).

River Panchganga: The study reveals that the river is polluted in same stretches near Kolhapur. A sudden increase in the concentration of nitrogen and some other components showed that there is a discharge of organic effluent. Besides, several small drains from the human settlements and the Shiroli industrial area in the vicinity also pour substantial quantities of wastewaters in the river. Dr. Anil Kulkarni, CHM Institute, Kolhapur and faulty from Shivaji University are working on pollution of Panchganga river.

The Bhima Basin: The physical, chemical and biological analysis of Mula, Mutha and Pavana river systems have been studied with reference to pollution since 1976 by Dr. Gunale, Dr. Patwardhan, Dr. Ghate, Prof. Thanedar, Dr. Gandhe and many students from Environmental Sciences and Botany Department, University of Pune and many other Institutions from Pune.
A detail report was prepared by Gunale and Patwardhan for IMPACT India with the help of Thermax, Pune.

The Tapi Basin: Tapi is the largest west following river of Maharashtra. About 80% of its catchment falls within the administrative boundaries of the stateThere are few reports such as work done by CPCB and Jagtap et al. with reference to water quality

Other rivers: Rivers from Mumbai and Konkan areas were investigated by Dr. Chaphekar, Dr. Haldar, Dr. Sawant and researchers from Institute of Science Mumbai. Studies carried out along the banks of the Kalu river estuary at Ambivali and Titwala revealed that the river was polluted at both sites. The intensity of pollution was greater at Ambivali due to the presence of industries in that area. Pollution at Titwala was due to the diurnal tidal action.
The Patalganga river is being used as a source of public water supply for drinking, agricultural and irrigation purposes. The major sources of pollution to the river has been identified as: Sullage and sewage from Khopoli township, Khalapur, other villages on the bank of the river. Effluents from the industries located at upstream of Khopoli and other industries between Khopoli and Turade. Washing of tankers containing chemicals at Shilphata and Lohop and domestic discharges along the stretch of the river.
Work on Dongarkhadi river by Jadhav, A. N. and Sawant, A. D. (1994) on the Environmental Impact Assessment of a lead smelter and chemicals to detect the reason of death of cattles due to lead poisoning at Talasari situated on the borders of Maharashtra and Dadra- Nagar Haveli. It was alleged that the Pb pollution in the environment was due to the operation of the smelter.

Chakrabarti and Ghosh analysed the physico-chemical and biological parameters of six stations on Pili river, in Nagpur.

Lakes: Many researchers have studied lakes from various part of the state. Many of these lakes / dams shoed increasing inflow of waste due to increasing developmental activities along its catchment area leading to eutrophication. Work of Pingle, Kanhere and Gunale on lakes such as Pashan, Katraj from Pune. Lake of Kolhaur and Satara studied by Dr. Trivedy, Dr. Goel and Dr. Khatavkar, Hartala and Velhala lake from Jalgaon by group led by Dr. S.N.Nandan. Dr. Salim Ali Lake from Aurangabad by Dr. Jayshree Deshpande.

All these studies indicate gradual changes from oligotrophic towards eutrophic conditions.

The Ujani backwater on Bhima river has been studied by Dr. Jagdale and his students, STP, University of Pune, in view of its importance as wetland. They are of opinion that Ujani wetland should be declared as one of the Ramsar Site in India.

Over all, major waterbodies both rivers and lakes show contamination. This is mainly due to its proximity to urban areas and also due to certain developmental activities.

Conclusion:

Based on the present status of water pollution in the State of Maharashtra following conclusions are made which could be used as a guideline for future work:

1. **The available work shows scattered reports having each with different approach. Based on present status of river pollution in Maharashtra, there is need to take up systematic long term monitoring program to assess the pollution of rivers and lakes in order to have uniform monitoring using defined protocols.**
2. **Significant levels of pollution are reported from Upper Bhima basin around Pune urban, Krishna basin along Karad, Sangli and Kolhapur, Godavari basin along Nashik.**
3. **There is rapid urbanization and industrialization in the catchments of Upper Bhima basin and Godavari basin, therefore these river basins could be brought under National River Action Plan.**
4. **Rivers like Kalu and others which are close to urban and industrial areas showed chemical pollutants.**

5. **Such a data will help to plan for restoration of river / lake ecosystems in the state using appropriate mechanism.**
6. **There is a need to regulate Urban and Industrial development particularly in the catchment areas of water bodies to ensure the quality of water and to protect human health.**
7. **There is a need to revise developmental zones along the water boodles, which are lifelines for water supply.**
8. **Important and unique water bodies from the state could also be identified for further protection under protected area network.**
9. **Series of maps could also be prepared using remote sensing and GIS showing types of land use pattern in the catchment area and degree and types of pollution.**
10. **Major thrust areas for research in restoration ecology could be identified for funding to the institutes and universities from the state.**
11. **Education and awareness is equally important aspect in environmental protection. A special chapter on water pollution based on present state of water bodies could also be incorporated at school level.**
12. **The major group working in the water pollution identified for long term monitoring program:**
    - **For greater Mumbai and Konkan: Institute of Science Mumbai**
    - **Western Maharashtra: Ch. Sahu Institute, Shivaji University, Kolhapur, Science College, Karad**
    - **Godavari river: KTHM College, Nashik, SRTMU, Nanded, S.B. College, Aurangabad**
    - **Bhima river basin: University of Pune, Science and Technology Park, NCL, ARI, etc**
    - **Wardha and other rivers: NEERI, University of Nagpur and other local colleges**
    - **Tapi river basin: North Maharashtra University, Colleges from Dhule.**

Chapter-1

MAHARASHTRA

1.1 Introduction:

1.1 a) Physiography:

Maharashtra is the third largest state in India having area of 307,690 Sq. Km and population 96,752,247. It has 35 districts with the capital being Mumbai. The state has strategic position with the Arabian Sea in the west. The Mumbai city has its importance for international trade and business.

Maharashtra has a western coastline stretching 330 miles (530 Km) along the Arabian Sea from Goa on the south to Daman on the north. Maharashtra as a cultural region, easily distinguished having five sub regions with distinctive physiographic, historical, economic and cultural characteristics as follows:

Konkan the coastal area between the crest of the Western Ghats hill system and the Arabian Sea has high annual rainfall (75-100 inches). Rice is the main crop while Cashews and mangoes as main fruits.

Desh (Deccan) Maharashtra's central and most representative sub region comprises of seven districts. The principal rivers are the Godavari, Bhima, and Krishna, which rise in the Western Ghats and flow southwestward to the Bay of Bengal. Pune city lies in this zone, which is known for its culture, education and for IT and BT.

Khandesh The sub region comprises the two districts of the Tapti (Tapi) River valley where alluvial bottomlands produce cotton, banana, oilseeds, and tobacco.

Marathwada This name is given to the five Marathi-speaking districts that were part of the former princely state of Hyderabad.Agriculture as source of livelihood is greater in this subregion than in any other.

Vidarbha having eight districts that constitute Vidarbha focus on Nagpur, the third-largest city in Maharashtra. The basaltic Deccan lavas reach their eastern limit in the vicinity of Nagpur.

Vidarbha region is predominent with the cotton, oilseeds, and millets of the black-soil valleys in its western sector and rice and tropical forests of the higher-rainfall eastern section.

The State of Maharashtra has major rivers such as the Krishna, Bhima, Godavari, Tapi-Purna and Wardha-Wainganga river. Forests comprising only 17% of the state area covers, the eastern region and the Sahyadri Range, while open scrub on the plateau. Water is the most precious natural resource of the state, greatly in the demand, and most unevenly distributed. A large number of villages lack drinking water, especially during the summer months.

1.1 b) Climate

i) Rainfall

The average rainfall over Maharashtra is 135 cm. A major part of the precipitation is received by the SW monsoon. Regional distribution of the rainfall ranging from more than 600 cm over Ghats to less than 50 cm in the east central Maharashtra.

ii) Soil

The soils of Maharashtra are residual, derived from the underlying basalts. In the semi-dry plateau, the black-cotton soil is clayey, rich in iron, but poor in nitrogen and organic matter; it is moisture-retentive. Soils of Maharashtra is basalt or derived from basalt, either as loose sediments of coastal colluvial or alluvial origin or as laterite or older or more recent deep weathering profiles. Alluvial deposits of the Tapi basin exhibit considerable thickness.

1.1 c) Population

As per the 2001 census, Maharashtra has a population of 96.75 million, making it the second most populous state in the country, after Uttar Pradesh. Maharashtra is the only state in the country to have 7 cities with over one million population. The state is the most preferred destination for migrants from all over the country and has contributed about 19 percent to the population growth of the state in the last decade alone (1991-2001).

1.1d) Industries

The state accounted for 22 percent of net value added in the organized industrial sector of the country in 1997-1998. The Annual Survey of Industries reveals changes in last four decades. In

1960, the consumer goods industries contributed 52 percent of the total value added by all industries followed by capital goods industries 28.3% and the intermediate goods industries 19.7%. In 1997-1998 their respective shares were 15.5%, 42.8 % and 41.7 %, which indicates a major shift.

Industrial Regions of Maharashtra

The state has 35 districts and they are grouped into seven industrial regions such as Greater Mumbai, Konkan, Pune, Nasik, Aurangabad, Amravati and Nagpur.

1) The Greater Mumbai and Peripheries of the Suburbs in Thane and Raigad Districts.

This is one of the most important industrial zone of India because it is located near the Gateway of India- commercial and economic capital of India. More than fifty percent of the factories and man- power are concentrated in this region. Textile was the largest group in the initial stage of development of industries but now engineering, chemical, transport, software and electronics are also other leading groups. Industries have dispersed from Mumbai to Thane, Kalyan, Ambernath, Badalpur and Panvel complex. On the Western railway line this belt stretches up to Tarapur, Dahanu and touches the border of Gujarat state.

2) Mumbai- Pune Corridor and Greater Pune

Outside Mumbai - Thane industrial region, Panvel is the main industrial center on Mumbai - Bangalore and Mumbai- Panaji national highways. Khopoli has developed at the base of Sahyadri as the complex of engineering, chemical, paper pulp and many small-scale industries. Tata hydroelectric power generation station supplies ample electricity to the neighbouring region. A new industrial complex Pimpri- Chinchwad near Pune extending up to Talegaon. Large factories producing machines, automobiles, electrical and electronic goods, plastics and pharmaceuticals are located along the Pune- Ahmednagar, Pune- Sholapur and Pune –Satara roads. All these have spread out from the fringe of the old city. More recently, Pune also is known for IT and BT.

3) Sholapur Textile Zone

Sholapur and Barsi are cotton textiles centers in SE Maharashtra. They have specialized in power looms. Maharashtra Industrial Development Corporation has developed many centers in Sangli, Kolhapur, Ichalkaranji, Madhavnagar and Miraj in Southern Maharashtra.

4) Western Tapi Valley Industrial Zone

Agro- based industries have developed in the Tapi valley. Cotton, groundnuts, banana and sugarcane are the agricultural raw materials in Khadesh (Dhule and Jalgaon districts). Recently MIDC areas are developed near Dhule and Jalgaon.

5) Eastern Tapi Valley Industrial Zone

This is the cotton-producing zone. Berarsi, Achalpur and Badnera are the leading industrial centers situated near the central railway line in the districts Amravati, Akola, Vardha, Chandrapur and Nagpur. Near Kamptee- Nagpur mineral based industries are well developed due to local coal, limestone and manganese mines. Here, engineering, transport equipment, cement and metal product manufacturing industries are located.

6) Krishna – Panchganga Basin Industrial Region

This is a unique triangular agro based region in Maharashtra. The region has industries like sugar and cotton textiles in Kolhapur and Ichalkaranji. Units producing agricultural implements, oil engines, spare parts of engines and transport vehicles have developed near Jaysingpur and Miraj.

7) Pravara- Nira Valley Region

This is a prosperous belt of sugar industries with Baramati, Phaltan, Koparagaon, Sangamner and Belapur as main centers. MIDC has developed small-scale industries and infrastructure.

8) Upper Godavari Valley Industrial Belt

This is the extension of Pune industrial region. Many industrial plants mostly electronics and agrobased are predominant in and around Nashik have developed.

9) Konkan Industrial Region

After the establishment of MIDC industrial activities took place in Raigad, Ratnagiri and Sindhudurg districts. Taloja, Roha, Patalganga, Mahad, Nagothane and Nanore in Raigad district; Chiplun, Loteparshuram, Ratnagiri, Dapoli and Sangameshwar in Ratnagiri and Kudal in Sindhudurg district have developed near Mumbai- Goa national highway and Konkan railway line.

1.1e) Urbanization

Maharashtra, the most highly urbanized state in India Development of rail and road network and the state's strategic location has led to promotion in the export of goods, a large number of market centers. This led to the string development of towns along the railways and highways. In 1901 it was only 16.59% of its population dwelling in towns and in 1991, 30.5 % of population of the state was urban. Urbanisation in the state has been primarily due to the increasing concentration of population in the existing towns.

1.2 Water: Indian Scenario

There is an ernomous unmet demand for water. Even as clean water sources are being viciously attacked by pollution and overexploitation, hardly any river or groundwater aquifer around urban areas which escapes the perils of pollution. Excess use of water for irrigation couple with the use of agrochemicals, which has resulted into salinization particularly in Western Maharashtra.

1.3 Water Quality Issues

Pollution from various sources that are responsible for contamination of the water such as:

- Release of pollutants from municipal, industrial effluents. Dumping of solid waste from various activities.
- Leaching of agricultural lands carrying materials used during agricultural practices such as fertilizers and pesticides.
- Run off from city streets, from solid waste storage sites, commercial activities in the urban environment and from industrial sites and storage areas.
- Erosion of soil and sedimentation in water bodies.

Increasing human activity that endangers water resources through:

- Increasing contamination with chemicals.
  Over use of water, with lesser recharging.
- Increasing pollution of surface water
- Increasing fecal matter

Assessment of water quality requires a wide range of parameters such as physical, chemical and biolobical.

Assessing the quality of water following parameters are analysed:

	Water Quality Parameters	
Physical	**Chemical**	**Biological**
Temperature	Dissolved Oxygen	Bacteria
Taste	Biochemical oxygen demand	(Pathogen)
Colour	Chemical oxygen demand,TOC	Coliform and
Odour	Alkalinity,pttm,acidity	other Bacteria
Turbidity	Redox potential,ammonia, nirates,	Algae
Foam and Froth	nitrites, phosphates	Viruses
Conductivity	Sulphides, sulphates, hardness,	
Solids (Dissolved)	chlorides,fluroides,calcium	
Solids (Suspended)	Magnesiun, Silica	
pH	Barium,Cadmium,Chromium,Lead	
	Manganese,Selenium,Silver	
	Zinc, detergents,phonels,pesticides,	
	radioactivity, aromatic hyrocarbons,	
	mercury, arsenic	

Table 1.1: Water Quality Parameters

(Source: Trivedy, P.K. and Goel, P.K. (1986). Chemical and Biological Methods for Water Pollution Studies. pp 4.)

Following standards and guidelines are reported as a background information for ready reference.

Table 1.2 Water Quality Standards for Best Designated Usages by MPCB

Category of Fresh	A-I	A -II	A -III	A -IV
Best Usage	Unfiltered Public water supply after approved disinfection	Public water supply with approved treatment equal to coagulation,	Not fit for human consumption, Fish & Wildlife Propagation.	Fit for Agriculture, Industrial cooling & process water.
Chemical Qualities :	**Maximum allowable concentration**			
1. Toxic Substances				
Arsenic (As)	0.3mg/l	0.03 mg/l	1.0 mg/l	0.1 mg/l
Cadmium (Ca)	0.01 mg/l	0.01 mg/l	-	-
Chromium (Hexa Cr)	0.05 mg/l	0.05 mg/l	0.05 mg/l	0.2 mg/l
Cyanide (Cn)	0.05 mg/l	0.1 mg/l	0.05 mg/l	0.2 mg/l
Lead(Pb)	0.1 mg/l	0.1 mg/l	-	0.1 mg/l
Boron	-	-	-	2.0 mg/l
Mercury (Hg)	0.001 mg/l	0.001 mg/l	0.001 mg/l	-
Gross alpha activity	3PCI/l	10^{-9}uc/ml	3 PCI/l	3 PCI/l
Gross Beta activity	30 PCI/l	10^{-9}uc/ml	30 PCI/l	30 PCI/l
2. Substances affecting health				
Fluoride (F)	1.5 mg/l	1.5 mg/l	-	1.0 mg/l
Nitrates (NO_3)	45 mg/l	45 mg/l	-	-
3. Substances affecting the potability of water				
pH	6.5 to 8.5	6.0 to 8.5	6.5 to 9.0	6.5 to 9.0
T.D.S.	-	T.D.S.	T.D.S.	-
Total Solids	1500 mg/l.	1500 mg/l.	-	-
Total Suspended Solids	25 mg/l	-	-	-
Total Hardness ($Caco_3$)	50 mg/l	500 mg/l	.	-
Total Residual Chlorine	-	-	-	-
Electrical conduct at 25 C	-	-	1000×10^{-6} mhos	3000×10^{-6} mhos
Free Carbon Di Oxide	-	-	12 mg/l	-
Free Ammonical	-	-	1.2 mg/l	-
Oil & Grease	-	-	0.1 mg/l	-
Pesticides	-	-	0.02 mg/l	-
Biotic Index	-	-	6.0 mg/l	-
Total Ammonical	1.5mg/l	1.5mg/l	-	50 mg/l
Chlorides (Cl)	600 mg/l	600 mg/l	-	600 mg/l
Sulphates	40 mg/l	40 mg/l	-	1000 mg/l
Copper (Cu)	1.5 mg/l	1.5 mg/l	-	-
Manganese (Mn)	0.5 mg/l	3.0 mg/l	-	-
Iron (Fe)	1.0mg/l	5.0mg/l	-	-
Sodium	-	-	-	-
Zinc (Zn)	15.0 mg/l	1.5 mg/l	5.0 mg/l	5.0 mg/l
Phenolic Compounds	0.002 mg/l	0.002 mg/l	0.05 mg/l	-
Alkyl Benzene	1.0 mg/l	1.0 mg/l	-	-
Mineral Oil	0.3 mg/l	0.3 mg/l		
Ammonia	1.5 mg/l	1.5 mg/l		
B.O.D. (5 days 20 ^{0}C)	2.0 mg/l (Monthly avg of Atleast 10 samples)	5.0 mg/l (Monthly avg of Atleast 10 samples)	10 mg/l	30 mg/l
C.O.D.	-	-	-	150 mg/l
D.O.	Not less than 5 mg/l	4.0 mg/l	Not less than 3 mg/l	Not less than 2 mg/l
Bacteria (MPN/100)	Coliform Bact. 250	Not greater than 5000		

Table1.3: CRITERIA FOR SITING OF INDUSTRIES WITH REFERENCE TO CLASSIFICATION OF RIVER ZONES

Sr.No.	Classification	Criteria	Type of Industry
	Fresh waters A-II		
		(a) 3 Kms. On the either side of river	No Development zone for any type of ndustries. Only specified Non - Industrial isted activities are allowed.
		(b) From 3 Kms. to 8 Kms. From river (H.F.L.) on either side.	Classified Green and Orange category of Industries irrespective of Investment, with requisite pollution control devices.
		(c) Beyond 8 Kms from river (H.F.L.) on either side.	Any type of industry with requisite pollution control devices.
	A-II	(a) 1 Km. On either side of river (H.F.L.)	Development zone. Only specified Non - Industrial listed activities are allowed.
		(b) 1 Km. To 2 Kms. On either side.	Classified Green and Orange category of Industries irrespective of Investment, with requisite pollution control devices.
		(c) Beyond 2 Kms.	Any type of industry with requisite pollution control devices.
	A-III	(a) Upto 1/2 Km. On either side	No Development zone for any type of industries. Only specified Non-Industrial listed acivities are allowed.
	A-IV	(b) 1/2Km. To 1 Km. On either side	Classified Gree and Orange category of Industries irrespective of Investment, with requisite pollution control devices.
		(c) Beyond 1 Km.	Any type of industry with requisite pollution control devices.

Note:

1) Distances mentioned in the policy note above are shortest distances measured as the crow flies.

2) High Flood Level (H.F.L.) of river will be considered as bank of the river for measuring the distances.

3) If the ridge line is nearer than prescribed zone bondary, restriction apply upto the ridge line.

4) Arrangement for pollution control shall be foolproof irrespective of the location.

5) In' No Development Zone', the permissible activities and non - permissible activities are separately prescribed.

6) Categorisation of industries is suggestive in nature and may be reviewed and modified by the Board, from time to time.

7) Existing industries in 'Non - Confirming Zone' will be allowed to continue with adequate pollution control arrangements. Expansion, diversification, modernisation, subsitution shall be allowed subject to reduction in pollution load at source.

8) This does not absolve the Project Proponent from observing any other Rules / Regulations applicable in specified areas like Coastal Regulation Zone / Bhatsa River Basin etc.

9) Cases in pipe line would be dealt on merits of each case and would be considered beyond a distance of 500 mtrs. From H.F.L. as per the Prevailing policy.

10) The above classification also covers lakes and other water bodies, excluding underground water sources.

11) Development activities in coastal areas will continue to be regulated by Ministry of Environment and Forests's notification (CRZ Notification) dated 19.02.1991.

1.4 National Water Policy 2002

National Water Policy has outlined the importance of regular monitoring of surface and ground water. A part of National Water Policy 2002 is reproduced below revelent to present report.

In view of the vital importance of water for human and animal life, for maintaining ecological balance and for economic and development activities of all kinds, and considering its increasing scarcity, the planning and management of the resource and its optimal, economical and equitable use has become a matter of utmost urgency. Concerns of the community need to be taken into account for water resources development and management.

Growth process and expansion of economic activities inevitably lead to increasing demands for water for diverse purposes: domestic, industrial, agricultural, hydro-power, navigation, recreation, etc. So far, the major consumption use of water has been for irrigation. While the gross irrigation potential is estimated to have increased from 19.5 million hectare at the time of independence to about 95 million hectare by the end of the year 1999-2000, further development of a substantial order is necessary if the food and fiber needs of our growing population are to be met with. The country's population, which is over 1027 million (2001 AD) at present is expected to reach a level of around 1390 million by 2025 AD.

Another important aspect is the water quality. Improvements in existing strategies, innovation of new techniques resting on a strong science and technology base are needed to eliminate pollution of surface and ground water resources, to improve water quality. Science and technology and training have to play important roles in water resources development and management in general.

The National Water Policy was adopted in September 1987. Since then, a number of issues and challenges have emerged in the development and management of water resources. Therefore, the National Water Policy (1987) has been reviewed and updated.

A well developed information system, for water related data in its entirety, at the national / state level, is a prime requisite for resource planning. A standardized national information system should be established with a network of data banks and data bases, integrating and strengthening the existing Central and state level agencies and improving the quality of data and the processing capabilities.

Standards for coding, classification, processing of data and methods/ procedures foe its collection should be adopted. Advances in information technology must be introduced to create a modern information system promoting free exchange of data among various agencies. Special efforts should be made to develop and continuously upgrade technological capability to collect, process and disseminate reliable data in the desired time frame.

Appropriate river basin organizations must be established for the planned development and management of a river basin as a whole or river sub-basins, wherever necessary. Special multi-disciplinary units should be set up to prepare comprehensive plans taking into account not only the needs of irrigation but also harmonizing various other water uses, so that available water resources are determined and put to optimum use having regard to existing agreements or awards of Tribunals under the relevant laws. The scope and powers of the river basin organizations shall be decided by the basin states themselves.

Following are the water quality aspects:

- Both surface water and ground water should be regularly monitored for quality. A phased programme should be taken for improvements in water quality.
- Effluents should be treated to acceptable levels and standards before discharging them into natural streams
- Minimum flow should be ensured in the perennial streams for maintaining ecology and social considerations.
- Principle of 'Polluter Pays' should be followed in management of polluted water.
- Necessary legislation is to be made for preservation of existing water bodies by preventing encroachment and deterioration of water quality.

Chapter – 2

2. River of Maharashtra

The major rivers of Maharashtra are Godavari, Krishna, Bhima, Tapi-Purna,Wardha and Wainganga. The rivers can be broadly divided into two categories – the east – flowing that drain into the Bay of Bengal, and the west – flowing into the Arabian Sea. The Former cover a greater part of Maharashtra state (about 75 %). Except for the Tapi river, most west draining streams of Konkan are short and have high-gradients.

The Godavari with its tributaries drains the largest percentage, almost half of the area of the state. Godavari has source frm the Sahyadris at Trimbak, 25 Km west of Nashik. Its most important tributary basin, is Wardha-Wainganga rivers whivh join to form the Pranhita which oins Godavari near Sironcha in Chandrapur district. The next important river is Krishna, which emerges from the Western Ghats near Mahabaleshwar. Its most important tributary River Bhima joins it in Raichur district. The Tapi river rises from Betul plateau in Madhya Pradesh. The other rivers are termed the Konkan streams; they are short and oriented east –west flowing roughly parallel to each other. The north Konkan streams are Pinjal, Vaitarna, Bhatsal and Ulhas while the South Konkan streams are Amba, Kundalika, Savitri, Vashisthi, Shastri, Kajvi, Waghothan and Gad.

Table 2.1: Showing Catchment area and Channel length of Some Major Rivers of Maharashtra (Source: Geography of Maharastra)

River	**Catchment area in km2**	**Stream length in km**
East- flowing Rivers		
Godavari*	53630	545
Wainganga	61093	609
Wardha	24087	483
Penganga	23895	676
Purna	2431	142
Manjra*	9960	
Bhima*	34314	550
Nira	6342	203
Sina	12092	313
Krishna*	15190	232
Koyna	4890	118
Panchganga	2575	74
Dudhganga	2350	103
West -flowing Rivers		
Tapi	51504	239
Purna	18929	274
Girna	10061	260
Vaitarna	3637	171
Ulhas	3864	145
Savitri	2899	99
Sastri	2174	64
Vashishthi	2239	48

- In Maharashtra (approximate)

Since all rivers are monsoon dominated, the annual flow pattern changes in accordance with the monsoon rainfall. The Rivers show

1. Dry or very low non-monsoon season flows,
2. Normal monsoon flows, and
3. Infrequent, high- magnitude floods.

Table 2.2: showing Districts drained by Rivers in Maharashtra.

River	River Basin Area in Maharashtra (sq. km.)	Districts Drained
Godavari	151,083	Nashik, Ahemdnagar, Aurangabad, Osmanabad, Bhir Nanded, Parbhani, Jalna, Nagpur, Wardha, Yavatmal Chandrapur, Bhandara, parts of Amravati, Akola and Buldana
Krishna Bhima (part of Krishna Basin)	74,069 34,134	Satara, Kolhapur, Sangli, Solapur and small part of Ahemdnagar Pune, Solapur, Ahemdnagar and Satara.
Tapi	52,226	Parts of Amravati, Akola and Buldana and Jalgaon and Dhulia Districts
Konkan rivers	29,854	Thane, Mumbai, Raigad, Ratnagiri (including Sindhudurg Districts)

(Source: Dikshit, K.R. (1986) Maharashtra in Maps. pp 26.)

(Drainage Pattern Map of Rivers of Maharashtra showen on page 16)

Some of the outstanding hydrological characteristics of the rivers of Maharashtra are as follows:

- Most rivers display a simple fluvial regime with only one pronounced maximum.
- Monsoon flows generally rise rapidly with the onset of monsoon rainfall but the flow levels and discharges fall less rapidly at the end of the monsoon season.
- Monsoon months are characterized by multiple short and sharp peaks, and on some occasions the daily discharge may increase by an order of magnitude in one day.
- Most rivers display remarkable inter-annual as well as intra- annual variations in the streamflows as well as in the flood magnitudes.
- Some rivers experience up to one to three orders of magnitude variations in discharge during the monsoon season.
- Unit discharge is generally higher for smaller catchments in the Ghat zone or Satpuda Ranges, and with an increase in the catchment area the unit discharge decreases.
- The discharge maxima is usually achieved in the month of July in the upper Krishna basin, in August in the Bhima and Wainganga basins, in August and September in the Tapi basin, and in September in the lower Godavari basin.
- The rivers of the Ghat zone experience low flood variability, but the rivers of the semi- arid zone are characterized by high variability and flashy discharges.

Chapter-3

Maharashtra Pollution Control Board (MPCB)

Maharashtra Pollution Control Board (MPCB) is implementing various environmental legislations in the state of Maharashtra, mainly including Water (Prevention and Control of Pollution) Act, 1974, Air (Prevention and Control of Pollution) Act, 1981, Water (Cess) Act, 1977 and some of the provisions under Environmental (Protection) Act, 1986 and the rules framed there under like, Biomedical Waste (M&H) Rules, 1998, Hazardous Waste (M&H) Rules, 2000, Municipal Solid Waste Rules, 2000 etc. MPCB is functioning under the administrative control of Environment Department of Government of Maharashtra.

Some of the important functions of MPCB are:

- To plan comprehensive program for the prevention, control or abatement of pollution and secure executions thereof,
- To collect and disseminate information relating to pollution and the prevention, control or abatement thereof,
- To inspect sewage or trade effluent treatment and disposal facilities, and air pollution control systems and to review plans, specification or any other data relating to the treatment plants, disposal systems and air pollution control systems in connection with the consent granted,
- Supporting and encouraging the developments in the fields of pollution control, waste recycle reuse, eco-friendly practices etc.
- To educate and guide the entrepreneurs in improving environment by suggesting appropriate pollution control technologies and techniques
- Creation of public awareness about the clean and healthy environment and attending the public complaints regarding pollution.

Following is a representative data on river monitoring under Global Environmental Monitoring system (GEMS) programme and Monitoring of Indian Aquatic Water Resources (MINARS) programmes.

Table 3.1 Water Quality data monitored by M.P.C.B. under MINARS Project

Sr.No.	Station	Parameter	Min	Max	Average
1	1252 Girna river Jalgaon	Ph	7.5	9	8.27
		BOD	3	8	5.5
		COD	16	32	22.67
		DO	6.1	7.3	6.8
		Tot.Coliform	150	175	165
2	1092 Kalu river Atale village	Ph	7.3	7.7	7.53
		BOD	5	7	6.33
		COD	16	96	45.33
		DO	5.5	6.5	6.07
		Tot.Coliform	140	350	238.33
3	1461 Bhatsa river	Ph	7	7.6	7.45
		BOD	5	8.5	6.73
		COD	16	40	25
		DO	5.4	6	5.78
		Tot.Coliform	175	275	206.25
4	1212 Wardha river Rajura Bridge	Ph	7.6	8	7.88
		BOD	5.5	9	6.58
		COD	16	40	26
		DO	5.4	6.5	5.73
		Tot.Coliform	95	200	127.5
5	1318 Mahim Creek	Ph	6.8	7.3	7.07
		BOD	6	60	31.33
		COD	144	376	234.67
		DO	3.5	4.9	4.2
		Tot.Coliform	175	275	208.33
6	1317 Thane Creek Elephanta Island	Ph	7	7.8	7.53
		BOD	5	32	24.33
		COD	172	364	246.67
		DO	3.4	5.2	4.23
		Tot.Coliform	120	275	198.33
7	1315 Wardha river-Pulgaon	Ph	7.4	8.8	8.25
		BOD	4	11.5	10.95
		COD	24	88	37.6
		DO	4.6	7.1	5.98
		Tot.Coliform	110	250	177.08

8	1463 Nira river- Sarola Bridge	Ph	6.8	8.6	7.55
		BOD	4	13	6.53
		COD	16	48	24
		DO	4.7	7.3	6.1
		Tot.Coliform	70	250	137.08
9	1192 Bhima river Daund	Ph	6.8	7.2	7.05
		BOD	5.5	9	7.13
		COD	20	24	23
		DO	2.9	5.4	4.53
		Tot.Coliform	150	225	181.25
10	1191 Bhima river Pargaon	Ph	6.9	7.4	7.15
		BOD	4.5	19	9.75
		COD	16	40	26
		DO	3.2	5.7	4.45
		Tot.Coliform	175	250	206.25
11	1190 Bhima river D/s of Band-garden	Ph	6.8	7.5	7.1
		BOD	15	58	29.75
		COD	32	96	74
		DO	0.5	4.1	2.43
		Tot.Coliform	115	250	156.25
12	1189 Bhima river Pune D/s of vithalwadi	Ph	7	7.5	7.23
		BOD	9.5	44	18.63
		COD	24	80	40
		DO	1.2	4.8	3.3
		Tot.Coliform	175	275	225
13	1094 Ulhas river Badlapur W/W	Ph	6.5	8.2	7.53
		BOD	3	9.5	5.41
		COD	16	32	18.8
		DO	5.6	7.5	6.7
		Tot.Coliform	95	275	172.5
14	1093 Ulhas river Mohane NRC Bund	Ph	6	8.2	7.56
		BOD	3	6.2	4.97
		COD	16	24	18.8
		DO	4.9	7..7	6.63
		Tot.Coliform	110	275	173.75
15	1316 Basin creek Dist-Thane	Ph	6.5	7.9	7.5
		BOD	6	38	20.25
		COD	56	352	212
		DO	2.5	6	4.48
		Tot.Coliform	95	200	153.75
16	1462 Patalganga river-MIDC W/W	Ph	6.6	7.9	7.3
		BOD	3	9.5	5.79
		COD	16	24	20.4
		DO	5.4	7.2	6.53
		Tot.Coliform	110	350	162.92

17	1151 Patalganga Shilphata Bridge	Ph	6.6	7.9	7.35
		BOD	3	10	6.39
		COD	16	32	20.8
		DO	4	7	6.33
		Tot.Coliform	110	275	177.08
18	1314 Tapi river Ubad village	Ph	7	8.9	8.18
		BOD	3	9	5.89
		COD	16	32	24
		DO	5.2	7.4	6.5
		Tot.Coliform	110	350	188.75
19	1251 Tapi river Bhusaval	Ph	7.4	9	8.3
		BOD	3	7.5	5.24
		COD	16	32	21.3
		DO	5.1	7.3	6.27
		Tot.Coliform	110	275	174.1
20	1313 Tapi river Ajanad Village	Ph	7.6	9	8.44
		BOD	3	9	5.63
		COD	16	32	23.2
		DO	4.8	7.4	6.18
		Tot.Coliform	110	225	158.33
21	1311 Panchganga river Ichalkaranji	Ph	6.9	7.7	7.23
		BOD	7.8	10	8.6
		COD	24	36	30.67
		DO	3.2	6.2	4.77
		Tot.Coliform	250	350	291.67
22	1153 Krishna river Rajapur weir	Ph	7	8.5	7.74
		BOD	2.8	8	5.26
		COD	16	28	20.4
		DO	5.4	7	6.44
		Tot.Coliform	110	275	183.33
23	1310 Krishna river Kurundwad	Ph	7	8.4	7.73
		BOD	3	9	5.63
		COD	16	170	37.5
		DO	5.3	7	6.43
		Tot.Coliform	16	350	223.83
24	1152 Kundalika river	Ph	7.3	8.6	7.8
		BOD	4.8	9	7.1
		COD	16	28	22.67
		DO	5.9	6	5.97
		Tot.Coliform	150	275	198.33
25	1253 Girna river Malegaon	Ph	7.6	8.1	7.83
		BOD	3.4	7	5.98
		COD	16	20	19
		DO	5.6	6.7	6.05
		Tot.Coliform	150	200	173.45

26	1211 Godavari river D/s of Nashik	Ph	7	8	7.54
		BOD	2	36	8.58
		COD	20	52	29.6
		DO	3.5	7	5.64
		Tot.Coliform	110	350	220
27	1096 Godavari river Ramkund	Ph	7.2	8	7.55
		BOD	3	35	8.69
		COD	16	56	25.2
		DO	3.2	7.5	5.56
		Tot.Coliform	120	350	200.83
28	1095 Godavari river Gangapur Dam	Ph	7	8.5	7.87
		BOD	4	9	5.93
		COD	16	32	20.4
		DO	5.3	7	6.33
		Tot.Coliform	170	350	218.3
29	1209 Godavari river Raher	Ph	7	8.8	8.06
		BOD	3	27	7.11
		COD	5.6	64	23.36
		DO	3.1	7.2	5.9
		Tot.Coliform	120	225	180.42
30	1312 Godavari river Jaikwadi	Ph	7.3	8.7	7.69
		BOD	3	20	7.23
		COD	16	56	24.4
		DO	4.6	7	5.6
		Tot.Coliform	170	350	222.5
31	1188 Bhima river Narsingpur	Ph	6.9	27	9.47
		BOD	4	10	6.52
		COD	16	44	24.8
		DO	5.3	7.3	6.33
		Tot.Coliform	120	275	153.33
32	1194 Krishna river Dhom Dam	Ph	7	8.1	7.46
		BOD	3	9	5.46
		COD	16	32	11.2
		DO	5	7.2	6.13
		Tot.Coliform	70	350	188.75
33	1210 Godavari river Nanded	Ph	7.3	8.8	8.13
		BOD	2.8	78	12.61
		COD	16	96	33.6
		DO	4.4	7.7	6.23
		Tot.Coliform	95	275	172.08

Table 3.2 Water Quality data monitored by M.P.C.Board under GEMS Project

Sr.No.	Monitoring Station	Parameter	Min	Max	Average
1	28 Bhima river Takli	Ph	7	8.7	7.93
		BOD	4	9	6.36
		COD	16	52	24.89
		DO	4.4	7.2	6.07
		Tot.Coliform	120	350	188.33
2	12 Godavari river Dhalegaon	Ph	7.3	8.8	8.07
		BOD	3	56	10.32
		COD	16	88	25.11
		DO	0.7	7.2	5.94
		Tot.Coliform	120	350	199.17
3	37 Krishna river Sangli	Ph	7	8.6	7.88
		BOD	4	9	6.32
		COD	20	56	26.67
		DO	4.3	7.2	6.07
		Tot.Coliform	95	350	182.92
4	36 Krishna river Karad	Ph	7.1	8.5	7.86
		BOD	4	8.5	6
		COD	16	32	23.5
		DO	4.2	7.2	6.38
		Tot.Coliform	70	170	127.92
5	11 Wainganga river - Ashti	Ph	7	8.6	8.03
		BOD	4.4	12	6.57
		COD	16	32	23.11
		DO	5	7.1	6.26
		Tot.Coliform	110	175	146.67

Table 3.3:River water Quality monitored by Regional / Sub Regional Offices during the year 2002-2003

Sr.No.	River	Monitoring Station	Region / Area	Class of Water	B.O.D.			C.O.D.			D.O.		
					Min	Max	Avg.	Min	Max	Avg.	Min	Max	Avg.
	SRO Thane II												
1	Vaitarna River	-	Thane				5	-	-	20	-	-	6.6
	RO Kalyan												
2	Bhatsa River	D/s of Liberty Oil Mill	Kalyan	A-I	4	7.5	5.5	16	40	28	5.9	7	6.5
3	Murbadi River	Nr. Murbad MIDC Bridge	Kalyan	A-II	4	5	4.5	16	32	24	5.4	7	6.6
4	Vaitarna River	Nr.Bhiwandi-Wada Rd. Bridge	Kalyan	A-II	5	9	7	32	40	36	6.1	7.1	6.6
5	Tansa River	Nr.Monatona Tyre Bridge	Kalyan	A-II	4	5	4.5	16	20	18	6.8	7	6.9
	RO Nagpur												
6	Nag River	Asoli Bridge	Nagpur	A-IV	52	145	98	170	231	200	0.7	4.75	2.72
7	Nag River	Bhandewadi	Nagpur	A-IV	80	130	105	200	340	270	-	-	-
8	Pilli River	Koradi Road	Nagpur	A-IV	20	35	27	70	120	95	3	5	4
9	Pilli River	Kamptee Road	Nagpur	A-IV	10	15	12	15	30	22	4.5	5.5	5
10	Bag River	U/s of Simplex Paper Mill Ltd. At Changera, Dist. Gondia	Nagpur	A-II	2.8	5.2	3.64	16	48	24	5.79	6.81	6.34
11	Bag River	D/s of Simplex Paper Mill Ltd. At Changera, Dist. Gondia	Nagpur	A-II	3	10.6	4.84	16	100	37.6	6.12	6.98	6.32
	SRO Nagpur II												
12	Wena River	Wena Dam Upper	Nagpur	A-II	2.7	3.32	2.9	12	24	17	6.22	6.88	6.5
13	Wena River	Near Sukli Dam	Nagpur	A-II	-	-	2.3	-	-	24	-	-	6.59
14	Wena River	Nr.National Highway Bridge, Butibori	Nagpur	A-II	2.8	4	3.6	16	28	22	5.29	7.09	6.2
15	Kanhan River	D/s of CIPL at Bridge Vill. Mathani.	Nagpur		2.86	3.2	3.05	16	20	17	5.92	6.28	6.14
16	Wena River	At Kandhali Village	Nagpur	A-II	-	-	2.8	-	-	16	-	-	6.23
17	Wena River	D/s Hinganghat at Bridge on Hyderabad National Highway	Nagpur	A-II	-	-	2.64	-	-	20	-	-	6.23
18	Wainganga River	U/s of M/s Ellora Paper Mill Ltd., Devada Khurd, Tq.Tumsar,Dist.Bhandara	Nagpur	A-II	2.6	5.6	3.4	16	24	18.4	5.73	6.89	6.15
19	Wainganga River	D/s of M/s Ellora Paper Mill Ltd., Devada Khurd, Tq.Tumsar,Dist.Bhandara	Nagpur	A-II	2.96	5.4	3.94	16	36	26.4	5.06	6.77	5.92
20	Wainganga River	D/s of M/s Ordanance Factory, Jawaharnagar, Dist. Bhandara.	Nagpur	A-II	2.4	3.6	2.85	16	40	20	6.15	6.62	6.35
21	Wainganga River	D/s of M/s Ordanance Factory, Jawaharnagar, Dist. Bhandara.	Nagpur	A-II	2.8	4.24	3.41	20	36	24.8	6.02	6.26	6.1

Sr.No.	River	Monitoring Station	Region / Area	Class of Water	B.O.D.			C.O.D.			D.O.		
					Min	Max	Avg.	Min	Max	Avg.	Min	Max	Avg.
	SRO Pune II												
22	Indrayani River	Alandi	Pune	A-II	6.4	12	8.95	20	32	30.6	3.92	6.49	5.19
23	Indrayani River	Moshi	Pune	A-II	10	12.8	11	32	44	35	3.72	6.4	5.11
24	Mula - Mutha River	D/s Theur	Pune	A-II	9	130	55.6	24	284	119	2.86	6.35	4.6
	SRO Pimpri Chinch.												
25	Pawana River	Ravet Weir	Pune		3	34	15	12	80	29.6	3.5	7.8	6.44
26	Pawana River	Chinchwadgaon	Pune		7	75	28	20	220	79.2	-	6.8	5.63
27	Pawana River	Pimprigaon	Pune		8.9	110	41	20	260	103	-	6.5	3.69
28	Pawana River	Kasarwadi	Pune		14	105	61	40	320	154	-	5	2.04
29	Mula River	Sanghvi	Pune		6	118	47	20	308	125	-	5.2	2.18
30	Pawana - Mula River	dapodi	Pune		7.6	95	44	20	288	125	-	6.4	2.78
	SRO Solapur												
31	Bhima River	U/s of New Bridge at Pandharpur	Solapur		5	10	7	20	36	28.8	-	-	-
32	Bhima River	D/s of Gopalpur at Pandharpur	Solapur		5	10	6.8	16	36	26.4	-	-	-
	SRO Satara												
33	Krishna River	Mahuli	Satara		7	15	11	20	40	30	5.6	6.3	5.95
34	Krishna River	Krishna-Vena confluence, Mahuli	Satara		7.2	12	9.1	20	32	26	6.23	6.85	6.54
35	Venna River	Mahuli	Satara		7.8	18	12.9	24	28	26	5.8	6.1	5.95
36	Nira River	Shirwal	Satara		10	16	13	32	40	36	6.9	7.01	6.95
37	Urmodi River	Nagthane	Satara		8.04	11	9.52	24	28	26	4.9	6.59	5.75
	SRO Jalgaon I												
38	Tapi River	Bhusawal intake	Jalgaon	A-II	3	7.5	5.3	16	32	19	5.1	7.3	6.2
39	Girna River	Girna Pumping Station	Jalgaon	A-II	3	8	5.5	16	32	23	6.1	7.3	6.8
	SRO Jalgaon II												
40	Rangawali River	Nr. Suruchi Hotel, Navapur	Jalgaon		-	-	6.5	-	-	28	-	-	4.2
41	Arunawati River	D/s of shirpur	Jalgaon		-	-	8	-	-	40	-	-	5.2
42	Burai River	At Chimtane	Jalgaon										
43	Tapi River	Sarangkhda	Jalgaon		5	6	5.5	12	20	16	4.8	5.1	4.9
44	Gomai River	D/s of Shahada	Jalgaon		-	-	10	-	-	52	-	-	5.2
45	Panzara River	D/s of Dhule	Jalgaon		8	18	14.3	24	56	36	4.6	5.2	4.9
46	Pati River	At Mulwad after confluence of Tapi River	Jalgaon		-	-	8	-	-	16	-	-	5.3

Sr.No.	River	Monitoring Station	Region / Area	Class of Water	B.O.D. Min	B.O.D. Max	B.O.D. Avg.	C.O.D. Min	C.O.D. Max	C.O.D. Avg.	D.O. Min	D.O. Max	D.O. Avg.
	RO Nashik												
47	Godavari River	Someshwar	Nashik	A-II	4.5	19.6	19.5	12	128	36.2	4.7	5.2	5.05
48	Godavari River	Anandvali	Nashik	A-II	4	18	10	12	132	38.5	4.7	4.8	4.78
49	Godavari River	Chikali Nala	Nashik	A-II	3.5	14.5	10.9	20	92	39.7	3.5	5.2	4.77
50	Godavari River	Victoria Bridge	Nashik	A-II	4	11	10.1	12	80	31	3.7	5.3	4.7
51	Godavari River	Saikheda Village	Nashik	A-II	4	23	10.5	12	100	33.5	3.9	5.1	4.82
52	Godavari River	Nandur Dam	Nashik	A-II	4.5	23	9.75	12	90	29.5	4.9	5.8	5.17
53	Dharna River	Dharna Dam	Nashik	A-I	4.5	19	8.1	12	80	25.2	4.9	5.5	4.9
54	Dharna River	MES Pumping Station	Nashik	A-II	5	24.5	8.9	12	120	30.4	4.8	5.2	4.9
55	Dharna River	Bhagur Pumping Stn.	Nashik	A-II	4.5	26	9.1	12	160	35.6	4.7	5	4.8
56	Dharna River	Waldav River	Nashik	A-II	4.5	21	8.1	12	64	22.8	4.9	5.1	5
57	Dharna River	Sansari	Nashik	A-II	4	23.5	9.6	12	140	33.6	5.1	5.5	5.3
58	Dharna River	Pune Rd. Bridge	Nashik	A-II	4.4	24	10	16	124	35.6	4.8	5.2	5.1
	SRO Ahmednagar												
59	Sina River	Nr. Bridge at Nalegaon	Nashik	A-II	-	-	4	-	-	16	-	-	-
60	Prawarana River	At Kolar	Nashik	A-II	-	-	5.5	-	-	28	-	-	4.9
	SRO Kolhapur												
61	Panchganga river	At Shirol	Kolhapur	A-II	5	15	7.2	16	40	27	1.4	7.1	5.73
	SRO Sangli												
62	Krishna River	U/s of Mai Ghat	Sangli	A-II	2.75	29	-	16	32	20	4.8	6.2	-
63	Krishna River	D/s of Mai Ghat	Sangli	A-II	2.5	28.5	-	5.4	5.6	-	5.4	5.6	-
	SRO Ratnagiri												
64	Muchkundi River	Nr. Highway Waked	Ratnagiri	A-II	1.5	2.2	1.9	12	20	16	5.3	6.8	6.3
	SRO Chiplun												
65	Vashisti River	U/s of M/s Theem Paper	Chiplun	A-II	1.8	6.75	4.3	8	40	24	6	6.9	6.45
66	Vashisti River	D/s of M/s Theem Paper	Chiplun	A-II	1.5	7.5	4.5	8	64	36	5.5	6.6	6.05
67	Jagbudi River	U/s of Khed	Chiplun	A-II	3	12.8	7.9	8	32	20	6.3	6.5	6.4
	RO Amravati												
68	Penganga River	Maslapen	Washim	A-II	-	-	-	16	64	-	-	-	-
69	Penganga River	Asegaonpen	Washim	A-II	4.8	4.8	4.8	32	32	32	5.34	5.34	5.34
70	Penganga River	Sukali	Washim	A-II	5.16	5.16	5.16	36	36	36	5.29	5.29	5.29
71	Penganga River	Ukali	Washim	A-II	5.2	5.2	5.2	44	44	44	5.12	5.12	5.12
72	Penganga River	Ekburji Dam,	Washim	A-II	6.2	6.2	6.2	56	56	56	5.84	5.84	5.84
73	Penganga River	Belkhed	Yavatmal	A-II	5.2	10.4	7.8	44	84	64	4.37	6.38	5.39
74	Penganga River	Umarkhed	Yavatmal	A-II	2.64	14.5	8.55	16	60	38	5.44	6.9	6.15
75	Penganga River	Nanded road bridge	Yavatmal	A-II	5.2	19.8	12.5	44	84	64	4.37	6.38	5.39
76	Penganga River	Village wada	Yavatmal	A-II	3.8	15	12.4	24	64	22	5.14	6.64	5.87
77	Pedhi River	Kund (Haturna)	Yavatmal	A-II	2.62	6.9	4.99	-	-	-	3.45	6.35	5.07
78	Pedhi River	Haturna	Yavatmal	A-II	3	14	7.01	-	-	-	1.05	6.04	4.61
79	Pedhi River	Bhatkuli	Yavatmal	A-II	2.74	18	8.84	-	-	-	-	5.94	3.64
80	Pedhi River	Dadhi-Pedhi	Yavatmal	A-II	5.84	13.2	10.1	-	-	-	2.1	5.68	4.4
81	Purna River	Vishroli	Yavatmal	A-II	2.8	4.8	3.8	-	-	-	4.01	6.12	5.27
82	Purna River	Cbz-A ' pur road.	Yavatmal	A-II	2.6	4.3	3.65	-	-	-	3.88	6.34	5.2
83	Purna River	Asegaon	Yavatmal	A-II	3.1	5.76	4.34	-	-	-	3.81	6.29	5.24
84	Purna River	Kholapur	Yavatmal	A-II	3.2	8.2	5.83	-	-	-	3.56	6.14	4.91
85	Purna River	Lasur	Yavatmal	A-II	2.8	9.6	4.56	-	-	-	3.65	6.21	5.08

Sr.No.	River	Monitoring Station	Region / Area	Class of Water	B.O.D.			C.O.D.			D.O.		
					Min	Max	Avg.	Min	Max	Avg.	Min	Max	Avg.
	RO Raigad												
86	Patalganga River	Gagangiri Maharaja Temple Khopoli	Raigad	A-II	4	7	4.8	12	20	16	5.2	7	6.1
87	Patalganga River	Savroli	Raigad	A-II	3	7.5	5.26	16	28	22.1	3.8	7.6	5.43
88	Patalganga River	Vayal Pump House	Raigad	A-II	4	6	5.08	16	24	21.8	3.2	7.4	6.02
89	Patalganga River	Kharpade Saline Water Zone	Raigad	A-II	4	19	12.2	14	86	44.3	2.9	6.5	4.28
	SRO Raigad - II												
90	Ulhas River	Karjat Bridge	Raigad		5	9	6.3	16	24.8	24	4.5	7.4	6
91	Balganga	High way Bridge	Raigad		7	18	12	24	104	57	2.1	6	4.1
92	Bhogawati River	High way Bridge	Raigad		4	8	5.9	24	40	32	5.9	7	6.4
93	Amba River	Palighat	Raigad		4	9	5.6	16	40	21	5.4	7.3	6.1
	SRO Raigad - III												
94	Kundalika River	Kolad Bridge	Raigad	A-II	4	78	7.57	76	68	77.3	4.6	7	6.3
95	Kundalika River	MIDC Jackwell Dhatav	Raigad	A-II	4.5	78	7.86	76	64	78	4	7.3	6.25
96	Kundalika River	Verse Village	Raigad	A-II	4	79.5	7.89	16	80	30.7	4	7.5	5.8
97	Kundalika River	Areye Khurd	Raigad	Saline Zone	3	800	114	16	7643	250	-	5.8	3.68
98	Kalu River	Birwadi Jackwell	Raigad	A-II	2	5.2	5	12	32	22	5.3	7	6.15
99	Savitri River	Dadali Bridge	Raigad	A-II	3	12	7.5	16	72	44	4.8	7.5	6.15
100	Savitri River	MIDC Jackwell, Nangalwadi	Raigad	A-II	2	11	6	8	40	24	5	7	6
101	Savitri River	Shedav Doh	Raigad	A-II	1	9	5.4	12	32	22	5.6	7	6.3
	SRO Aurangabad - I												
102	Godavari River	Kaigoan Toka	Aurangabad	A-II	8	120	27.6	24.8	3040	382	3.2	7.2	5.4
103	Godavari River	Up Stream of Paithan	Aurangabad	A-II	3.5	13	8.2	8	42.4	25	4.6	86	19.2
104	Godavari River	Down Stream of Godavari River, Paithan	Aurangabad	A-II	3	33	11	6	32	18.6	4.8	7.2	6.23
105	Godavari River	Wadvali Village	Aurangabad	A-II	4	12.5	8.1	8	34	22.5	5.4	7.1	6.2
106	Sukna River	Jalna Rd. Bridge Chikalthana	Aurangabad	A-II	14	210	135	49.2	605	393	6.4	6.9	6.65
107	Sukna River	Sukna Dam	Aurangabad	A-II	4.5	32	13.1	12	120	30.2	2.2	7.6	5.08
	SRO Aurangabad - II												
108	Godavari River	Shahagre	Aurangabad	A-II	5	29	11.5	2	92	42.2	5.3	5.8	11.5
109	Sindfana River	D/S Majalgaon	Aurangabad	A-II	8	32	13.7	2	112	43.4	4.6	6.8	5.4
	SRO Aurangabad - III												
110	Manjara River	Sangvi	Aurangabad	II	6	13	9.5	18	34	26	5.2	7.2	6.2
111	Manjara River	D/S Kaflam	Aurangabad	II	8	15	11.5	26	36.8	31.4	6.7	7.2	6.92
112	Manjara River	Bhatkheda	Aurangabad	II	5.5	12	8.75	14.8	32.4	23.6	4.9	7	5.95
113	Terna River	Erandwadi	Aurangabad	II	5.5	13	9.25	21.2	34.8	28	6.1	7.1	6.6
114	Terna River	Ujani	Aurangabad	II	4.5	12	8.25	24	30.4	27.2	5.8	7.1	6.45
115	Terna River	Hattanga	Aurangabad	II	4	11	7.5	22.8	29.2	26	5.6	7	6.3
	SRO - Nanded												
116	Godavari River	U/S Nanded	Nanded	II	6.5	29	15.2	16.4	108	48.5	3.6	7.3	5.85
117	Godavari River	D/S Nanded	Nanded	II	7	64	50.5	21.2	222	64.6	-	8	5.66

Chapter-4

4.The Godavari Basin

The Godavari River System

Godavari proper has its origin at Trimbakeshwar. Godavari system within Maharashtra is the largest river system as far as its aerial extent is considered. Together with its eastern tributaries like Wardha-Wainganga it spreads over 151,803 sq km within Maharashtra.

The Godavari River drains the largest area of the state. It flows through Nashik, Ahemdnagar, Aurangabad, Osmanabad, Bhir, Nanded, Parbhani, Jalna, Nagpur, Wardha, Yavatmal, Chandrapur, Bhandara, and parts of Amravati, Akola and Buldana. The areas are known for the industries, agriculture and also are center for trade and religion. Major cities llike Nashik, Ahemdnagar, Aurangabad, and Nagpur in the recent years have many industries developed, a lot of agriculture is also practiced in these area. Nashik and Nanded are major urban areas along the bank of Godavari and religious places.

Present status of River Godavari: Number of workers have monitored the river water quality.

1. Work carried out by the C.P.C.B (1995) on the Godavari river revels that the BOD values indicated that the river stretch from Gangapur to Nanded was found polluted and the remaining stretch was found relatively clean in the years 1990 to 1999. The river water at Down Stream of Nasik was grossly polluted and maximum BOD value was 8.9mg/l during 1995.

2. The work done by Dr. V.B. Gaikwad and Dr. V.R. Gunale (1997-98) on water quality of Godavari river in and around Nashik region. Pooled Pollution Level: a unique approach was implement based upon pooling the rank of other pollutants. The fractional ranks due to individual pollutants at a site were added and their cumulative average was henceforth referred to as Pooled Pollution Level. This approach indicates overall cumulative pollution, representing the contribution of all pollutants in a year at one site. The decreasing order of polluted sites were as follows:

Godvari + Ahilya Sangam > Chikhali Nala (B.M.) > Underbridge > Gadage Maharaj Math > Modkeshwar temple > Godavari + Kapila Sangam > Talkuteshwar temple > Gharpure Ghat (D.M.) > Ganagwadi Bridge > Eklahara (B.M.) > Eklahara (A.M.) > Hans Raj Yogashram > Pitrutirth >

Kushawart > Ramtirth > Kashyapi River > Chikhali Nala (D.M.) > Dasak bridge > Someshwar > Gharpure ghat (A.M.) > Ramwadi Bridge > Ramkund > Kashypi + Godavari sangam > K.T.H.M. Point > Chakratirth > Gangasagar > Anandwali > Ganeshgaon bridge > Chikhali Nala (A.M.) > Dam downstream.

Physical parameters, especially turbidity and colour, indicated that Godavari water does not meet the norms to the potable water. Subsequent chemical patterns have added evidences to substantiate the same. Finally it has been summarized that a single pollutant was not be hazardous to create an impact; instead pooled pollution level makes vital impact on biological processes and hence it needs to be considered seriously.

3. Work carried out by the M.P.C.B. (2002-2003) on the River water quality status of Godavari river shows the following results;

Table 4.1: Water analysis done by M.P.C.B.

Sr.No	Monitoring Station	PH	BOD	COD	DO
1	D/s of Nashik (M)	7.54	8.58	29.6	5.64
2	Ramkund (M)	7.55	8.69	25.2	5.56
3	Gangapur Dam (M)	7.87	5.93	20.4	6.33
4	Raher (M)	8.06	7.11	23.36	5.9
5	Jaikwadi (M)	7.69	7.23	24.4	5.6
6	DhangarTakli, Nanded	8.13	12.61	33.6	6.23
7	Dhalegaon (G)	8.07	10.32	25.11	5.94
8	Someshwar, Nashik	8.11	19.5	36.2	5.05
9	Anandvali, Nashik	8.3	10	38.5	4.78
10	Chikali Naila, Nashik	8.2	10.8	39.7	4.77
11	Victoria Bridge, Nashik	8.3	10.12	31	4.7
12	Saikheda Village,	8.4	10.5	33.5	4.82
13	Nandur Dam, Nashik	8.3	9.75	29.5	5.17
14	U/s of Paithan,	7.6	8.2	24.9	19.2
15	D/s of Paithan,	7.8	11	18.6	6.2
16	Wadvali Village,	7.9	8.1	22.5	6.2
17	Shahgad	7.71	11.5	42.2	11.5
18	U/s of Nanded	7.71	15.22	48.5	5.8
19	D/s of Nanded	7.68	50.5	64.6	5.7

4. In the study conducted by K. K. Deshmukh and N. J. Pawar in Sangamner area on the Pravara River, 68-groundwater samples were taken in two seasons- pre monsoon and post monsoon. 54 of them were from irrigated area and 14 from non-irrigated area.

Rapid chemical changes evidenced by diverse hydro-chemical characteristics in the irrigated agricultural zone have lead to faster chemical evolution of ground water. As against this, in the non-irrigated agriculture less hydro-chemical diversity reflected slow process of chemical evolution of ground water. In addition to sugar industry several allied industrial units have also come up in the area. The effluents from sugar industry, with little or no treatment have been stored in lagoons and then discharged into the natural stream flowing through the agricultural area for a distance of about 8 to 9 km. This effluent stream finally meets the Pravara river at Sangamner. While flowing through the natural stream, the effluent infiltrates through the soil zone into the near by dug / bore wells thereby adversely affecting natural groundwater quality.

Table 4.2: Summary of physico-chemical characteristics of groundwater from Sangamner area, District Ahmednagar, Maharashtra.

	Pre monsoon		Post monsoon	
Parameter	**Min.**	**Max.**	**Min**	**Max**
pH	7.6	8.6	7.9	8.9
EC uS/cm	360	10,360	513	11,100
TDS(ppm)	230.4	6630.4	328.32	7104
Na epm	0.7	16.5	0.30	21.4
K epm	0.01	0.09	0.1	0.64
Ca epm	0.64	8.6	1.8	24.21
Mg epm	0.56	12	0.6	38.47
Cl epm	0.25	16.9	1.26	42.59
HCO_3 epm	1.34	12.37	2.22	11.83
$S0_4$ epm	0.57	3.54	0.36	3.11
NO ppm	0.21	196	0	121.5
B ppm	0	6.28	0.05	5.1

5. Number of workers Aher HR, Zinjad DG, Gunjal PS, Kuchekar SR (2002), Bhosle (2003) and Islam (2002) made survey of the water pollution in Godavari river Pravara river and Nanded and the which shows that Chemical analysis of water samples from Pravara river basin and Pravara left bank canal shows that the water is characterized by alkaline earth. Water samples from thirteen spots of down stream from Bhandara to Babhaleshwar were collected for analysis at an interval of ten kilometers. The results show that the physico-chemical characteristic of water changes to downstream from Bhandara to Babhaleshwar due to human activities.

6. Nanded is another major town on the bank of Godavari recoives domestic waste. Work by Islam SR, Gyananath G. (2002) from Swami Ramanand Teerth Marathwada University on contamination of chemical fertilizers in ground water and seasonal variations. Attempt is made to understand the implications of chemical fertilizers on ground water quality of Nanded. The mean recorded values of sulphate, phosphate and nitrate levels were found 10.26-34.83 mg/l, 0.052-0.194 mg/l and 3.43-11.37 mg/l, respectively. Sulphate and nitrate levels were within permissible limits but phosphate levels higher than the permissible limits. Paper presents a case study on the influence of seasonal variations on groundwater quality in Nanded district, Maharashtra. The study shows a marked seasonal trend in various physico-chemical parameters in ground water.

7. Tile (1998) as his M.Sc. project analysed water quality of the Godavari river from Someshwar to Panchak covering 12 km area and the Nandini river from Kamblewadi to Dwaraka covering 8 km area of Nashik city. The physico- chemical analysis of water from various stations were as follows;

Table 4.3: Physico- chemical analysis of Godavari river and Nandini river.

Sr. No.	**Station**	**Parameter**									
		Ph	**DO**	**BOD**	**COD**	**Hardness**	**Ca**	**Mg**	**Chloride**	**Alkalinity**	**Oil & Grease**
	Godavari										
1	Someshwar	7.6	4.9	7.5	17	90	50	25	40.5	48	90
2	Anandwali	7.5	5	12	31	75	37	24	56.19	55	75
3	K.T.H.M.	7.8	5.1	7.4	15	52	24	1	39.15	65	56
4	Ramwadi	8.5	3.6	32	80	60	28	21	34.75	120	68
5	Ramkund	8.6	3.8	34	75	85	42	30	40	135	80
6	Amardham	7.8	3.2	37	92	80	45	26	37.75	160	45
	Nandini										
7	Kamblewadi	8.2	2	45	110	80	47	26	215	125	46
8	Shahunagar	8	2.7	63.3	117	100	55	35	257	138	66
9	Vinaynagar	8.1	1.2	48	122	70	38	28	225	193	43
10	Dwarka	7.8	1.5	44.6	113.5	66	35	22	220	150	40
11	Takli	7.6	2.4	40	112	120	64	40	171.9	160	75
12	Panchak	7.8	4.1	35	80.5	104	57	35	148.8	138	56

Values are given in mg / l except Ph

Another worker Sunita Nande (2000) monitored the Phyisco-Chemical Characteristics of Godavari and Kadwa River near Sinnar, where she had selected total 9 sites along both the rivers. 5 sites on Godavari and 2 along Kadwa and these two met each other near Nandur Madyameshwar weir, 2 sites were taken at this point.

Godavari River is important in the development of agricultural and industrial sectors of Nashik and the adjoining areas. Unfortunately the same river is being polluted by indiscriminate disposal of sewage and industrial waste, heavy use of fertilizers and pesticides and human activities. River pollution has already acquired a serious dimension in India.

Table 4.4: Physico-Chemical Characteristics Of Godavari and Kadwa River.

Physico-Chemical Characteristics Of Godavari and Kadwa River

At Various Sampling Site

Parameters	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**	**Site 9**
Physical									
Temperature	23.8	23.6	23.5	22.7	22	21	23.2	23.5	23.2
Conductivity	227	241	228	334	310	278	279	484	252
Ph	8	7.9	8.4	8	7.7	8	8.3	8.3	7.9
T.D.S.	5	4.2	9.2	9.7	6	7.3	6.2	11	6.7
Chemical									
Alkalinity	150	125	290	180	190	275	175	215	185
CO	11	13.2	14	20.9	8.8	12	13.2	26.4	19.2
Chlorides	35.5	42.6	36.5	46.86	42.6	35.5	44	96.56	85.2
Total Hardness	112	112	175	164	172	144	180	200	164
Ca^{++}Hardness	28.05	25.65	16.03	36.06	34.4	32.06	28.85	38.06	27.25
Mg^{++}Hardness	83.95	86.35	158.9	127.9	137.6	111.9	161.1	161.1	126.9
DO	5.8	5.2	4	6.7	7.6	6.2	6.3	6.2	5.2
BOD	20	17	30	37	25	18	17	21	21
COD	52	40	84	100	74	61	48	55	66
Sulphate	53.5	55.8	69.4	59.4	58.6	61.6	46.6	54.2	73.6
Phosphate	0.172	0.1	0.269	0.258	0.175	0.246	0.169	0.213	0.099
Sodium	6	8	9	10	11	10	8	12	10
Potassium	1	1	2	3	2	2	2	2	1

Another group from swami Ramanand Teerth Marathwada University, Nanded is regularly monitoring Godavari River pollution from Nanded area under the guidance of Prof. Yedekar (personal communication).

Chapter- 5

5. The Wardha and Wainganga Basin

The Wainganga and Wardha River Systems

After confluence of the Wainganga and the Wardha river it is known as Pranhita river. It is one of the largest tributaries of Godavari system. The important tributaries of the Wainganga system, besides Wardha, are Kanhan and Mul. The Bembla and Penganga both the tributaries of Wardha also have sizeable catchment areas. Together with these rivers, Pranahita has catchment area of 1.09 lakh sq. km.

Work carried out by M.P.C.B (2002-2003) on various parameters of Penganga river shows the following results;

Table 5.1: Water analysis of Penganga river

Sr.No.	Monitoring Station	PH	BOD	COD	DO
1	Maslapan	7.56	-	26	-
2	Asegaon	7.82	4.8	32	5.34
3	Sukali	7.56	5.16	36	5.29
4	Ukali	7.8	5.2	44	5.12
5	Ekburji Dam	7.8	6.2	56	5.84
6	Belkhed	8.13	7.8	64	5.39
7	Umar Khed	7.89	8.55	38	6.15
8	Nanded Rd. Bridge	8.13	12.5	64	5.39
9	Village wada	7.65	12.4	22	5.87

Chapter-6

6. The Krishna Basin

The Krishna River System

The Krishna system occupies 258,948 sq. km of the area within Maharashtra. Physiographically all the area of Krishna catchment within Maharashtra can be considered as part of the upper Krishna basin.

The Krishna river is the next important river after river Godavari. It drains different districts such as Satara, Kolhapur, Sangli, Solapur and small part of Ahemdnagar. It has a number of tributaries, of which the Bhima River is most important and joins it in Karnataka State. These areas have many sugar plants, which use large quantities of water for their operations and discharges of effluents. The sugar fields also utilize large amounts of fertilizers and pesticides that ultimately find its way into natural water body and contaminate it. Karad city in Satara district is an important trade, agro-industrial and educational center. Karad station is used by six large co-operative sugar mills and Koyana Hydro project for loading and unloading machinery etc, which pollute the water through agricultural runoffs; fertilizers and pesticide and domestic waste. Kolhapur and Solapur have many industries developed, which also pollute the water and has adverse effect on the aquatic flora and fauna. Most of the domestic waste and industrial waste are found to be discharged into the water with partial or no treatment. Thus making the water unfit of human consumption and also hampers the life harbouring in the water.

1. Work done by Dr. Boralkar and others during July –December 1980 on the Krishna River Ecosystem between the Karad- Sangli area which is about 120 km. This is where the river is subjected to maximum human activities in this state. 8 stations were selected to study river such as; 1. Sangam (Karad), 2. Krishna Bridge (Karad), 3. Khubi, 4.Kole, 5. Jackwell (Sangli), 6. Ganesh Temple (Sangli) 7. Haripur Naka (Sangli) 8. Haripur. At these stations different physico-chemical parameters were analysed. The D.O content varied between 0 to 13.6 mg / l, the BOD of the water was between 21 to 130 mg /l the alkalinity ranged between 6.0 mg /l to 256 mg / l. Sulphates ranged from 0.0487 to 847.0 mg / l. the

Chlorides concentrations was between 3.1 to 280.6 mg / l. The Most Probable Number of coliforms (MPN) studies to asses the fecal pollution load was more than 2400 cells / ml of the river water. This region entails special significance for the river water quality as more than seven sugar factories discharge their effluents directly or indirectly into the river. High levels of nitrates were due to large quantities of nitrogenous fertilizers, which were used for agricultural purpose and from liberal discharge of organic wastes.

2. Survey carried out by the C.P.C.B. (1995) on the Krishna river shows that BOD values indicated that the water quality deteriorated over the period 1990 to 1999 at Mahabaleshwar, Karad, Sangli and Rajapur. The BOD values increased from 3.1 mg/l to 5.2 mg/l at Mahabaleshwar, 4.5 mg/l to 5.5 mg/l at Karad and 4.1mg/l to 6.0 mg/l at Sangli during 1990 to 1999 respectively. The water quality was very bad at the stations Mahabaleshwar, Karad, Sangli and Rajapur during 1999 as compare to the years of 1990 and 1995.

3. Work carried out by the M.P.C.B. (2002-2003) on the Krishna rivers shows the following results;

Table 6.1: Water analysis of Krishna river

Sr.No.	Monitoring Station	PH	BOD	COD	DO
1	Rajapur Weir (M)	7.7	5.26	20.4	6.44
2	Kurundwad (M)	7.7	5.63	37.5	6.43
3	Dhom Dam (M)	7.46	5.46	11.2	6.13
4	Sangli (G)	7.88	6.32	26.67	6.07
5	Karad (G)	7.86	6	23.5	6.38
6	Mahuli, Satara	7.78	11	30	5.9
7	Krishna-Vena Confluence	7.7	9.1	26	6.5
8	U/s Maighat, Sangli	8.1	15.5	20	5

4. Trivedy, R.K et al. (1991) studied heavy metal such as: Cu, Mn, Cd, Ni, Zn and Iron from the River Krishna, Maharashtra, during the year 1987. The sampling was done at 7 sites spread over 260 Km. The sites were subjected to different level of human activity & pollution; however, there was no point source of pollution. Average concentration of various metals in the river was: Cu 0.02 to 0.08 mg/L, Mn 0.07 to 5.2 mg/L, Cd 0.001 to 0.04 mg/L, Nickel 0.19

to 0.91 mg/L, Zn 0.19 to 0.99 mg/L and Iron 0.35 to 1.49 mg/L. Concentration at several places exceeded the drinking water and irrigation standards.

In another work carried out from 1985-87 with the objective to study the sources of pollution in the river. 10 Sampling sites were studied. It was seen that Krishna river, after the Dhom dam, is subjected to various degrees of pollution. As per various physico-chemical criteria studied mainly BOD, COD, DO, N NH_3, Chlorides, it appears that no site is free from pollution. Even site 1 which is just after the Dhom dam is polluted due to influence of cultural activities and agriculture and possible occasional discharge from a hand made paper mill.

5. The studies done by S. K. Soam and J.P. Singh (1997) on the Krishna river using Spatial modelling approach to water pollution monitoring in the sugar belt of Maharashtra, which is one such polluted rivers of the country, flows in the states of Maharashtra, Karnataka and Andhra Pradesh. The present study is taken up for the monitoring, identification and suggesting preliminary measures of water pollution control in the Satara-Sangli stretch (stretch-I) also known as the country's sugar-belt, of the Krishna basin in Maharashtra with the help of Geographic Information System (GIS). The stretch-I, has been identified by CPCB and MPCB (Maharashtra Pollution Control Board) for the restoration of water quality under the National River Action Plan (NRAP).

Satara - Sangli Stretch The total geographical area of the Krishna basin in Satara is 10,816 km2 (4%) and that of Sangli is 8,572 km2 (3.2%).

Fertiliser and Pesticide Consumption**:** To get higher yields in the cultivated land, farmers apply more and more of chemical fertilizers. The total pesticide consumption in Maharashtra is 711 MT/Year, of which 7% is consumed in Satara and 6.4% in Sangli. In these two basin districts organo-chlorine share is the highest. The application rate per hectare is about 0.09.

Water Consumption and Effluent Discharge: Major industrial sectors are in power, fertiliser, sugar and cement industries. In Satara and Sangli fifteen medium to large size sugar industries are located. There are many liquor factories located along the stretch-I. The quantity of water that is consumed for domestic, industrial and irrigation uses are respectively 66, 18 and 3366 MCM. Correspondingly, the amount of effluent that is being discharged from urban, industrial and irrigation are 29, 14 and 673 MCM. From the sugar factories and its surrounding domestic locations about 13400 and 1525 cubic meter of effluents are being discharged everyday.

Soam and Singh used different factors those affect the water quality are physical, chemical and socio-economic parameters of the river basin. Using GIS, the database on pollution load, the relationship between pollution load with population, fertiliser consumption and factory location, and the river zonation have been assessed and graphically presented.

6.1 River Panchganga

Panchganga is a tributary of Krishna river, it originates at Kerli at a distance of 72 km from Radhanagari Dam and passes through Ichalkarnji City, located at a distance of 48 km from Kerlik. It meets Krishna at Narsobawadi. Along the bank of the river, there are two major towns – Kolhapur and Ichalkarnji with their industrial activities they have polluted the river which is their source of water supply.

1. Studies done by Trivedy (1990) on river Panchganga reported it to be considerably polluted near the Kolhapur city due to the disposal of sewage and industrial waste from two nalas. The water supply to the city is made from the river and the water is collected from a place, just near the outfall of sewage and industrial waste carrying nalas. The study was carried out on the sites before and after these outfalls; physico-chemical and biological characteristics of the river have been studied. The study reveals that the river is facially polluted throughout it stretch near Kolhapur. A sudden increase in the concentration of nitrogen and some other components showed that there is a discharge of organic effluent after site 1, but the results of biological analysis confirmed the increased pollution after the entry of the nalas. The value of Nygaard's compound index in the river ranged from 10.5 to 12.0 and the value of Palmer's algal genus index from 20 to 29.0 both indicating high organic pollution of the river. Ecological study of the River Panchganga passing through Kolhapur a religious and industrial city of southwestern Maharashtra shows that the river receives the wastewaters mainly from a drain called Jayanti Nalluh, which carries sewage, tannery effluents and other waste-waters from the city. Besides, several small drains from the human settlements and the Shiroli industrial area in the vicinity also pour substantial quantities of wastewaters in the river.

2. Study carried out by Goel and Bhosale (2001) on the river Panchganga, where five sampling sites were selected on the basis of the magnitude of pollution and usage of the river stretch. The water was analysed for a number of physico-chemical and biological parameters over a period of one year covering all the seasons. The maximum COD went up to 200 mg/L indicating organic pollution. Similarly, ammonia, nitrate and inorganic phosphorus also recorded higher values up to 3.36, 6.55 and 0.83 mg/L respectively. Ecological studies with special reference to biological component on river Panchganga at Kolhapur shows a large proportion of the catchment is comprised of urbanized and industrial areas with considerable human activity influencing the river.

The levels of the parameters like nitrogen, phosphorus, chloride, sulphide and COD clearly reveals the polluted nature of the river. Many of the algal species out of the total 61 reported from the river like *Euglena, Scenedesmus, Spirulina, Microcystis, Chlamydonmnas* and *Anabena* are recognized pollution indicators. Zooplankton also comprises of some pollution tolerant species like *Brachionus, Keratella, Cyclops* and *Chydorus*. The study indicates that both chemical and biological aspects reveal a grossly polluted nature of the river having almost insignificant self purification capacity to assimilate pollution in this stretch. The problem becomes more grave, especially during the summer season.

3. In another study by Trivedy and Nakate (2000) on the heavy metal account in the river shows that copper content was 10-to 50 μg/ l which is in fact the highest desirable limit for water quality. Manganese concentration at site 1 to3 was in the range of 20-to 130 μg/ l but the same was usually above 1000 μg/ l and upto 2160 μg/ l at site 4. Thus the municipal drain is the main source of manganese Cadmium concentration was below 5 mg/L in the river water, while the prescribed standard for the same is 10-μg/ l in the river water. Nickel concentration in the industrial drain (Kabnoor drain) was in the range of 10 to 40 μg/l, while in the municipal drain it was 30-to 90 μg/ l. The concentration of zinc was much higher in the Kabnoor drain 170-to1320 μg/L, while it was only 51 to 130 μg/L in the municipal drain. The higher concentration in the former drain is due to industrial discharge. The concentration of cobalt was in the range of 10 to 50μg/L however; lead concentration at site 3 and 4 was around 100μg/L or above on few occasions, which is above the prescribed limit.

4. Investigations done by Goel and Autade (1995) on the ecological studies on the River Panchganga exhibits that the mangnitude of parameters like nitrogen, phosphrous, chloride, sulphide and COD clearly reveals the polluted nature of the river. A total of 61 algal species were found in the river of which many like *Euglena, Scenedesmus, Spirulina. Microcystis, Chlamydomonas* and *Anabaena* fall in the category of pollution indicators. The zooplanktons also consist of many pollution tolerant species like *Brachionus, Keralella, Cyclops* and *Chydorus*.

The results of the study shows that the river is suffering from pollution arising out of the discharge of diverse wastewaters from point and non point sources, which has resulted in almost insignificant self-purification capacity of the river in this particular stretch.

5. Meenal Bapat (2003) as a part of her Ph.D Thesis under guidance of R.K.Trivedy on the water quality of the river Krishna and Panchganga during 2001-2002. Data on physico chemical characteristics of the river Krishna in three seasons from its origin in Mahabaleshwar (Gomukh) to terminus at Narsobawadi showed that it was alarming state, the dissolved oxygen content of this river was very low almost throughout the river. Most of the values were below 5.0 mg/L putting a serious question mark on the survival of fish and other organisms. Very low DO values were recorded at Wai downstream (Mukti Dham), Karad downstream, Walwa and at various sites in Sangli often below 3.0 mg/L suggesting a very heavy pollution of the river at these points due to disposal of sewage Following were the sampling sites of river Krishna; 1. Gomukh. 2. Dhom Dam Downstream, 3. Ganesh Mandir (Wai), 4. Mukti Dham (Wai), 5. Mahuli (Satara), 6. Karad Bridge U/S, 7. Karad Bridge D/S. 8. KarveU/S, 9. KarveD/S, 10. Kole, 11.Walwa, 12.Audumbar Mandir, 13. K.T.Weir (D/S) Sangli, 14. Krishna Warna Sangam, 15. Narsobachi wadi and following are the sites of river Panchganga1. Sidheshwar Temple, 2.Before Jayanti nallah 3. After Jayanti nallah, 4. Ganga Ghat 5. Shiroli Bridge, 6. Shahu Dham. Dr Anil Kulkarni (1992-93 and 2001) assessed the quality of surface and groundwater from Panchganga river area and analysed water qualiy indices. He showed that 70% of pollution is due to domestic waste.

6.2 River Koyana

Studies by Trivedy et al. (1990) on the Koyana river shows that the presence of few pollution tolerant species like *Oscillatoria, Spirulina, Navicula* etc. indicate that the organic pollution has been slowly setting in the river. It is observed that the water of the river Koyana is quite clean but the disposal of domestic sewage at Karad has considerably deteriorated the water quality and phytoplankton flora.

Work done by Khatavkar (2000) on the heavy metal content of Krishna and Koyana rivers revels that the level of heavy metals was not very high in the rivers overall. Maximum concentration of all the heavy metals was always found at sites 6 in the river Krishna, which is explainable by high concentration of metals brought about by Sheri Nala. Iron concentration in the river Krishna varied from 623 to 3425 μg/L against world average of 670 μg/L in present studies too; it appears that the high iron content at site 6 was only due to a heavy inflow of sewage. In the river Koyana iron concentration was much less than the river Krishna but the nullahs; especially Karad Nalla had higher concentration, which is again due to Sewage & Strom water. Worlds mean concentration of Zinc is 20 μg/ L Both the rivers had much higher concentration than this. Although the zinc appears to be naturally high in this area, waste discharge also contributes significantly as zinc concentration was quite high in nullahs meeting the River. Similar trend was found with regard to manganese.

Chapter-7

7. The Bhima Basin

Bhima River system

Bhima The Bhima river rises in Western Ghats, at an altitude of about 945 metres and flows south-east wards through Maharashtra and Karnataka. It flows for 861 km before joining the Krishna near Kudlu in Raichur taluk. It has a drainage area of 70,614 sq km out of which 18,315 sq km lies in Karnataka.

7.1 Mula, Mutha and Pavana Rivers

This is one of the river basin having rapid growth of urbanization and industrialization. Major city like Pune has developed along the banks of Mula- Mutha rivers, while Pavana River passes through township of Pimpri- Chinchwad. Establishment of industries like chemical industry, paper and pulp, automobiles and mechanical etc in the cities, has led to significant impact on the quality of water. Most of the domestic waste and industrial waste are discharged into the water- course with little or no treatment. The implication of such inhuman practices causes massive pollution and threat to flora and fauna of the water-body.

1. Studies carried out by the M.P.C.B. (2002-2003) on the Bhima river on parameters such as pH, BO, COD and DO shows the folling results;

Table 7.1: Water analysis of Bhima river

Sr.No.	Monitoring Station	PH	BOD	COD	DO
1	Daund (M)	7.05	7.13	23	4.53
2	Pargaon (M)	7.15	9.75	26	4.45
3	D/s of Band garden, Pune (M)	7.1	29.7	74	2.4
4	D/s of Vithalwadi, Pune (M)	7.23	18.6	40	3.3
5	Takli, Solapur D/s (G)	7.93	6.36	24.89	6.07
6	U/s of New Bridge,	7.6	7	28.8	-
7	D/s of Gopalpur, Pandharpur	7.6	6.8	26.4	-

2. Work done by V.R.Gunale for Ph.D (1974 to 1977) on the water quality level at the confluence of Mula- Mutha rivers in Pune city. Samples from 9 stations were collected on these rivers such as; Sangam Bridge, Bund Garden, Vithalwadi, Holkar Bridge, Dapodi Bridge etc. The physico-chemical as well as algal analysis were done monthly for 4 years. It was seen that the D.O. ranged from 0 to 6mg/ l. At Sangam Bridge the DO had dropped to zero level resulting in an unfavourable environment for the biota. The CO_2 ranged from 3 –13mg / l. BOD was 75 to 200 mg/ l in summer months. The nitrate level was from 1.944 to 3.720 mg/l and the phosphate content ranges between 0.5 to 2.5 mg / l. The rivers received effluents from the domestic waste. The presence to many algae indicated that these rivers were organically polluted and has a high degree of anaerobic decomposition that also gives rise to characteristic odour.

3. Studies conducted by S.G. Tupe, R.S. Jadhav, S.S. Zinjarde, V.R. Gunale and B.K. Patwardhan (1999) on the bacteriological quality of the Mula-Mutha rivers for a period of three months January, February and March at seven different sites along the Mula-Mutha rivers, Pune. The analysis revealed the presence of high total viable counts, indicators of faecal pollution namely, *Escherichia coli* and faecal Strepto-cocci, pathogens such as *Salmonella* species and *Vibrio choleras* at most of the downstream sites. The quality of water at the upstream Khadakwasla site, from where Pune city gets its water supply, had a lower load of bacteria and on most occasions did not show the presence of the two pathogens. Water at the downstream sites, flowing out of the city limits, is bacteriologically of poor quality and is unfit for human use.

The results of Total Viable Count (TVC) at the seven shows that the viable counts at the Khadakwasla site are the least, but there is an increase in the total number of E -organisms thereafter. At the very next site, i.e. Vittalwadi, there is an increase in the viable counts and high counts persist at all the downstream sampling sites. The mean counts, they obtained at the seven sites, were 4 x 10^3 at Khadakwasla, 10 x 10^5 at Vitthalwadi, 3 8 x 10^5 at Ganvare bridge, 40 x i 0^s at Sangam bridge, 24 x 10^5 at Aundh bridge, 34 x $I0^5$at Holkar bridge and 84 x $I0^5$at at Bund garden.

4. IMPACT India invited University of Pune to carry out systematic survey for Pavana,Mula and Mutha rivers with the support from Thermax, Pune. A report on water quality was prepared and submitted to Honourible Governor, Maharashtra state and also Collector, Commissioners of both the Municapal Corporation. This report was prepared to take steps to improve the condition of river ecosystem. As a follow up of this PMC and PCMC have initiated measures to reduce the inflow of the waste.

Then, PMC with the help of School of Health Sciences, University of Pune took regular monitoring of rivers. Gunale, V.R. and Patwardhan, B. (2000) on the rivers showed that Dissolved oxygen content has decreased while alkalinity and water hardness have increased. Increasing levels of calcium, magnesium, phosphates, sulphates, chlorides and heavy s have all been reported. Studies conducted the last 20 years have consistently reported eutrophication of the river water, an important indicator of water pollution. The Pimpri Chinchwad industrial complex along the banks of the Pavana River has added to the industrial and domestic effluents. (Gunale, 1978: Pawar, 1985; Wagh et al, 1987; Shirwalkar, 1991; Virwabharam, 1995). The increase in pollution result from the discharge of industrial domestic effluents into the rivers without pretreatment. There are few industries with full-scale effluent treatment plants and many with no mechanism for effluent treatment at all. Many of the most polluting industries are small-scale operations and cannot afford waste treatment plants (Gunale, 1978).

It was observed from the concentrations of dissolved oxygen decreases downstream indicating increase in the pollution of Sangam Bridge, the quality of water is highly polluted which is evident from DO values, which are less than one ppm. The concentration of BOD and COD increases downstream indicating presence of high oxygen demanding waste in water. Increase in the Cl- content of water downstream suggest that there is input of domestic effluents in the river. In general, the electrical conductivity of water increases in the downstream direction reflecting higher ionic content of water. Decrease in pH of water downstream is slightly acidic and might be the result of mixing of acidic waste waters.

The DO concentrations at Wakad, Aundh and Dapodi on the iecreases downstream. This suggests that the river water is highly polluted from Aundh to Dapodi. This stretch of the river also shows concomitant increase in the BOD and COD values. The value of COD and BOD slightly decreases at Dapodi, due to mixing of Mula River with Pavana river water. The values of Cl and PO_4 show continues increase from Wakad to Dapodi indicating increase input of domestic effluents in the river. The EC of the water goes on increasing from Wakad to Dapodi, suggesting that the load of dissolved solids in water is also increasing. The pH value also shows increase supporting above interference. The river stretch between Aundh and Dapodi is highly polluted.

The DO values of the river water are fairly low at all the stations of Pavana, indicating that the river water is highly polluted. The inference is supported by higher values of BOD and COD. The Cl and PO_4 concentration increases downstream, indicating mixing of domestic effluents in the river. The EC values of the river are on lower side at Thergaon. However, the value increases by many folds at Sangvi and Holkar Bridge, indicating mixing of concentrated effluents from both domestic as well as industrial sources. The increase in pH values downstream supports this inference. By and large, the river stretch between Thergaon and Holkar Bridge can be considered as highly polluted.

Table 7.2: Water analysis from Mutha & Mula rivers for the month of August 1998.

	Khadak-wasla	Vitthal-wadi	Garware	Sangam bdg.	Bund garden	Aundh	Holkar bdg.
Temp.	25.8	25	24.5	225.3	23.9	23.5	23.8
pH	6.8	7.1	7.5	6.5	7.3	6.4	6.7
EC	86	160	294	552	542	678	623
Alkalinity	65	195	200	160	150	155	160
Free CO_2	2.2	4.4	6.6	11	8.8	4.4	4.4
DO	10.14	8.51	0.0	2.0	2.7	8.31	6.69
BOD	2.1	4.5	14.4	48.6	28.1	62	45
COD	4	8	32	108	56	124	92
Phosphorus	0.06	0.17	0.84	0.22	0.25	0.1	0.28
Sulphate	1.75	1	3	2	2 .5	1.5	1.1
Chloride	28.4	34.08	41.18	29.82	28.4	22.72	28.4
Hardness	38	148	140	136	126	120	116
Ca	12.024	40.08	36.87	36.072	31.26	28.86	30.46
Mg	1.949	11.695	11.69	11.21	11.695	12.18	9.746

5. Thanedar (2001) studied the Mula, Mutha River for its physico-chemical parameters. Five sampling stations studied were: Station 1 Khadakwasla Down stream- Station, 2 Karvenagar, Station 3 Two Wheeler Bridge (T.W. Bridge), Station, 4 Sangam Bridge, Station 5 Bund garden. It is seen that Khadakwasla, Karvenagar, Two wheeler bridge stations, the pH value of river water is within the permissible limit of 6.5 to 8.5 for most part of year. Hence it can be concluded that river water is suitable for use for domestic purposes. For Sangam Bridge station the pH varies from 6.6

to 9.1 and for Bund Garden station the pH varies from 6.3 to 8.8, which shows that pH value exceeds the permissible limit and hence not suitable for use as domestic purpose.

The value of Dissolved Oxygen changed from Khadakwasla station to Bund garden in decreasing value. The DO at Khadakwasla is 7 to 8 mg/l, which is very good for aquatic life and degradation of organic matter. The DO at Karvenagar is in limit 3 to 4 mg/l, but DO content in river is very less at Two-Wheeler Bridge, Sangam Bridge and Bund Garden. It is seen that at the last three stations DO is decreased up to 0 mg/l which is very alarming, as this level shows that at this phase no aquatic life is present in river and also whatever degradation of organic matter takes place is due to anaerobic bacteria. BOD at Khadakwasla station exceeds the permissible limit (30 mg/lit). But at the Karvenagar, Two-Wheeler Bridge, Sangam Bridge, Bund Garden stations this value exceeds the permissible limit and it has reached up to 500 mg/l at Sangam Bridge, which is very high, and according to BIS standards the effluent of this much amount should not be disposed into inland water.

COD shows that at Khadakwasla station COD of river water is very less. At the Karvenagar station maximum value is about 300mg/l and for Two-Wheeler Bridge, Sangam Bridge, Bund garden stations the value varies between 300 to 650 mg/l which is according to the BIS standards very high compared to the permissible value (i.e. 250 mg/l) for effluent discharged into inland surface waters. The sulphates value and chlorides are within the permissible limit (200 mg/ lit) and (250 mg/ lit) respectively for all the stations.

6. Work done by N.J. Pawar and I.J. Shaikh in a small watershed area near Kedgaon in the Pune district of Maharashtra on a small stream, Hadal Odha that has an aerial extend of 135 sq km, drains this watershed. It discharges into the Janal Odha that ultimately joins the Bhima River. Samples were taken from 29 stations. The parameters such as pH, nitrates and chlorides of the water were analysed. The concentration of nitrate (as NO_3) ranges from 2.2 ppm to 64 ppm. While Chloride Cl ranges from 3.3 to1511 ppm. The value of pH ranges form 6.9 to 9.08. The sample showed high values of nitrate coinciding with agricultural land use indicating fertilizers as the main source of nitrate pollution of ground water also the area is irrigated for sugarcane cultivation especially form down-stream part of the basin.

In another work done by Gandhe, R.V. and Gandhe, K. on the Riverine Watermoulds from the Mula and Mutha Rivers. Five sampling stations were on Mutha river and six on Mula river. These tations were selected in relation with the point source of pollution such as outfall discharge of domestic waste, industrial effluent release and non-point source such as agricultural runoffs. It was concluded that *Saprolegniales* and *Lagenidiales* showed distinct seasonal periodicity. A total of 11 genera and 34 species were isolated from 11 different sampling stations of the rivers. The water bodies constantly received domestic waste throughout the year and therefore, converting into organically rich habitat. *Thraustotheca clavata* was isolated as a pollution indicator.

7. Work done on the Mula, Mutha and the Pavana Rivers by the students of University of Pune as their M.Sc. Project.

Madhuri Dixit (1996) analysed ground water and showed that the disposing of waste on the ground and in water bodies resulted in pollution. In the study salinity and alkalinity were found to be higher at Vishrantwadi and Lohegaon. This was due to the fact that the application of fertilizers causes leaching of salts into the ground, causing water to become alkaline.

Studies done by Basil Toppo (1997) on the Mula-Mutha shows that the river is heavily polluted by industrial and domestic effluents and hence the river water is unfit for human consumption. It is proved by the presence of pollutants in the river water, the presence of heavy metals in high concentration and extensive growth of water hyacinth. The problem of water hyacinth can be tackled by making use of it for human benefits. It can be used for compost, pulp for paper, and biogas generation. It can also be used as biofliter for water pollution control.

Ravindra Kshirsagar (1997) on the physico-chemical and biological analysis of water showed, that waters at all the six sites were used for cleaning of cattle and utensils, washing clothes, and bathing. Garbage was disposed of in the canal waters. High BOD values were observed though never beyond 3ppm,which is due to fast flowing nature of the water. Presence of blue-green algae, chloroccocoiles, indicates organic pollution in the waters. High MPN values at all sites shows that the water has high bacterial counts and is not potable. From the metal analysis of water, it was seen that iron was found at all sites, but the concentration was less compared to the standard value, and other toxic metals like cadmium and chromium were absent.

Work done by Priya Chanda (1998) on the chemical analysis of groundwater samples from the basaltic aquifers reveals that the value of nitrates was high. The areas showed higher nitrate concentration were coincident with intensive agricultural landuse. The high values of nitrates in the sugarcane fields can be considered as strong evidence that fertilizer is a major source of nitrate contamination of groundwater in the area.

The work done by Mrudula Kale and Ashwini Erande (2000, the analysis of heavy metals in river water samples reveals that the concentrations of copper, cadmium and nickel were well below the permissible levels in surface waters as compared to the Indian standards, however only mercury was found to be almost ten times higher than the permissible limits. Large fluctuations were observed among all metals with respect to seasonal pattern. This may be due to the quality of sewage and industrial effluents given out every month. The use of agro-chemicals could have contributed in the total load of heavy metals in the river water.

Studies carried out by P.Bineesha in 1995 to estimate the amount of accumulation of heavy metals in *Polygonum glabrum* along the banks of these rivers showed the following result.

Average concentration of Cu, Zn, Cd and Pb (μg /g)					
Sr. No.	**Sampling Sites**		**Total**		
		Cu	**Zn**	**Cd**	**Pb**
1	Khadakwasla	188.5	52.2	23.04	312.2
2	Vithalwadi	189.6	538.1	47.08	484.1
3	Natraj Causeway	177.2	42	42.46	602.4
4	Bund Garden	86.7	164.6	43.63	490
5	Holkar Bridge	263.2	247.1	67	569.5

Table 7.3: Average concentration of heavy metals in *Polygonum glabrum.*

Studies by V.B. Gaikwad (2001) in Pune city illustrated that there are more than 12 nallas of which 8 are major. The river Mula – Mutha flows through the city for a distance of 5km but these nallas are part of this river system collectively flows for more than 40 km. More than 90% pollution contribution to the river is due to these nalas. Garbage and solid waste are dumped into them.

The city has tremendous population growth and thus waste generation. Thus this river is domestic and industrial effluent load of 554 million liters of liquid effluent generated each day. 422 million liters (82.1%) are released directly into the river without treatment Paranjpye 1997.

Status Report of Water Quality (1997) given by M.P.C.B.

Sr.No.	Sampling Sites	pH	DO	BOD	COD	Suspended Solids	Oil & Grease	Sulphates	Chlorides	Phosphates
1	Near Dattawadi - Mahatre Bridge	7.6	-	67.5	200	614	7.6	35	55	5.78
2	Confluence of Gaikwad Nala & River	7.62	-	74	220	276	7.2	29	51	10.9
3	River D/S of Mahatre Bridge confluence of Ambil Adha and river	7.83	-	50	120	184	2.4	40	49	5.06
4	Confluence of Tilak Nalla	7.71	-	32.5	96	72	6	27	37	3.11
5	U/S of Asthabhuja Causeway	7.71	-	42.5	120	56	4.8	35	33	2.8
6	D/S of Maharshi Shinde Bridge	7.67	-	20	52	40	2.8	42	34	2.5
7	U/S of Shivaji Bridge near Amriteshwar Ghat	7.59	-	118	348	184	7.2	31	54	5.28
8	U/S of Dengale Bridge	7.72	3.36	28.5	64	44	3.6	39	30	1.66
9	U/S of Sangam	7.77	3.03	9.8	28	18	2	40	32	1.84
10	U/S of Wellesy Bridge	7.72	3.45	22.8	68	12	1.6	42	42	1.7

Table 7.4: Water Quality of Mula- Mutha Rivers

Studies done by M.Hooda, A. Sukhatankar, R. Menon, J. Vokkalkar and A. Mirande during (1991-1992) on the pollution Status of River Pavana in its Pimpri Chinchwad Municipal Corporation stretch concluded the following results:

1) The stretch of river under study falls under the CLASS III, that is the river water has condirable potential for further use if cleaned up.
2) The major polluting sources of the river are Kalewadi Nalla and Thergaon Nalla and the pollutants discharged by them have been analysed to be of industrial origin.
3) The demographic and industrial growth statics show tremendous growth by the year 2001. This will lead to further decline in river water quality.
4) The river water on the entire stretch that is from Thergaon wier (Big) is not suitable for drinking purpose. Hence under no circumstances should the water be used for drinking in this stretch.

Chapter-8

7. The Tapi Basin

Tapi is the largest west following river of Maharashtra. About 80% of its catchment falls within the administrative boundaries of the state. One of its main tributary from the left bank, river Purna maintains similar westward orientation like Tapi. Other major tributaries of the river Tapi from the left bank are Waghur, Girna, Panjra and Burai.

The Tapi drains through parts of Amravati, Akola, Buldana, Jalgaon and Dhulia Districts. These cities are famous for industries and are important trade centers. As in recent years population has increased, and so have industries. Most of the domestic wastes and industrial wastes were found to be discharged into the water with partial or no treatment these pollute the water and have adverse effect on the aquatic flora and fauna

1. Work done by the C.P.C.B. (1995) on the Tapi River water quality shows that BOD values indicated that the water quality of the river deteriorated at Ajnand Village, Bhusaval and Kathore and at the remaining stations, the water quality was relatively good during the years 1990, 1996 and 1999.

2. Studies carried out by the M.P.C.B. (2002-2003) on the Tapi river on parameters such as $_PH$, BO, COD and DO shows the folling results;

Table 8.1: Water analysis of Tapi river

Sr.No.	Monitoring Station	PH	BOD	COD	DO
1	Ubad Village (M)	8.18	5.89	24	6.5
2	Bhusawal (M)	8.3	5.24	21.3	6.27
3	Ajanad Village (M)	8.44	5.63	23.2	6.18
4	Sarangkheda, Jalgaon	8.35	5.5	16	4.9
5	Bhusawal Intake,	8.2	5.3	19	6.2

3. Work done by J.Jagtap, B. Kachawe, L.Deshpande and P.Kelkar on the water quality of Purna river for irrigation purpose was monitored at various locations along 78 km stretch upstream and downstream, from Jigaon dam in Buldana district. The assessment was carried out during pre-monsoon, monsoon and post- monsoon seasons. The results indicate higher concentrations of certain ions during pre- monsoon and post – monsoon seasons which may attribute to seepage of ground water from aquifer to surface water body. The sodium percentage in the study area ranges between 35-62%, 28-39 % and 45-76% of the surface water during pre-monsoon season, monsoon and post-monsoon respectively. From the studies it was concluded by the author that the water samples collected form the study area are within the permissible limits for irrigation purpose.

3. Studies conducted by M.R. Kumanat, on the Aner River, which is an important tributary of River Tapi. It joins Tapi near Ghodgaon village. A Dam was constructed for irrigation purpose for Tehasil Shirpur and Tehasil Chopda. Three stations were selected on the river and three stations were selected on the dam. Physico-chemical and algal analysis of the water was done monthly. The water pollution tolerant genera and species were recorded from 3 stations of Aner dam and river. As by the Palmer's pollution index number, the total score of all the three stations of the dam and the river was greater than 20 confirming high level of organic pollution. It was also seen that the river was much contaminated or polluted than that of dam due to the disturbance and contamination from human activities at the site.

Chapter-9

9. Other Rivers

Kalu River

G. N. Mhatre, S. B. Chaphekar, I. V. Ramani Rao, M. R. Patil and B. C. Haldar (1979). The Kalu is a small river originating in the Western Ghats which, after flowing westwards for about 80 km, receives another small river-the Bhatsai-and later meets the Ulhas river near Kalyan, an industrial suburb of Bombay. It receives effluents from" more than 150 industrial units before it meets the Arabian Sea. In the study area 6 sites were taken for the analysis.

Table 9.1 a: Water Quality of the River Kalu, sampled during March – May 1978

Parameters	Ambivali	Titwala
Colour	Colourless to Pink	Colourless
pH Range	2.7 – 7.0	6.1 – 6.3
Salinity (Cl^- g/L)	1.0 – 4.6	4.1 – 4.5
Heavy metals in water		
Hg	0.0001– 0.006	0.0006 – 0.005
Pb	0.08 – 0.69	0.25 – 0.50
Cd	0.01 – 0.86	0.017 – 0.07
Cu	0.01 – 0.12	0.0 – 0.31

Table 9.1 b : Heavy metal content in Sediment, and Plant species in the Kalu river ecosystem

Plants	Concentration of metals in (µg/g)	
	Ambivali	Titwala
Heavy metals in sediment		
Hg	1.5 – 140	39.0 – 52.0
Pb	5.4 – 10.6	3.8 – 4.4
Cd	0.62 – 12.6	0.42 – 6.8
Cu	91.0 – 864	78.0 – 89.0

Pycreus macrostachyos		
Hg	3.3 – 110	1.4
Pb	100	3.0
Cd	2.5 – 10.0	2.5
Cu	9.0 – 26.4	23.0

Studies carried out along the banks of the Kalu river estuary at Ambivali and Titwala revealed that the river was polluted at both sites. The intensity of pollution was greater at Ambivali due to the presence of industries in that area whereas no industries existed at Titwala. Pollution at Titwala was due to the diurnal tidal action. The fauna studied also had accumulations of metals such as Hg, Pb, Cd and Cu.

In another studies carried out by S.A.Salgare and R.N. Acharekar on the effect of industrial pollution on the plants growing near Kalu river. The effluents are dumped into this river. To detect the toxic effects of polluted water of Kalu river on the content of amino acids of its vegetation, 10 weeds were collected from the 2 sites of Kalu river. The studies showed that the industrial pollution at Kalu river inhibited the content of the 3 amino acids studied *viz.* arginine, glutamic acid, valine. Industrial pollution at the Kalu river caused maximum inhibition in the content of glutamic acid (40.65%) and in valine (44.83%).

In similar studies it was seen that the The studies concluded that the Industrial pollution at Kalu river inhibited the content of all the 3 minerals; sodium, calcium and magnesium in all the 3 weeds; *Celosia argentea, Corchorus capsularis, Corchorus olitorius* . It was pointed out that very high percentage of inhibition in the content of all the 3 minerals in all the 3 weeds investigated was recorded in the collections made from Ambivali than Titwala.

Patalganga River

Work carried out by M.P.C.B (2002-2003) on various parameters of Patalganga river shows the following results;

Table 9.2: Water analysis of Patalganga river

Sr.No.	Monitoring Station	PH	BOD	COD	DO
1	MIDC Water Works	7.3	5.79	20.4	6.53
2	Shiphata Bridge (M), Raigad	7.35	6.39	20.8	6.33
3	Gagangiri Maharaj Temple,	7.2	4.8	16	6.1
4	Savroli, Raigad	7.17	5.26	22.1	5.43
5	Vayal Pump House, Raigad	7.15	5.08	21.8	6.02
6	Kharpade (Saline Zone),	7.12	12.18	44.31	4.28

Study carried out by Ingle, S. and Suryawanshi, S. A. (1991) on the Bivalve, Lamellidens corrianus (Lea) with reference to Patalganga River Pollution. The river is being used as a source of public water supply for drinking, agricultural and irrigation purposes. The major sources of pollution were: Sullage and sewage from Khopoli township, Khalapur, other villages on the bank of the river. Effluents from the industries located at upstream of Khopoli and other industries between Khopoli and Turade. Washing of tankers containing chemicals at Shilphata and Lohop and domestic discharges along the stretch of the river.

The D.O. ranged 2.6 to 9.0 mg/l. CO_2 ranged between 0.0 to 15.0 mg/l. The B.O.D ranged between 1.6 to 4.8 mg/l. Silicates content showed very less variation at the sampling stations and ranged between 1.2 to 7.8 mg/l. Comparatively low levels of Nitrates were recorded throughout the study. It ranged from 0.1 to 8.4 μg/l. Phosphates ranged from 0.12 to 0.55μg/l. Cadmium levels ranged from ND to 4.0 μg/l in water and ND to 0.43 μg/g in the sediments. Fe and Mn showed the highest levels of 278 μg/l & 125 μg/l in the water and 2095 μg/g & 440.9 μg/g in the sediments respectively. Concentration of other metals in water were Co ND – 10 μg/L, Cu 1 – 350 μg/L, Ni 3.5 - 25 μg/L, Pb ND – 100 μg/L and Zn 3 – 130 μg/L. The concentrations of these metals in the sediment were found to be Co 8 – 64 μg/g, Cu 14 – 104 μg/g, Ni 7 – 193 μg/g, Pb 13 – 67 μg/g and Zn 24 – 204 μg/g.

Work done by T. Chakrabarti, T.K.Ghosh, A.Chanorkar, L.M.Sangolkar (2003) on Patalganga river. The physico-chemical, microbiological and biological parameters show that the pH of the river water varied between 7.6 t0 8.18 during summer season while in winter it ranged from 7.05 to 7.97.

The DO was less than 4 mg/ l at 5 sampling stations and at one of the sampling station it was below3 mg/l during summer indicating stress condition for major biological forms. While in winter DO was favourable to aquatic organisms. Fairly high BOD and COD values were recorded at all stations. This suggests pollution from the industrial discharges. Presence of fecal coliform and *E. coli* indicated fresh sewage pollution. Chlorophyceae and cyanophyceae were most dominant throughout the river stretch. Presence *of Tabellaria, Chlorella* and *Oscillatoria* indicated organic pollution in river. There was also reduction in the number of fish population.

Industrial areas of western India.

For this study MIDC-Thane area have been selected. The area has many industries such as chemical industry, textile, dyeing and printing, electroplating, pulp and paper, refineries, sugar factories and distillery industries. In such industries different processes and sub-process like bating, pickling, tanning, dyeing and fat liquoring causes water pollution. 15 water samples were analysed from this industrial area.

Table 9.3: Physico - Chemical parameter of industrial waste

Parameters	**Thane MIDC**
Physical	
Total Solids	2629
T.D.S	2516.5
T.S.S	137.5
Chemical	
Cl	62.41
So	2438
Alkalinity	200
Acidity	75
Hardness	840
COD	2460
Nitrate	10.5
Phosphorous	6.55

Pili River

Studies done by T. Chakrabarti and T.K.Ghosh on the physico-chemical and biological parameters of six stations on Pili river, in Nagpur indicated that station 1 showed DO value 9.5 mg/l and S5 and S6 measured 1.0 mg/l and 0.1 mg/l during winter and summer seasons respectively. Variation in pH was within 7. and 8.12 indicating slight alkaline conditions which favour aquatic growth. The COD and BOD values were below 250 and 120 mg/l respectively. The presence of high values of COD and BOD at station S6 indicates that the river receives a high quantity of organic and inorganic wastes from industries and households nearby. High conentration of phytoplankton was noticed in summer while the reverse occurred in case of zooplankton which tend to decrease in summer at most of the stations. The presence of fecal coliform at all the six stations indicated that the water was unfit for drinking without treatment.

Survey of Nag and Pili Rivers in Nagpur, Maharashtra (1999)

The Nag and Pili Rivers were studied by N.N. Rao, A. U. Mahajan, T. Nandy & S. N. Kaul that originate in the western catchment areas of Nagpur city flow towards east of the city. Water reservoirs that feed these rivers Nag and Pili are Ambazari lake and Gorewada lake, respectively. Throughout their course traveling around 16 and 19 km for Nag and Pili rivers, respectively within the municipal limits. In the recent years due to insufficient overflow of water and release of all sewerage and other domestic waste into these rivers, especially Nag river, is refered to as 'open sewers' presenting aesthetically unpleasant look, emanate malodor, and pose a great health risk.

A survey study was performed under Ministry of Environment & Forests, Government of India, funded project.

Findings

- Ambazari and Gorewada lakes are the source of fresh water to rivers Nag and Pili, respectively. The physico-chemical characteristics of water samples from both these lakes conform to CPCB criteria for classification of Inland Surface Water and IS 2296:1982 under Class D
- The Shannon Wiener diversity index of Ambazari lake is 2.7 indicating mesotrophic status, while the diversity index of Gorewada lake is 3.7 indicating oligotrophic status a cleaner condition of the lake
- The freshwater inflow in Nag river occurs whenever there is an overflow from Ambazari lake

- The BOD and COD concentrations in Nag river water samples varies from 82 to 295 mg/L and 162 to 560 mg/L, respectively. The BOD and COD concentrations in Nag river are comparable with raw sewage characteristics of selected cities in India
- The dissolved oxygen concentration in Nag river is nil. The fecal coliforms (FC) concentration in Nag river water sample were higher compared to the FC concentrations in sewage of Gandhinagar, Bhilai and Baroda cities
- Concentration of BOD, COD and fecal coliforms counts in Nag river virtually indicate that raw sewage is flowing in Nag river
- Flow in Nag river is 175.4 mld. This constitutes 174.9 mld domestic wastewater and 0.492 mld industrial wastewaters and there is no fresh water entering in Nag river
- In Pili river there is perennial fresh water inflow due to overflow of excess water from Gorewada lake
- A total of 118.36 mld water flow in Pili river. This constitutes 12.96 mld fresh water, 105.35 mld domestic wastewater and 0.0435 mld industrial wastewater
- The maximum observed DO at the origin of Pili river is 6.6 mg/L which gradually decreases to 0.1 mg/L before confluence with Nag river
- The concentration of BOD increases from 5 mg/L to 70 mg/L and COD from 57.5 mg/L to 217 mg/L. This indicates gradual degradation of river on its course
- Unlike Nag river, Pili river is not fully urban river as the northern part of its catchment area is not inhabited
- The measured quantity of domestic wastewater in both Nag and Pili rivers is 285.25 mld which is 74.7% of total water supply of 382 mld to Nagpur city
- The total flow in Nag river is 175.40 mld and in Pili river is 118.36 mld. Out of which 72.56 ml is pumped from Nag river for irrigation and 221.2 mld of water flows down after confluence in the river
- Five groups of zooplanktons were recorded in Nag river and eight groups were recorded in Pili river
- Structure of vegetation along the Nag river indicate dominance of wasteland species.

Table 9.4 : Sampling Locations in Pili River

Sampling Location	Description	**Approximate Distance from Gorewada lake, Km.**
1.	Gorewada lake	0
2.	500 m d/s Gorewada Lake	0.5
3.	Jaffar nagar	3.5
4.	Koradi road corssing	5.0
5.	Jaripatka	7.0
6.	Kamptee road crossing	12.0
7.	Kalmna Basti	17.0
8.	100 m u/s confluence point at Pawangaon	19.0

Table 9.5 : Sampling Locations in Nag River

Sampling Location	**Description**	**Approximate Distance from Ambazari lake, Km.**
1.	Ambazari lake	0
2.	Inside VRCE Campus	1.0
3.	Behind University Girls Hostel	1.5
4.	Behind Shankarnagar Post Office	2.0
5.	Ramdaspeth (behind NIT Chairman's Bunglow)	2.75
6.	Ramdaspeth (near University Library)	3.25
7.	Dhantoli (u/s Dagadi Pool)	4.50
8.	Imamwada bridge	5.25
9.	Samrat Ashok square	7.25
10.	Bhola Ganesh square	8.50
11.	Hivarinagar bridge	10.00
12.	Bhandara road bridge	12.75
13.	Bharatwada bridge (u/s confluence point)	15.75
14.	Pawangaon d/s of confluence point	16.25

Sonvad Dam and Devbhane Dam of Dhule.

Investigation were done by S.N.Nandan & D.S.Jain to examine the water quality of Sonvad Project Dam & Devbhane Dam of Dhule District of Maharashtra. Algal and water samples of Sonvad Project Dam and Devbhane Dam were collected at monthly intervals from 3 different stations from February 2000 to January 2002 In total of Composition of 4 groups of algae 196 taxa were recorded belonging 55 genera at 3 station of sonvad dam & 178 taxa of 59 genera of devebhane dam of Dhule. The most pollution tolerant species were found in stations of Sonvad dam and 3 stations of Devbhane dam.

Panzara Dam and River Pimpalner, Dist- Dhule

The above area was studied by Dr. Y.S.More and Dr.S.N.Nandan. The investigation carried out the limnology of Panzara Dam and river of Pimpalner, Dist- Dhule.Three stations of Dam DSI, DSII, DSIII and three station of river RSI, RSII and RSIII were selected for the study from Jan.1994 to Dec.1995. Panzera river is a tributary of river Tapti. Algal and water samples were collected at monthly intervals from dam & river stations. from boths the sites more than 300 algal taxa were recorded from four groups of algae (Chlorophyceae, Cyanophyceae, Bacillariophyceae & Euglenophyceae. It was proved that the river water is organically polluted in increasing order from RSI, to RSIII In the present investigation population of Cyanophyceae & Chlorophyceae was dominant than other algal groups in river. The 4 groups population of algae was less in the dam as compare to the river sites. Physico-chemical parameters and multifactorial correlations were studied by statistical methods. It was concluded that dam water sites were not more polluted than that of river sites, which is supported by all indices.

Chapter-10

10. Lakes

Dhom reservoir

Dhom reservoir acquires special significance as it falls under a very sparsely inhabited area and the human activity is very low. The water of this reservoir is also used for drinking. R.K. Trivedy, (1995) worked on assessing the conditions and showed the level of dissolved oxygen content (5.6 to 12.2 mg./l) also indicates the same fact. Values of COD were usually below 20 mg/l. Ammonia content in polluted water bodies is usually above 1.0 mg/L. in the Dhom reservoir most of the values were below 0.4 mg/ l. Calcium, Sodium, Potassium and magnesium content was low. However, the higher concentration of nitrogen and phosphorus is of concern. Higher chloride content (3.52 to 71.0 mg/l) and most probable number of coliforms (4 to 63/100 ml) also indicates towards mild fecal pollution of the reservoir. However, the water quality of this reservoir is suitable for drinking and water can be used directly after chlorination. The phytoplankton composition of the reservoir indicates that water of this reservoir is slowly getting mesotrophic.

Lentic water resources in Southwestern Maharashtra: Sudies by Trivedy, et al (1988) on the quality of lentic water esources in South western Maharashtra reveals that only one waterbody, Koyna can be classified as oligotrophic by all chemical and biological classifications. Waterbodies like, Radhanagri, Dhom, Kas, Medha, Nahavi, Kadegaon are oligotrophic or mesotrophic according to the schemes based on chemical parameters.

It was seen that the water bodies showing oligotrophy or mesotrophy by chemically oriented systems, infact, have become mesoeutrophic or eutro-phic as indicated by biological parameters. Studies show that total concentration of phytoplankton is a reasonably good indicator of trophic status of water body. Among the various algal groups, an overabundance of diatoms certainly indicates clean conditions, but both Chlorophyceae and Cyanophyceae were dominant in a highly polluted water body. The freshwater lakes and reservoirs in the South-western Maharashtra are under threat and are showing signs of gross deterioration. Immediate conservation measures and reconsideration in utilization strategy is required if these water bodies are to be saved for posterity.

Lakes of Satara and Kolhapur

In a study by Khatavkar, (1990) worked on the phytoplankton composition of four water bodies in Satara and Kolhapur districts of southwestern Maharashtra was carried out to assess their pollution level. Presence of several pollution tolerant species such as *Closterium. Cosmarium. Scenedesmus, Pandorina, Anabaena, Microcystis, Oscillaloria, Navicula, Nitzschia, Euglena, Phacus and Lipodndis* revealed the high pollution levels in these water bodies. In another work done by Khatavkar and Trivedy (1995) on four man-made reservoirs in South Western Maharashtra and fall in the two districts - Satara and Kolhapur. Two water bodies Lake Rankala and Ambedkar Tank were situated in Kolhapur. Shambhu lake is situated at Shingnapur and Yamai at Aundh which falls in Satara district. Out of four water bodies two viz Shambhu and Rankala mainly used for drinking water supply and other two Yamai and Ambedkar Tank are used for irrigation and other purposes. Shambhu lake is apparently free from Pollution.

Lakes in Kolhapur

Five lakes in Kolhapur were studied by Trivedy (1983) on such as: Rankala, Rajaram, Kalamba, Kotteerth and Residency. All water bodies contain high quantities of nutrients and turned eutrophic. Abundance of cyanophycean phytoplankton and the occurrence of thick water blooms confirmed their eutrophic status. Only one lake was subjected to least humun activity wand was least polluted indicated by low nutrient content, phytoplankton density and distinct phytoplankton composition. There was alarming deterioration of quality of freshwaters in Kolhapur city.

Lakes of Satara

Investigations done by Kulkarni (1988) on physico – chemical characteristics of two freshwater bodies situated at Aundh in Satara district of Maharashtra. Monthly observations show that these two water bodies have become highly eutrophic due to diverse human activities like cloth washing, bathing and entry of agricultural run - off. Considerable quantities of nitrogen and phosphorus are found in detritus and living biomass.

Chatri Lake in the Vicinity of Amravati City

The study was carried out by U. S. Chaudhari, Seema Johari and P. R. Chaudhari (1997) on the Chatri lake which is situated away from the busy city. It has a catchment of 9076 sq.km.

This lake was once used for drinking water purpose. Since 'Upper Wardha Project' came into existence the lake water is not used for drinking purpose. The present situation is such that, the lake water is receding and becomes shallow due to heavy sedimentation. It appeared from the observations that low sodium and potassium content and reduction of photic zone due to high turbidity resulted in low phytoplankton density in the lake. Thus lake is oligotrophic in nature. Increased chlorides in water might be due to feacal matter of animal who came to the lake daily in large number for drinking and grazing. As the lake is not polluted by domestic wastewater increasing chloride content probably may be due to the feacal released in lake. Manganese contents were quite due to low algal growth and macrophytes.

From the above results, it appears that, due to high turbidity the lake does not have any submerged flora and less diversified biota. Hence, the lake is oligotrophic with poor nutrient content and less algal growth. Another reason is due to low input of organic nutrients from external sources.

Table 10.1: Physico-chemical parameters of Chatri Lake.

Sr. No	Prameters	Months			
		February	March	April	May
01.	pH	8.55	7.91	7.68	9.85
02.	Temperature in "C	20.90	29.12	29.16	29.30
03.	Do in mg/L	12.19	3.05	8.08	3.80
04.	Bod in mg/L	3.55	4.63	24.08	4.70
05.	Total dissolved solids in mg/L	40.00	64.00	40.00	80.00
06.	Turbidity in NTU	49.84	67.96	49.46	84.50
07.	Total alkalinity as CaCO, in mg/L	1393.00	500.00	345.00	1815.00
O8.	Bicarbonate alkalinity as CaCo, in	920.00	250.00	345.00	766.00
09.	Carbonate alkalinity as CoCo, in mg/L	320.00	250.00	00.00	908.00
10.	Hydroxide alkainity as CoCo, in mg/L	153.00	00.00	00.00	141.00
11.	Chlorides in mg/L	37.57	28.61	17.47	32.14

12.	Suphates in mg/L	2.41	2.25	1.64	1.03
13.	Manganese in mg/L	0.06	0.06	1.10	0.23
14.	Soidum in mg/L	0.00	0.00	1.12	1.80
15.	Potassium in mg/L	0.89	1.10	2.24	3.91
16.	Salinity in mg/L	37.60	28.64	17.50	32.17
17.	Nitrate in mg/L	0.31	0.35	0.37	1.16
18.	Total Phosphorus in mg/L	0.79	0.73	0.96	1.24
19.	Inorganic phosphorus in mg/L	0.47	0.44	0.52	0.28
20.	Organic Phosphorus in mg/L	0.32	0.29	0.44	0.96
21.	Free CO, in mg/L	2.20	2.24	4.99	5.62
22.	Chlorophyil-a in mg/m^1	0.01	0.01	0.09	0.06

Urban Ecosystem- A Case Study of the City of Thane.

Studies conducted by T. Chandrashekhar (1999) on Thane City for his Ph. D. Thesis. He studied the phyisco-chemical parameters of the lakes of the city. The result is as follows

Table 10.2: Lakes of Thane City

Parameters	Khidkali Lake	Kacharali Lake	Kharegoan Lake	Abhiruchi Lake	Makhmali Lake	Jail Lake	Upvan Lake	Balkum Lake	Railadevi Lake	Masunda Lake	Lake	Kausa Lake	Brahmala Lake	Naar Lake
DO mg/l	6.5	7.03	6.17	5.83	5.77	5.17	4.57	6.5	6.53	5.5	1.1	1.5	4.27	4.23
BOD mg/l	13.7	4.44	15.3	12.7	8.67	18.7	15.3	12.7	6.83	14	47.3	22.7	26.3	50.7
COD mg/l	48	19	35	37	12	44.3	36	31.7	12.3	33	137	75.7	130	197
Mn mg/l	0.1	0.5	0	0	0	0	0.36	0.9	0	0	0	0.48	0.42	0.12
Cu mg/l	0.02	0.61	0	0.78	0.55	0.11	0.13	0.01	0.02	0	0	0	0.02	0.08
Zn mg/l	0.9	0.07	0	0.08	0.15	0.05	0.1	0.94	0	0.1	0.1	0.17	0.11	0.07
Mg mg/l	12.3	13.7	25	23.7	20	8.1	11.7	14.1	18.7	12	26.4	19	18.8	23
Cd mg/l	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pd mg/l	0.08	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphate mg/l	3.7	1.67	2.72	4.03	0.69	4.17	3	3.17	1.5	2.2	5.5	5.17	12.1	15
Nitrate mg/l	0.2	0.08	0.1	0.22	0.19	0.09	0.04	0.3	0.17	0.4	0.25	0.15	0.07	0.05
Sulphate mg/l	65	27.7	78	61.7	83	62.7	86	118	164	127	94	95	108	99.3

From his studies, he concluded that all the lakes are in different stages of degradation mainly due to the lack of maintenance and misuse of the water bodies. All the lakes are eutrophicated. None of them is good for drinking or domestic use. The quality has deteriorated due to the uncontrolled entry of domestic waste coming from the surrounding areas. Immersion of Ganesh Idols during the festivals, washing of animals, clothes, vehicles and solid waste are dumped which lead to such condition of the lakes.

Pashan Lake

Lake Pashan within Pune urban area has been extensively studied. As early as 1980 Pingle analysed physico-chemical and biological parameters. He showed diversity in phytoplankton and oligotrophic nature of water with exception of mesotrophic in summer and along littoral zone. Then, after 18 years Dr. (Mrs.) Khanhere took detail survey in view of changing catchment area. She studied various key parameters to assess the changing quality of water. The lake showed increasing growth of macrophytes both rooted and floating, common algal blooms. Biological Index showed lake becoming eutrophic due to increasing inflow of waste and deposition of soil and other debris. Now, this lake has been dewatered to remove the deposited sediments with an aim to restore it. There are number of M.Sc. Project on this lake due to its position and being an urban water body.

Lodhe Water Reservoir From Tasgaon Tahsil

Studies carried out by Khabade S.A., Mule M.B. and Sathe S.S. (2000) on Lodhe Reservoir where they analysed the Physico- Chemical Parameters of Lodhe water monthly during July 1999 to June 2000 from 2 sites: Site I (S-I) which lies near the dam's earthen embankments and Site II (S-II) is near the feeders canal which recharge the reservoirs water.

The Lodhe Reservoir is man made the local people use the water for various purposes such as domestic use, agriculture and culture etc. Presently in the upper catchment area farmers are practicing grape cultivation, floriculture, etc. in the vicinity.

In future there is threat of contamination of Lodhe water reservoir from the surface runoff of used fertilizers and pesticides.

The results revealed that there were significant seasonal variation in some physico – Chemical parameters and found that they are in the normal range indicating better quality water resource.

Table 10.3: Physico- Chemical Parameters of Lodhe Reservoir.

	Site	
Parameters	**S1**	**S2**
pH	8.4	8.3
Electrical Conductivity	0.489	0.501
Total Alkalinity	324.3	310.1
Hardness	196	207.5
Magnesium	23.2	21.9
Calcium	42.32	43.4
Chlorides	36.7	36.7
Residual chlorine	Absent	Absent
DO	8.79	8.98
Free CO_2	Absent	Absent
Hydrogen Sulphide (H_2S)	0.57	0.572
Total Solids	541.19	502.2

Values are given in mg/l, E.C in µmhos/cm and pH

Dr. Salim Ali Sarovar (Delhi Gate Lake).

The studies were carried out by Dr. Jayashree Deshpande (2001). The lake is situated in the foothills of “Manju Hills” near “ Delhi Darwaja” of Aurangabad. This lake that was once measuring 52 hectares now has shrunk to 20 hectares because of urbanization and lack of proper management. The lake water is getting polluted because of the release of sewage from CIDCO area, human activities, cattle washing and grazing etc.

The lake was divided into east and west zones to study its physico- chemical and phytoplankton studies.

In the East and West zone CO_2 ranged from 3.8 to9.2. The BOD in the East zone was from 14 to 60, while in the West zone it was from 15 to 68. The COD was ranging from 154 to 280 in the East zone while in the West zone it was ranging from 150 to 282. In the East zone range of Chlorides was 35 to 218, Sulphate: 120 to 190, Phosphate: 3.8 to7.2 and Nitrate 0.06 to 0.70 and in the West zone range of Chlorides was 42 to 295, Sulphate: 128 to 248, Phosphate: 4.0 to 9.8 and Nitrate 0.02 to 0.60. All the year around the East zone had a fishy odour while in the West Zone it had grassy and muddy odour.

Hartala Lake of Jalgaon District

In the investigations done by S.N. Nandan and S.R. Mahajan (2000) on the physico-chemical data of water of Hartala Lake located near the village Hartala of Taluka Muktainagar of Jalgaon. Palmer's pollution indices were calculated for assessing the organic pollution of the lake. At all stations of Hartala lake 32 pollution tolerant species of algae wee recorded and these were responsible for the development of detectable odour in water.

The Hartala lake supported growth fishes, crab, bivalves which were unfit for human consumption yet were eaten by people from Muktainagar, Varangaon, Bhusawal and Jalgaon city. Three stations were under quantitative and qualitative study of 4 groups of algae along with the physico-chemical analysis. The results of which are in the following table:

Table 10.4: Physico- Chemical Parameters of Hartala lake.

Paramters	**Station H-I**	**Station H-II**	**Station H-III**
Odour	Fishy	Fishy	Fishy
Temperature	28.67	25.75	26.75
Free CO2	65.8	52.24	43.38
Dissolved 02	11.83	11.97	13.23
Bicarbonate	251	250	241.7
Total Alkalinity	251	250	250
Calcium	29.48	29.58	29.82
Magnesium	11.25	11.68	11.08
Hardness	119.75	121.65	120
Chloride	21.17	29.59	20.35
Phosphate	0.16	0.16	0.15
Nitrate	3.77	2.32	1.9
Total Solids	3099	1580	1572
PH	7.89	7.91	8.08
Palmer's Pollution index	38	36	33

Hartala and Velhala lake

Investigations done by S.R.Mahajan and S.N.Nandan on Hartala and Velhala lake of Jalgaon district shows that both the lakes are polluted using algae as indicators.The Hartala lake is located near the village Hartala while Velhala lake is located near village Velhala of Bhusawal taluka Dist-Jalgaon. The samples of water and algae were collected at monthly intervals from 3 stations each of Hartala and Velhala Lake and analysed for physico-chemical parameters. From the studies 32 pollution tolerant species of algae from 3 stations of Hartala lake and 23 pollution tolerant species of algae from 3 stations of Velhala lake were observed. Pollution index of algal genera (Palmer, 1969) at stations of Hartaia Lake and stations of Velhala Lake was calculated.

Panshet and Ujani

CWPRS undertook pilot study on two reservoir, one in the upstream reaches of Bhima river basin in Maharashtra state, viz. Panshet and other in the lower reach viz. Ujani The study on dynamics of aeration of water discharged from lower level outlets of dams would also be useful to know the actual DO status of waters and its potential to get rejuvenated when discharged downstream. A three dimensional mathematical model was developed and calibrated with the help of extensive water quality data collected over different seasons in the two reservoirs. The observed water qualities of these two reservoirs speak about the cumulative effect of surrounding geology, land use pattern and over all nature of waste that they receive. The biodiversity and growth of aquatic flora and fauna found in Ujani reservoir would help in clearing fear about rapid deterioration of water quality in downstream reservoirs. However, the study indicated need for timely action for preventing and controlling untreated disposal from point non-point sources to avoid further deterioration.

Ujani wetland

A study done by Ms. Pooja Kanwar under the guidance of Prof.Dr R. Jagdale on the Ujani wetland, which is a man- made wetland and is amongst the 16 wetlands, the Government of India has chosen it for immediate conservation. The backwater of Ujani is a huge shallow expanse harboring number of migratory species of birds. It has high diversity and hence high conservation value. This wetland is a part of Upper Bhima Basin. The most important part of bird habitat is located near Bhiwan a small town located 100 kms from Pune on the Pune- Solapur National Highway.

Based on the habitat suitability studies and assessment of impacts of various parameters, for increasing the suitability of the habitat for flamingoes authors strongly recommend the following :

1. The region through which the road goes is the most suitable habitat for flamingoes. To ban use of submerged road .

2.Creation of protected islands near Kumbhargao region.

3.Control on cattle grazing in draw-down area.

4.Regulation of fishing activity.

5.No new pumping stations to be allowed in the suitable habitat.

6. Restriction on the agriculture during draw-down period in the sensitive zone.

7.Control the growth of aquatic marcophytes.

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