CONSERVATION PLAN FOR GODAVARI RIVER

A DISSERTATION

Submitted in partial fulfillment of the requirements for the award of the degree

of

MASTER OF TECHNOLOGY

in

CONSERVATION OF RIVER AND LAKES

By

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CANDIDATE DECLARATION

I hereby certify that the work which is being presented in this dissertation, entitled "**CONSERVATION PLAN FOR GODAVARI RIVER**", in partial fulfillment of the requirement for the award of the degree of master of technology in "**CONSERVATION OF RIVERS AND LAKES**", Submitted in **Alternate Hydro Energy Centre, Indian Institute of Technology Roorkee** is an authentic record of my own work carried out during the period from July 2009 to June 2010 under the supervision of **Dr. D.K. Srivastava, Professor, Department of Hydrology and Dr. Sunil Kumar Singal, Senior Scientific officer, Alternate Hydro Energy Centre, Indian Institute of Technology Roorkee.**

I have not submitted the matter embodied in this dissertation for award of any other degree.

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ABSTRACT

Godavari is the second largest river in India and referred as the Vriddh (Old) Ganga or the Dakshin (South) Ganga. Godavari is one of the most sacred rivers of India. Pollution in this peninsular river is fast reaching to unsafe levels. The Godavari originates near Triambak in the Nasik district of Maharashtra, and flows through the states of Madhya Pradesh, Karnataka, Orissa and Andhra Pradesh. Although its point of origin is just 380 kms away from the Arabian Sea, it journeys 1,465 kms. to fall into the Bay of Bengal. Some of its tributaries include Indravati, Manjira, Bindusara and Sarbari. Some important urban centers on its banks include Nasik, Aurangabad, Nagpur, Nizamabad, Rajahmundry, and Balaghat.

Rivers are under increasing stress due to urbanization and other anthropogenic activities, leading to their over exploitation and degradation. Like most other rivers, domestic pollution is the biggest polluter of the river Godavari, accounting for 82 per cent of total pollution, whereas industrial pollution accounts for about 18 percent. The present study covers all the aspects that are related with the conservation of the Godavari River i.e. water quality monitoring, watershed management, public participation and awareness.

The study covers about 213 kms area of the river Godavari which includes Nasik and Aurangabad city. At Nasik city about 7 stations are identified to know the polluting strength and according to that the conservation measures are done on the River. The Sampling point locatons are Gangapur Dam, Chikhali Nall, Someshwar temple, Ramkund, Goda-kapila sangam, D/s of Nasik city and Saikheda village. Also at Aurangabad 6 sampling stations namely; Kaigaon Toka, Jaikwadi Dam, U/s of Paithan, D/s of Paithan, Wadwali village and Shahagad were identified to know the pollution strength of the River. The samples were collected and analyzed for evaluating the physical, chemical and Biological parameters in the environmental laboratory of Maharashtra Pollution Control Board (MPCB), Nasik and Aurangabad. The data taken from the field as well as the data collected from the Central Pollution Control Board were used to compute the National Sanitation Foundation Water quality Index (NSFWQI), which is mostly applicable parameter in USA and India. The results of the NSFWQI of Godavari River indicate that its water quality is bad -Medium over the stretch considered. Based on the results, the

existing conservation measures have been reviewed and additional measures are suggested. The study concludes that major cause of pollution is industrial effluents and domestic pollution.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS AND NOTATIONS

AHEC	Alternate Hydro Energy Centre
AM	Annual Maintenance
ASP	Activated Sludge Process
BOD	Biochemical Oxygen Demand
C	Centigrade
CPCB	Central Pollution Control Board
CPHEEO	Central Public and Health Environmental Engineering Organisation
COD	Chemical Oxygen Demand
TVS	Total Volatile Solids
CO_2	Carbon dioxide
DO	Dissolved Oxygen
EB	Electricity Bill
EIA	Environmental Impact Assessment
FAB	Fluidized Aerobic Bed
FC	Feacal Coliform
FPU	Final Polishing Unit
GOI	Government of India
ha	Hectares
HP	Horse Power
HRT	Hydraulic Retention Time
IITR	Indian Institute of Technology, Roorkee
km	kilometer
lpcd	Liters per capita per day
FAB	Fluidized Aerobic Bed

LCC	Life Cycle Cost
LCCA	Life Cycle Cost Analysis
mg/l	Milligram per liter
MoEF	Ministry of Environment and Forest
MPN	Most Probable Number
ml	Milli liter
MLD	Million Liter per Day
MLSS	Mixed Liquor Suspended Solids
NRCD	National River Conservation Directorate
NPV	Net Present Value
OHT	Over Head Tank
O&M	Operation and Maintenance
PLC	Programmable Logic Controller
ROI	Return On Investment
Rs.	Rupees
SBR	Sequencing Batch Reactor
SS	Suspended Solids
STP	Sewage Treatment Plant
SVI	Sludge Volume Index
sqft	Square Feet
sqm	Square meter
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
UASB	Upflow Anaerobic Sludge Blanket
UNEP	United Nations Environment Programme
WHO	World Health Organization
WSP	Waste Stabilization Pond

CHAPTER NO.1

INTRODUCTION

1.1 GENERAL:

It is well known that about 2.5% of water resources available on this Planet 'Earth' are potable and remaining 97.5% is sea water. If we remove water in the form of icebergs on North and South Poles, hardly 0.26% water is available for human being, irrigation and industrial use. This is true for past thousands of years and future thousands of years. The quantum of water is fixed but the population /industrial demands are not! Therefore the efficient water resources management and storing / diverting available water resource are the need of the day. The construction of various structures for storages of water as and when required in and/ for isolated pockets, without planning, is the most undesirable approach. India is a vast country with varying climatic conditions- snow clad peaks of Himalaya, desert of Rajasthan, place like Cherapunji getting the highest rainfall area in the World, (1000cm.). The population of India is estimated to reach between 1.5-1.8 billion by the year 2050. The United Nations agencies have put this figure at 1.64 billion. With the present population of around 1000 million, the per capita water availability comes to about 1170 m^3/person/year. The average annual surface water flows in India has been estimated as 1869 billion cubic meters of which only 690 billion cubic meters can be utilized, if appropriate storages can be treated. The reason for this vast difference between potential (1869 billion cubic meters) and the conditional availability (690 billion cubic meters) has been well recognized due to the monsoonic climate, besides topographical and geological limitations. [1,2,3]

Water is most essential but scarce resource in our country. Presently the quality and the availability of the fresh water resources and the most pressing of the many environmental challenges on the national horizon. The stress on water resources is from multiple sources and the impacts can take diverse forms. Geometric increase in population coupled with rapid urbanization, industrialization and agricultural development has resulted in high impact on quality and quantity of water in our country. The situation warrants immediate redressed through radically improved water resource and water quality management strategies. The present study highlights the steps involved in preparation of a water quality management plan in a rational manner.

Water is a chemical substance that is composed of hydrogen and oxygen and is vital for all known forms of life. Water can dissolve many different substances, giving it varying tastes and odors. Humans and other animals have developed senses which (more or less) enable them to evaluate the Portability of water by avoiding water that is too salty or putrid. Humans also tend to prefer cold water to lukewarm water since cold water is likely to contain fewer microbes. The taste advertised in spring water or water derives from the minerals dissolved in it: Pure H_2O is tasteless and odorless. The advertised purity of spring and mineral water refers to absence of toxins, pollutants and microbes. In typical usage, water refers only to its liquid form or state, but the substance also has a solid state, ice, and a gaseous state, water vapor or steam. Water covers 71% of the Earth's surface. On Earth, it is found mostly in oceans and other large water bodies, with 1.6% of water below ground in aquifers and 0.001% in the air as vapor, clouds (formed of solid and liquid water particles suspended in air), and precipitation. Oceans hold 97% of surface water, glaciers and polar ice caps 2.4%, and other land surface water such as rivers, lakes and ponds 0.6%. A very small amount of the Earth's water is contained within biological bodies and manufactured products. Water on Earth moves continuously through a cycle of evaporation or transpiration (evapotranspiration), precipitation, and runoff, usually reaching the sea. Over land, evaporation and transpiration contribute to the precipitation over land. Clean drinking water is essential to human and other life forms. Access to safe drinking water has improved steadily and substantially over the last decades in almost every part of the world. There is a clear correlation between access to safe water and GDP per capita. However, some observers have estimated that by 2025 more than half of the world population will be facing water-based vulnerability. [4]

1.2 WATER ON EARTH:

Hydrology is the study of the movement, distribution, and quality of water throughout the Earth. The study of the distribution of water ishydrography. The study of the distribution and movement of groundwater is hydrogeology, of glaciers is glaciology, of inland waters is limnology and distribution of oceans is oceanography. Ecological processes with hydrology are in focus of ecohydrology. The collective mass of water found on, under, and over the surface of a planet is called the hydrosphere. Earth's approximate water volume (the total water supply of the world) is 1,360,000,000 km^3 (326,000,000 mi^3). Groundwater and fresh water are useful or potentially useful to humans as water resources. Liquid water is found in bodies of water, such as an ocean, sea, lake, river, stream, canal, pond, or puddle. The majority of water on Earth is sea water. Water is also present in the atmosphere in solid, liquid, and vapor states. It also exists as groundwater in aquifers. Water is important in many geological processes. Groundwater is ubiquitous in rocks, and the pressure of this groundwater affects patterns of faulting. Water in the mantle is responsible for the melt that produces volcanoes at subduction zones. On the surface of the Earth, water is important in both chemical and physical weathering processes. Water and, to a lesser but still significant extent, ice, are also responsible for a large amount of sediment transport that occurs on the surface of the earth. Deposition of transported sediment forms many types of sedimentary rocks, which make up the geologic record of Earth history. The water cycle of the nature in Fig 1.1 shows that how the nature is responsible the water change in atmosphere. Fig 1.2 shows the distribution of water on Earth i.e. about 97 % water is saline and only 3 % of water is fresh water, out of 3% fresh water about 68.7 % water is in terms of Glaciers and icecaps and 30.1 % water is in ground i.e. groundwater. Potable water is only 0.9 % from that only 0.3 % water is on surface. From 0.3 % surface water 87 % is lake water, 11% swimps and only 2% water is available in Rivers.[5]

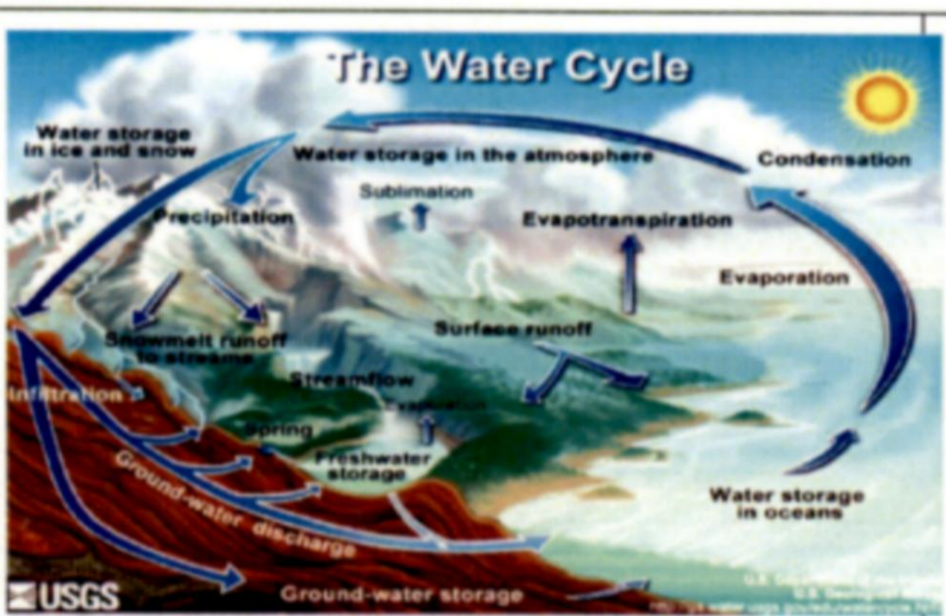

Fig 1.1 : Water cycle of nature [5]

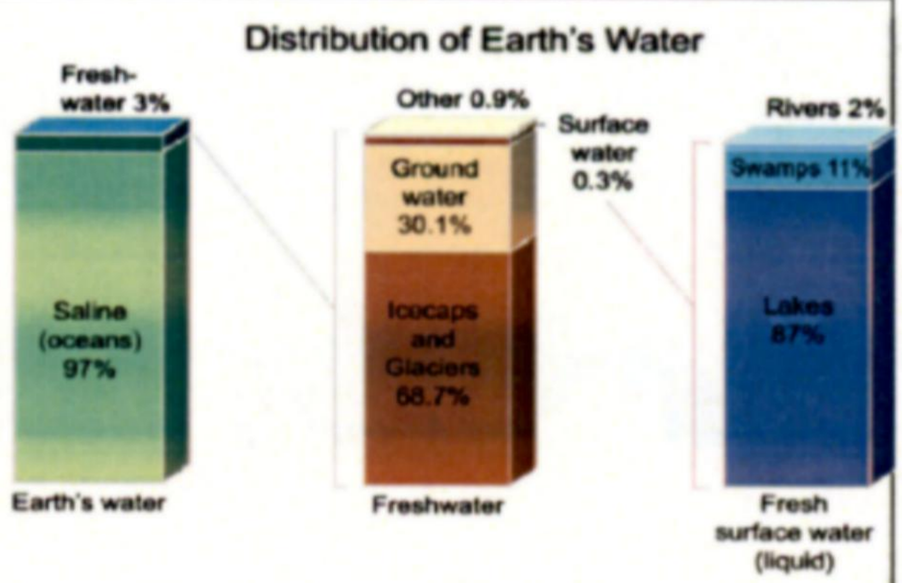

Fig.1.2 :Distribution of earth water [5]

1.2.1 Availability of Water in India

India receives 4% of World water. This availability decreases as given below.

♦1950--5.20 Thousand metre cube

♦1991--2.20.Thousand metre cube

♦2000--1.80 Thousand metre cube

♦2025--1.00 (Projected) Thousand metre cube

The availability of water from various sources is given in Table 1.1.

Table 1.1: Water Availability in India [6]

Sr. No.	Source of water availability	Quantity (billion M^3)
1	Average annual precipitation	4000
2	Average annual water run-off potential	1869
3	Utilizable surface water	690
4	Replenishable ground water	432

1.3 WATER RESOURCES OF INDIA

India has 1869 cubic km of total natural runoff. Out of which only 690 cubic km. of surface water resources and 432 cubic km. of ground water resources are in the form of utilizable resources. Around 16% of the world population residing in India possesses only 4 % of world water resources. Therefore the pressure on water resources in India is very high.

Population growth along with improved level of living standards has increased the demand of fresh water availability. It is projected that the demand would be huge by 2025. According to Standing Sub-committee, Ministry of Water Resources, a total annual demand for water will increase to 1093 BCM in 2025 from 634 BCM in 2000. Demand of Drinking water, which has been given the first priority in National water policy, will also go high from 42 BCM to 52 BCM.

On the other side resources of water supply are limited. Ground water, being an important source of drinking water and food security for India, supplies around 80 per cent of water for domestic use in rural areas. India has developed almost all the ground water resources. It has also been realized now that ground water quantity and quality are declining and deteriorating rapidly. This has implications on per capita availability of fresh water. The available water per capita per year is 2384 cubic metre in the year of 2000 as against 6008 cubic metre in 1947. This shows a drastic decline in per capita availability of water. It has been projected that per capita per year water availability would be only 1389 cubic metre by the year of 2025. [7]

According to **Water stress Index** given by Falkenmark and Widstrand in 1992, a region whose renewable fresh water availability is below 1700 cubic meters/capita/annum is a 'water stress' region, and the one where availability falls below 1000 cubic meters/capita/annum experiences chronic 'water scarcity'. Several parts of India are classified as water stressed, for example, regions in the Indus, Krishna, Mahi, and Ganga sub-basins. A few parts of India are water scarce, namely, the regions under east flowing rivers between Pennara and Kanyakumari, between Mahanadi and Pennar, Cauvery, etc. As per this index, India as a whole may face severe water stress by 2025 with a per capita availability of only 1389 cubic meters.

1.3.1 Fresh Water Storage:

Some runoff water is trapped for periods of time, for example in lakes. At high altitude, during winter, and in the far north and south, snow collects in ice caps, snow pack and glaciers. Water also infiltrates the ground and goes into aquifers. This groundwater later flows back to the surface in springs, or more spectacularly in hot springs and geysers. Groundwater is also extracted artificially in wells. This water storage is important, since clean, fresh water is essential to human and other land-based life. In many parts of the world, it is in short supply.

1.3.2 Drinking Water:

Safe drinking water is linked closely to the well-being of human life. In India, the primary sources of drinking water, that include surface water and groundwater, are contaminated by different physical impurities, agricultural and industrial wastes and underground chemicals and minerals. Water borne diseases are widespread, especially among the low income class of the society. It is a cause of growing concern that many Indians do not have access to safe drinking water. Thus, the regular testing of water quality and using an appropriate water purification system depending upon the quality of water is essential for good health.

1.3.3 Rainfall and Potential of Flow

The annual average rainfall over India based on the daily data collected by Indian Meteorological Department from more than 3000 rainfall-recording stations for a period of 50 years (1901-1950) is computed as 105 centimeters. It is largest network anywhere in the world for a country of a comparable size. From precipitation alone India receives 4000 Km^3, including snowfall. Of this 3/4 part occur only during monsoon. A good part of it is lost through the process of evaporation and plant transpiration, leaving only half of it on the land for us to use. After allowing for evapotranspiration losses the country's surface flow is estimated as 1880 Km^3. Due to topographical, hydrological and other constraints, it is assessed that only about 700 Km^3 of surface water can be put to beneficial use by conventional methods of development. The annual replenishable ground water resources are assessed to be about 600 Km^3 of which the annual usable resources are estimated at 420 Km^3. Since independence, the country has been planning to utilise this water by prolonging its stay on land by using engineering innovations such as dams and barrages. Estimated Water Budget of India is given in figure 1.3. [7]

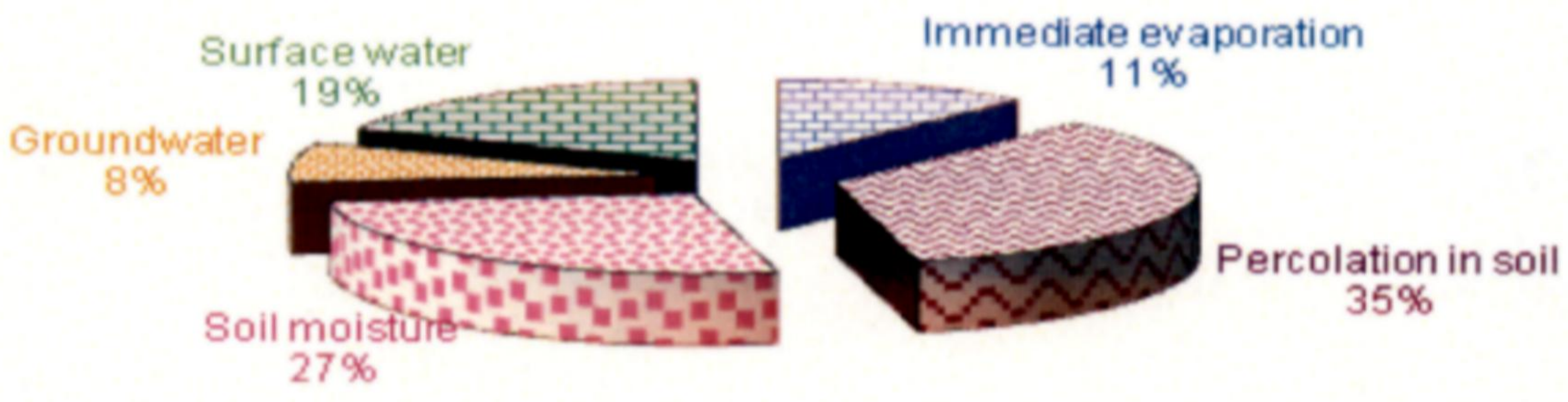

Fig. 1.3: Water Budget of India [7]

According to Ministry of Water Resources (CWC, 2000). During 1.1.98 to 31.12.98 maximum rainfall was received in coastal Karnataka (416 Cm.) followed by Arunachal Pradesh (379 Cm), Konkan and Sub Himalayan West Bengal, Sikkim (328 Cm), Goa (326 Cm) and Kerala (312 Cm). The rainfall less than 50 Cm was recorded in western Rajasthan during the same period. The Resources potential of the country, which occurs as natural run off in the rivers, is about 1869 km^3 as per the latest estimates of Central Water Commission, Ministry of Water Resource Govt. of India. Considering both surface and ground water as one system. Ganga- Brahmaputra-Meghan system is the major contributor to total water resources potential of the country. Its share is about 60 percent in total water resources potential of various rivers. The per capita availability of water works out to 1905 cubic metre (cu.m.) as on 31st March 1999. Due to various constraints of topography, uneven distribution of resource over space and time, it has been estimated that only about 1122 km^3 of total potential of 1969 km3 being due to surface water resources. Again about 40 percent of utilizable surface water resources are presently in Ganga- Brahmaputra- Meghan system. In majority of river basins, present utilization is significantly high and is in the range of 50 percent to 95 percent of utilizable surface resources. But in the rivers such as Narmada and Mahanadi percentage utilization is quite low. The corresponding values for these basins are 23 percent and 34 percent respectively.

The distribution of water resources potential in the country shows that as against the national per capita annual availability of water of 1905 m^3. the average availability in Brahmaputra and Barak is as high as 16589 m^3 ,while it is as low as 360 m^3 in Sabarmati basin. Brahmaputra and Barak basin with 7.3 percent of geographical area and 4.2 percent of pollution of the country has 31 percent of the annual water resources. Per capita annual availability for rest of the country excluding Brahmaputra and Barak basin works out to about 1583 m^3. Any situation of availability of less than 1000 m^3 per capita is considered by international agencies as scarcity Conditions. Cauvery, Pennar, Sabarmati, East Flowing rivers and West Flowing rivers are some of the basins that fall into this category.

1.3.4 Water Bodies

Inland water resources of the country are classified as rivers and canals; reservoirs; tanks and ponds; beels, oxbow lakes, derelict water; and brackish water. Other than rivers and canals, total water bodies cover an area of about 7 million hectare. Of the rivers and canals, Uttar Pradesh state occupies the first place with the total length of rivers and canals as 31.2 thousand km, that is about 17 percent of the total length of rivers and canals in the country. Other states following Uttar Pradesh are Jammu and Kashmir and Madhya Pradesh. Among the remaining forms of the inland water resources, tanks and ponds have maximum area 2.9 million hectare followed by reservoirs 2.1 million hectare. Most of the area under tanks and ponds lies in Southern states of Andhra Pradesh, Karnataka and Tamil Nadu. These states, along with West Bengal, Rajasthan and Uttar Pradesh account for 62 percent of total area under tanks and ponds in the country. As far as reservoirs are concerned, major states like Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Rajasthan and Uttar Pradesh account for larger portion of area under reservoirs. More than 77 percent of area under beels, oxbow, lakes and derelict water lies in the States of Orissa, Uttar Pradesh and Assam. Orissa ranks first as regards the total area of brackish water and is followed by Gujarat, Kerala and West Bengal. The total area of inland water resources is, thus, unevenly distributed over five states namely Orissa, Andhra Pradesh, Gujarat, Karnataka and West Bengal accounting for more than half of the country's inland water bodies. [8]

India's landscape, across rural and urban areas, is dotted with water bodies that include natural lakes, ponds, and man-made tanks. While several natural water bodies find a mention in mythology, many man-made ponds, lakes and reservoirs boast of a royal origin as they were built by kings from different eras. As diverse as the country's heritage, these water bodies integrate culture with traditional wisdom to harvest rainwater and replenish water tables. With time, the expanding concrete jungles and a disregard for ecology reduced many of the water bodies to mere shadows of their original glory. Today, environmental groups and urban city planners are taking steps to revive the water bodies. Table 1.2 and 1.3 shows the major and medium river basins list of India.

Table 1.2: Major River Basins of the Country [3]

Sl. No.	Name of the River	Origin	Length (Km.)	Catchment Area (Sq. Km.)
1.	Indus	Mansarovar (Tibet)	1114 +	321289 +
2.	a) Ganga	Gangotri (Uttar Kashi)	2525 +	861452 +
	b) Brahmaputra	Kailash Range (Tibet)	916 +	194413 +
3.	Sabarmati	Aravalli Hills (Rajasthan)	371	21674
4.	Mahi	Dhar (Madhya Pradesh)	583	34842
5.	Narmada	Narmada Amarkantak (Madhya Pradesh)	1312	98796
6.	Tapi	Betul (Madhya Pradesh)	724	65145
7.	Brahmani	Ranchi (Bihar)	799	39033
8.	Mahanadi	Nazri Town (Madhya Pradesh)	851	141589
9.	Godavari	Nasik (Maharashtra)	1465	312812
10	Krishna	Mahabaleshwar (Maharashtra)	1401	258948
11	Pennar	Pennar Kolar (Karnataka)	597	55213
12	Cauvery	Coorg (Karnataka)	800	81155
Total				2528084

Table 1.3: Medium River basins of the Country [3]

Sr. No.	Name of the River	Village/Distt. (Origin)	State	Length (Km.)	Catchment Area (Sq. Km)
West Flowing Rivers					
1.	Ozat	Kathiawar	Gujarat	128	3189
2.	Shetrunji	Dalkania	Gujarat	182	5514
3.	Bhadar	Rajkot	Gujarat	198	7094
4.	Aji	Rajkot	Gujarat	106	2139
5.	Dhadhar	Panchmahal	Gujarat	135	2770
6.	Purna	Dhosa	Maharashtra	142	2431
7.	Ambika	Dangs	Maharashtra	142	2715
8.	Vaitarna	Nasik	Maharashtra	171	3637
9.	Dammanganga	Nasik	Maharashtra	143	2357
10	Ulhas	Raigarh	Maharashtra	145	3864
11	Savitri	Pune	Maharashtra	99	2899
12	Sastri	Ratnagiri	Maharashtra	64	2174
13	Washishthi	Ratnagiri	Maharashtra	48	2239
14	Mandvi	Belgaum	Maharashtra	87	2032
15	Kalinadi	Belgaum	Karnataka	153	5179
16	Gangavati or Bedti (in	Dharwar	Karnataka	152	3902

	upper reaches)				
17	Sharavati	Shimoga	Karnataka	122	2209
18	Netravati	Dakshina Kannada	Karnataka	103	3657
19	Chaliar or Baypore	Elamtalvi Hills	Kerala	169	2788
20	Bharathapuzha (known as Ponnani)	Annamalai Hills	Tamil Nadu	209	6188
21	Periyar	Sivajini Hills	Kerala	244	5398
22	Pamba	Devarmalai	Kerala	176	2235
23	Burhabalang	Mayurbahanj	Orissa	164	4837
24	Baitarni	Keonjhar	Orissa		12789
25	Rushikulya	Phulbani	Orissa		7753
26	Bahuda	Ramgirivillage	Orissa	73	1248
27	Vamsadhara	Kalahandi	Orissa	221	10830
28	Nagavali	Kalahandi	Orissa	217	9410
29	Sarda	Vishakhapatnam	Andhra Pradesh	104	2725
30	Eleru	Vishakhapatnam	Andhra Pradesh	125	3809
31	Vogarivagu	Guntur	Andhra Pradesh	102	1348
Total					**4251.61**

1.3.5 Rivers

India is blessed with many rivers. As many as 13 of them are classified as major rivers whose total catchment area is 252.8 million hectare (m.ha). Of the major rivers, the Ganga- Brahmaputra- Meghna system is the biggest with catchment area of about 110 m.ha which is more than 43 percent of the catchment area of all the major rivers in the country. The other major rivers with catchment's area more than 10 m.ha are Indus (32.1 m.ha). Godavari (31.3 m. ha), Krishna (25.9 m.ha) and Mahanadi (14.2 m.ha). The River basin wise perennial riverine length is as shown in Fig. 1.4.

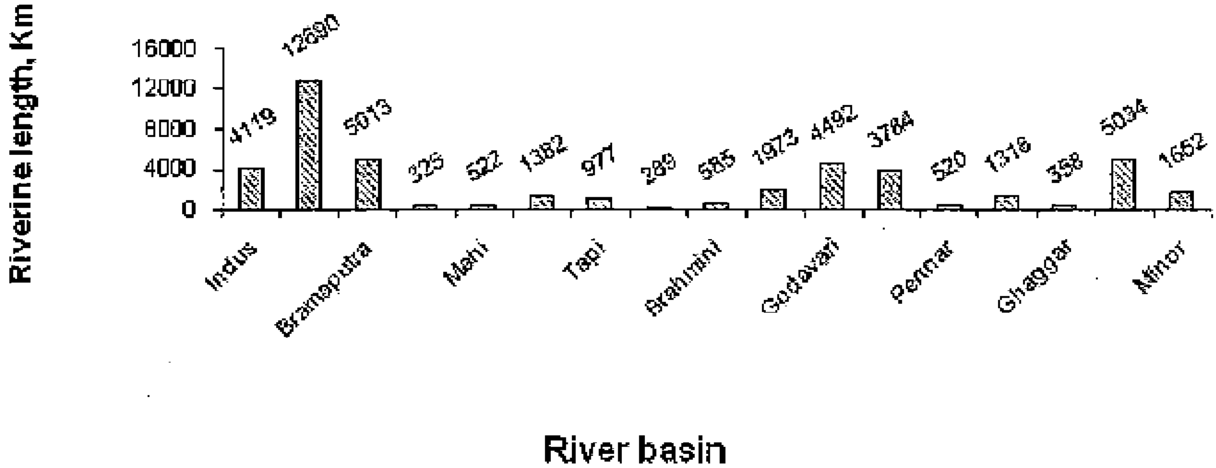

Fig.1.4: River-Basin-Wise Perennial riverine Length [9]

The catchment area of medium rivers is about 25 m.ha. Of the medium rivers, Subarnarekha is the largest with catchment area of about 1.9 m.ha. The rivers are characterized by unidirectional current with a relatively high, average flow ranging from 0.1 to 1 m/s. Map of River Basins of India is shown in Fig.1.5.

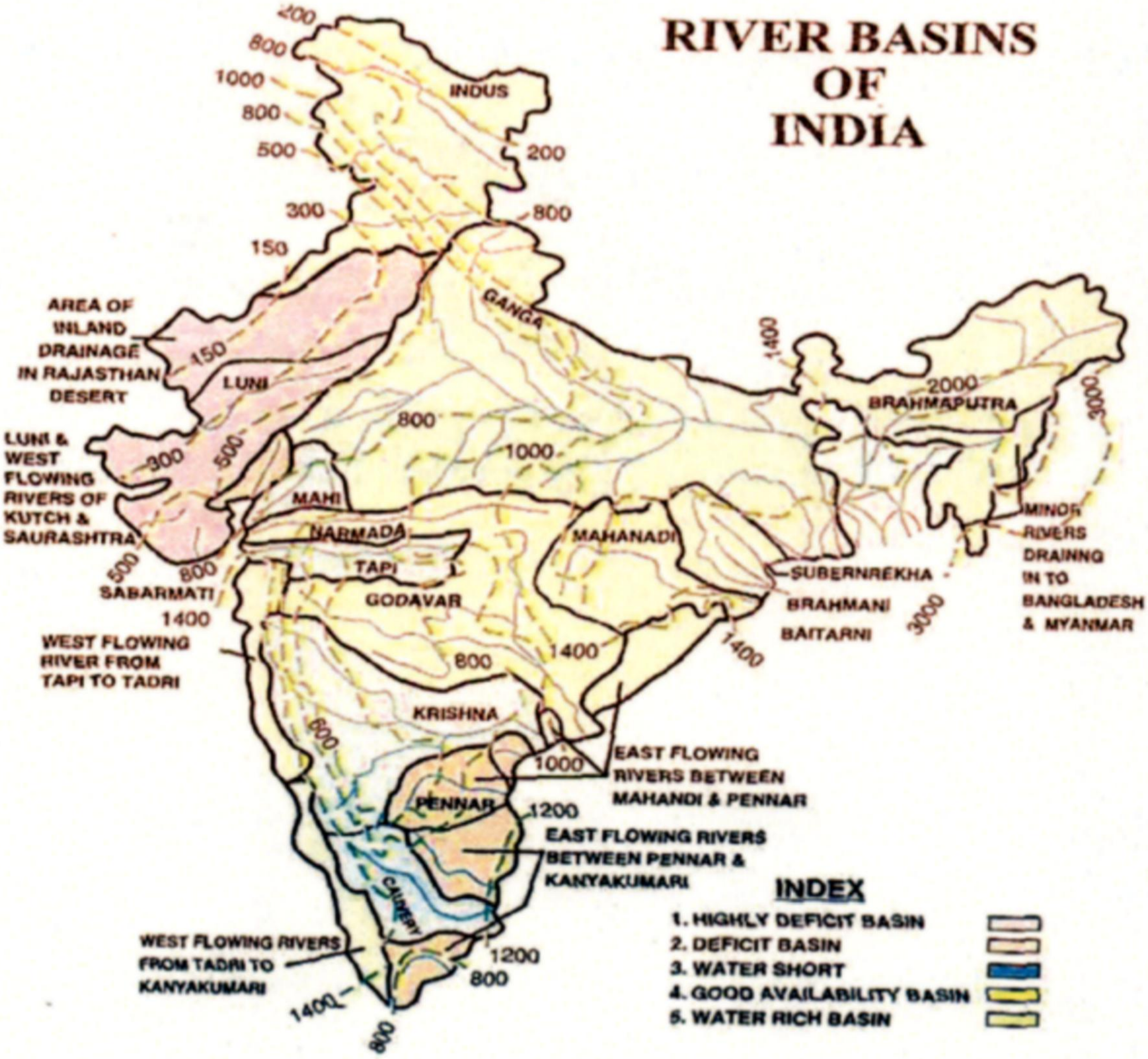

Fig.1.5: River Basins of India [3]

The river flow is highly variable with time depending on climatic situation and the drainage pattern. In general thorough and continuous vertical mixing is achieved in rivers due to prevailing currents and turbulence. Lateral mixing may take place only over considerable distances downstream of major confluence. The other rivers with catchment area more than 1 m.ha are Palar (including tributary Cheyyar), Ponnaiyar, Baitarni and Vamshadhra.

1.3.6 River Basins

Almost the entire country is criss-crossed by rivers. There are fourteen major river basins in the country which occupy eighty three percent of total drainage basins, contribute eighty five percent of total surface flow and house eighty percent of the country's population. They are Brahmaputra, Ganga, Indus, Godavari, Krishna, Mahanadi, Narmada, Cauvery, Brahmini, Tapi, Mahi, Subernrekha, Pennar and Sabarmati. Three major divisions based on drainage basins are accepted for Indian rivers as shown in Table 1.4

Table 1.4: Classification of River Basins of India [10]

Category	**Basin Area (Km^2)**	**Number of Basins**	**Percentage of Total Drainage Area**
Major	More than 20,000	13	82.4
Medium	Between 2000 and 20,000	48	8
Minor and Desert	Less than 2000	52	9.6

There are few desert rivers, which flow for some distance and get lost in deserts. There are complete arid areas where evaporation equals rainfall and hence no surface-flow. The medium and minor river basins are coastal rivers. On the east coast and part of Kerala, the width of land between mountain and sea is about 100 km, and the riverine length is also about 100 km. whereas, the rivers in the rest of the west coast are much shorter as the width of the land between sea and mountains is less than 10 to 40 km.

A look into the river basins map of India reveals some interesting features. The Brahmaputra, Ganga, Indus basins along with that of Godavari cover more than half of the country. The whole of the west coast stretching 1500 km between Surat in Gujarat and Cape Comorin in Tamilnadu are fed by fourteen medium and eighteen minor river basins leaving important cities like Bombay, Panaji, Cochin, Trivandrum out of major river basins. On the east coast of Peninsular India there are three pockets, which are out of any major river basins. These three pockets are: the area south of River Cauvery starting from Madurai to Cape Comorin; the area between Pennar and Cauvery basin wherein Chennai and Pondicherry are located; and the area between Mahanadi and Godavari basins in Orissa coast. There is a tremendous variation both in the quantity of discharge from a major basin to minor one and also in the quality of discharge from region to region. With a few exceptions, all the medium and minor river basins originates in the coastal mountains, and thus exhibit a common features of fast flowing and monsoon-fed in the hilly regions and by the time they reach the plains they are tidal. Industries or communities are located in the plains. The treated or untreated discharges from such sources would always find a situation where pollutants once discharged into the rivers continue to oscillate like a pendulum as because the river is not receiving any flow from the mountain in dry weather. During monsoon, when rain water flows down the river the discharged pollutants, although oscillate because of tide, got flushed out by upland flow. As the discharge location moves downstream, the flushing out time for pollutants decreases exponentially.

1.3.7 Ground Water

The groundwater is characterized by a rather steady flow pattern in terms of direction and velocity. The average flow velocities commonly found in aquifers (groundwater reservoirs) range from 10^{-10} to 10^{-3} m s^{-1} and are largely governed by the porosity and the permeability of the geological material. As a consequence mixing is rather poor and, depending on local hydro geological features, the groundwater dynamics can be highly diverse.

There are several transitional forms of water bodies that demonstrate features of more than one of the three basic described above. The most important transitional water bodies are:

- Flood plains: intermediate between lakes and rivers with seasonal variability.
- Reservoirs: intermediate between rivers and lakes depending on their seasonal pattern of operation in relation to the river discharges.
- Marshes: intermediate between lakes and phreatic aquifers and
- Alluvial and karstic aquifers: intermediate between rivers and groundwaters.

As a consequence of the range of flow regimes noted above, large variations in water residence times occur in the different types of inland water bodies. The hydrodynamic characteristics of each type of water body are highly dependent on the size of the water body and on the climatic conditions in the drainage basin. The governing factor for rivers is their hydrological regime i.e. their discharge variability. Lakes are classified by their water residence time and their thermal regime resulting in varying stratification patterns. Groundwater's greatly depend upon their recharge regime i.e. infiltration through the unsaturated aquifer zone, which allows for the renewal of the groundwater body.

Analysis of basin wise potential of ground water by the Ministry of Water Resources indicates that the Ganga Basin has the maximum potential which is 171 Km^3. Other basins are far behind the Ganga that accounts for more than 39 percent of total potential in the country. As a consequence of its prime place regarding availability, the quantities of ground water potential in the basin apportioned for different uses is very high vis-a vis other rivers. Net draft though highest in the Ganga, yet ground water development percentage is highest in the Indus basin, where it is 78.9 percent. the other basins which have exploited more than 50 percent of their ground water resources are (a) Cauvery (b) Madras and South Tamil Nadu composite and (c) Kutch and Saurashtra composite. Ground water development is the lowest in the Brahmaputra (3.37 percent), followed by Meghna (3.94 percent), Mahanadi (6.95 percent), Brahmani with Baitarni (8.45 percent), Subarnarekha (9.57 percent) North East Composite (17.20 percent) and Godavari (19.53 percent). Exploitation in the basins of northern part of the country like Indus and Ganga is comparatively far better than those in others.

1.4 QUALITY OF DRINKING WATER IN INDIA

The goals of Millennium Declaration made by UN in September of 2000 represent a partnership between the developed and the developing countries. MDGs direct to act together for achieving sustainable development in general and eliminating the world poverty in particular. The goal, which ensures environmental sustainability, primarily addresses the water and sanitation issues of the world. Two targets to achieve this goal are; to reduce the proportion of people without sustainable access to safe drinking water by fifty percent by 2015 and to improve the lives of at least 100 million slum dwellers significantly by 2020. Where does India stand in providing safe and sustainable water supply to all its villages and towns? There are statistics on access to water supply which claim India has progressed very well in providing drinking water supply to all. However, almost all the statistics assessing the coverage of drinking water do not define what exactly safe and sustainable drinking water supply is. Quality of water is always neglected. Even, the improved definition suggested by the WHO and the UNICEF clarifies in its methodology that access to water and sanitation does not imply that the level of service or quality of water is "adequate" or "safe". It is not that we lack standards for quality criteria of drinking water, but what is required is considering those standards into the definition of safe and sustainable drinking water supply. It needs a fresh survey to be carried out in order to estimate the actual number of people having access to safe and sustainable drinking water supply by incorporating the quality criteria into its definition. This paper critically presents the drinking water scenario in India. It argues that if India strictly enforced the quality criteria (which are significant in the context of Indian situation) and accepts the definition of improved water sources presented by the WHO and the UNICEF, it has to conduct a fresh survey and this will result into the dramatic fall in the percentage of population having access to safe and sustainable water supply. However, it will present the real situation of India.

1.5 Nature of Aquatic Environment

All freshwater bodies are interconnected, from the atmosphere to the sea, via a hydrological cycle as explained earlier. Thus, water constitutes a continuum, with different stages ranging from rainwater to marine salt waters. There are three major types of fresh water ecosystems having distinct hydrodynamic features as described below:

Table 1.5: State wise Details of Inland Water Resources (Lakh Hectares) [11]

S. No.	Name of the State/UT	Rivers & Canals (Length in Kms)	Reservoir	Tanks, Lakes & Ponds	Beels, Oxbow Lakes & Derelict Water	Brackish Water	Total Water Bodies
1.	Andhra Pradesh	11514	2.34	5,17	-	0.64	8.15
2	Arunachal Pradesh	2000	-	0.01	0.03	-	0.04

S. No.	Name of the State/UT	Rivers & Canals (Length in Kms)	Reservoir	Tanks, Lakes & Ponds	Beels, Oxbow Lakes & Derelict Water	Brackish Water	Total Water Bodies
3.	Assam	4820	0.02	0.23	1.10	-	1.35
4.	Bihar	3200	0.60	0.95	0.05	-	1.60
5.	Goa	250	0.03	0.03	-	-	0.06
6.	Gujarat	3865	2.43	0.71	0.12	3.76	7.02
7.	Haryana	5000	NEG	0.10	0.10	-	0.20
8.	Himachal Pradesh	27781	0.07	0.17	0.06	-	0.30
9.	Jammu and Kashmir	3000	0.42	0.01	-	-	0.43
10.	Karnataka	9000	2.20	4.14	-	0.08	6.42
11.	Kerala	3092	0.30	0.30	-	2.43	3.03
12.	Madhya Pradesh	20661	2.94	1.19	-	-	4.13
13.	Maharashtra	16000	2.79	0.50	-	0.10	3.39
14.	Manipur	3360	0.01	0.05	0.40	-	0.46
15.	Meghalaya	5600	0.08	0.02	NEG	-	0.10
16.	Mizoram	1395	-	0.02	-	-	0.02

S. No.	Name of the State/UT	Rivers & Canals (Length in Kms)	Reservoir	Tanks, Lakes & Ponds	Beels, Oxbow Lakes & Derelict Water	Brackish Water	Total Water Bodies
UNION TERRITORIES							
17	Andaman & Nicobar Islands	115	0.01	0.03	-	0.37	0.41
18	Chandigarh	2	-	NEG	NEG	-	-
19.	Dadra & Nagar Naveli	54	0.05	-	-	-	0.05
	Total	**185734.00**	**20.50**	**28.55**	**5.45**	**14.22**	**68.72**

Source: Fisheries Division, Dept. of Agriculture & Co-operation, Ministry of Agriculture

N.A. : Not Available,(P) : Provisional; NEG : Negligible

1.6 WATER POLLUTION –POINT AND NONPOINT SOURCES

There are many specific causes of water pollution, but before we list the toppers, it's important to understand two broad categories of water pollution:

"Point source" — occurs when harmful substances are emitted directly into a body of water.

"Nonpoint source" — delivers pollutants indirectly through transport or environmental change.

An example of a point source of water pollution is a pipe from an industrial facility discharging effluent directly into a river. An example of a nonpoint-source of water pollution is when fertilizer from a farm field is carried into a stream by rain (i.e. run-off).

Point-source pollution is usually monitored and regulated, at least in Western countries, though political factors may complicate how successful efforts are at true pollution control. Nonpoint sources are much more difficult to monitor and control, and today they account for the majority of contaminants in streams and lakes. Now, on to the more specific categories of water pollution causes.

1.6.1 Water Pollution

The problem of fresh water pollution in India came to the forefront towards the beginning of 1970's with the domestic sewage and industrial waste discharges being the most critical sources of pollution in cities. This resulted in the promulgation of the Water (Prevention and Control of Pollution) Act, 1974 and establishment of the National Water Quality Network in 1979. The sources of water pollution include point and non-point sources like discharges from industries and storm water respectively. While pollution from point sources can be controlled, it is difficult to control pollution from non-point sources such as agriculture run-off, leaching from waste disposal sites and storm water.

The total wastewater generation from domestic sources in class I towns is 16.27 billion litres and of this a mere 25% is treated. The increase in treatment capacities have also not shown a commensurate increase as the share of waste water which is untreated and disposed into our surface water bodies, has increased from 61% in 1978-79 to 76% in 1994-95 (CPCB 2000).

Water pollution, in the industrial sector is concentrated within a few subsectors mainly in the form of toxic wastes and organic pollutants. Of the total pollution load generated by industrial subsectors, 40%–45% is contributed by the processing of industrial chemicals. In terms of the total organic pollution, expressed as BOD, nearly 40% arises from the food industries followed by industrial chemicals and the pulp and paper industry (World Bank 1996). Other major sector of concern is that of small-scale industries with more than 2 million units where pollution abatement has been neglected so far. Depending on the traditional crafts and culture of the area, small-scale industries like chemical, textiles, food processing and tanneries are found in large clusters in different states. States with over a lakh registered small-scale industries include Andhra Pradesh, Gujarat, Madhya Pradesh, Punjab, Tamil Nadu, Uttar Pradesh, and West Bengal. Of these very few of the clusters have opted for CETPs (Common Effluent Treatment Plants) to control water pollution but most of these CETPs either do not function at all or do not treat effluents to the desired quality.

Presently the institutional mechanisms to address pollution in the agriculture sector are also missing, as the sector is out of the ambit of the pollution control boards. The problem is acute in the riparian states of Punjab, Haryana, Uttar Pradesh and Tamil Nadu. Excessive use of fertilizers has led to an increase in the levels of nitrates in the shallow groundwater sources. The nitrate content of well water in a few districts of Uttar Pradesh, Haryana, and Punjab is far beyond the standard prescribed safe limit of 45 mg/litre (Kansal, Grewal, and Dhaliwal 1994). Severe degradation of ground water sources is also resulting from dumped solid wastes and human waste in dug wells.

1.6.2 Water Quality Profile:

Pressures due to inadequate collection and inefficient treatment of domestic wastewater, discharge of highly complex wastes from industries and the polluted runoff from agricultural fields, have resulted in considerable degradation in the quality of water sources. Indicators of this deterioration include depletion of oxygen, excessive presence of pathogens, settling of suspended material during lean flow conditions, and bad odour.

The quality of river water is monitored at 480 stations under different programmes such as MINARS (monitoring of Indian national aquatic resources), GEMS (global environmental monitoring systems), and GAP (ganga action plan). A number of physical, chemical, biological and bacteriological parameters are being measured under the programme, but the important ones include BOD (biochemical oxygen demand), DO (dissolved oxygen), and TC (total coliform) count. Heavy metals are however not included under the monitoring programme. Some of the polluted river stretches, their critical parameters and possible sources of pollution are listed in the Table 1.6 below.

Table 1.6: List of polluted river stretches [10]

River	Polluted stretch	Desired class	Existing class	Critical parameters	Possible source of pollution
Sabarmati	Immediate upstream of Ahmedabad upto Sabarmati Ashram	B	E	DO, BOD, Coliform	Domestic and industrial waste from Ahmedabad
Subarnarekha	Hatia dam to Bharagora	C	D/E	-do-	Domestic and industrial waste from Ranchi and Jamshedpur
Godavari	Downstream of Nasik and Nanded	C	D/E	BOD	Wastes from sugar industries, distilleries and food processing industries
Krishna	Karad to Sangli	C	D/E	BOD	Wastes from sugar industries and distilleries

1.7 URBANISATION & WASTEWATER MANAGEMENT IN INDIA

The process of urbanization in India since the beginning of last century reveals a steady increase in the size of its urban population, number of urban centers, and level of urbanization since 1911 onwards and a rapid rise after 1951. From a modest base of 25.8 million persons in 1901, the number of urban dwellers has risen to 285 million, signaling a phenomenal eleven fold increase in urban population over the period 1901-2001.

The urban India has become a massive and perhaps a frightening reality as far as waste management is concerned. This country can no longer afford to allow urban areas constituting cities and towns of varying magnitude to take care of them; they need the full and undivided attention of our planners and decision makers for protection of environment, aquatic resources and ultimately for better management of health aspects.

The Central Pollution Control Board realized the gravity of water quality deterioration in water bodies and instituted studies on the wastewater management in India with changing urban pattern during last three decades and highlighted the need for urban wastewater management. The comparison of water supply, wastewater generation, collection and treatment during 1978-79, 1989-90 and 1994-95 indicates that the wastewater generation has increased from 7,007mld in 1978-79 to 16,622 MLD in 1994-95 in class I cities (population one lakh or above). However, the treatment capacity has increased from 2755.94 MLD in 1978-79 to 4037.20 MLD in 1994-95, which was only 39% and 24% of the wastewater generated respectively.

Table 1.7: Decadal trend of water supply and sanitation status in class I cities and class II towns

Parameters	Class I Cities			Class II Towns		
	1978-79	1980-90	1994-95	1978-79	1989-90	1994-1995
Number	142	212	299	190	241	345
Population (millions)	60	102	128	12.8	20.7	23.6
Water Supply (MLD)	8638	15191	20607	1533	1622	1936
Wastewatergenerated (MLD)	7007	12145	46662	1226	1280	1650
Wastewater treated (MLD)	2756 (39 %)	2485 (20.5 &)	4037 (24 %)	67 (5.44 %)	27 (2012 %)	62 (3.73 %)
Wastewater untreated (MLD)	4251 (61 %)	9660 (79.5 %)	12625 (76 %)	1160 (94.56 %)	1252 (97.88 %)	1588 (96.27 %)

As per the updated status for the year 2003, out of 22,900 MLD of wastewater generated, only about 5,900 MLD (26%) is treated before letting out, the rest i.e., 17,100 MLD is disposed of untreated. Twenty-seven cities have only primary treatment facilities and forty-nine have primary and secondary treatment facilities. The level of treatment available in cities with existing treatment plant in terms of sewage being treated varies from 2.5% to 89% of the sewage generated. Treated or partly treated or untreated wastewater is disposed into natural drains joining rivers or lakes or used on land for irrigation/ fodder cultivation or disposed into the sea or a combination of them by the municipalities. The mode of disposal in 118 cities is indirectly but ultimately into the rivers/ lakes/ ponds/ creeks; in 63 cities to the agriculture land; in 41 cities directly into rivers and in 44 cities, it is discharged both into rivers and on agriculture land.

1.7.1 Urban Water Scenario

Even though the rate of urbanization in India is among the lowest in the world, the nation has more than 250 million city-dwellers. Experts predict that this number will rise even further, and by 2020, about 50 per cent of India's population will be living in cities. This is going to put further pressure on the already strained centralized water supply systems of urban areas. The urban water supply and sanitation sector in the country is suffering from inadequate levels of service, an increasing demand-supply gap, poor sanitary conditions and deteriorating financial and technical performance. According to Central Public Health Engineering Organization (CPHEEO) estimates, as on 31 March 2000, 88 per cent of urban population has access to a potable water supply. But this supply is highly erratic and unreliable. Transmission and distribution networks are old and poorly maintained, and generally of a poor quality. Consequently physical losses are typically high, ranging from 25 to over 50 per cent. Low pressures and intermittent supplies allow back siphoning, which results in contamination of water in the distribution network. Water is typically available for only 2-8 hours a day in most Indian cities. The situation is even worse in summer when water is available only for a few minutes, sometimes not at all.

Table 1.8: Rate of Water Cess [38]

Purpose for which water is consumed	**Maximum rate (Paisa per kilolitre)**	**Maximum rate (Paisa per kilolitre) in case of non-compliance of the water user with the environmental standards**
Industrial cooling, spraying in mine pits or boiler feeds	1.50	2.25
Domestic purpose	2.00	3.00

Processing whereby water gets polluted and the pollutants are easily biodegradable and are toxic.	4.00	7.50
Processing whereby water gets polluted and the pollutants are not easily biodegradable and are toxic.	5.00	7.00.

Source: The water (Prevention and Control of Pollution) Cess Act, 1977

The National River Conservation Plan (NRCP) was launched in 1995 to cover 18 major rivers in 10 states of the country. Under this action plan pollution abatement works are being taken up in 46 towns in the states of A.P., Bihar, Gujarat, Karnataka, Maharashtra, M.P., Orissa, Punjab, Rajasthan and Tamil Nadu. About 1928 MLD of sewage is targeted to be intercepted, diverted and treated. The total NRCP sanctioned cost is of Rs. 737.13 Crore. The following Fig 1.6 gives a repartition of this cost by state.

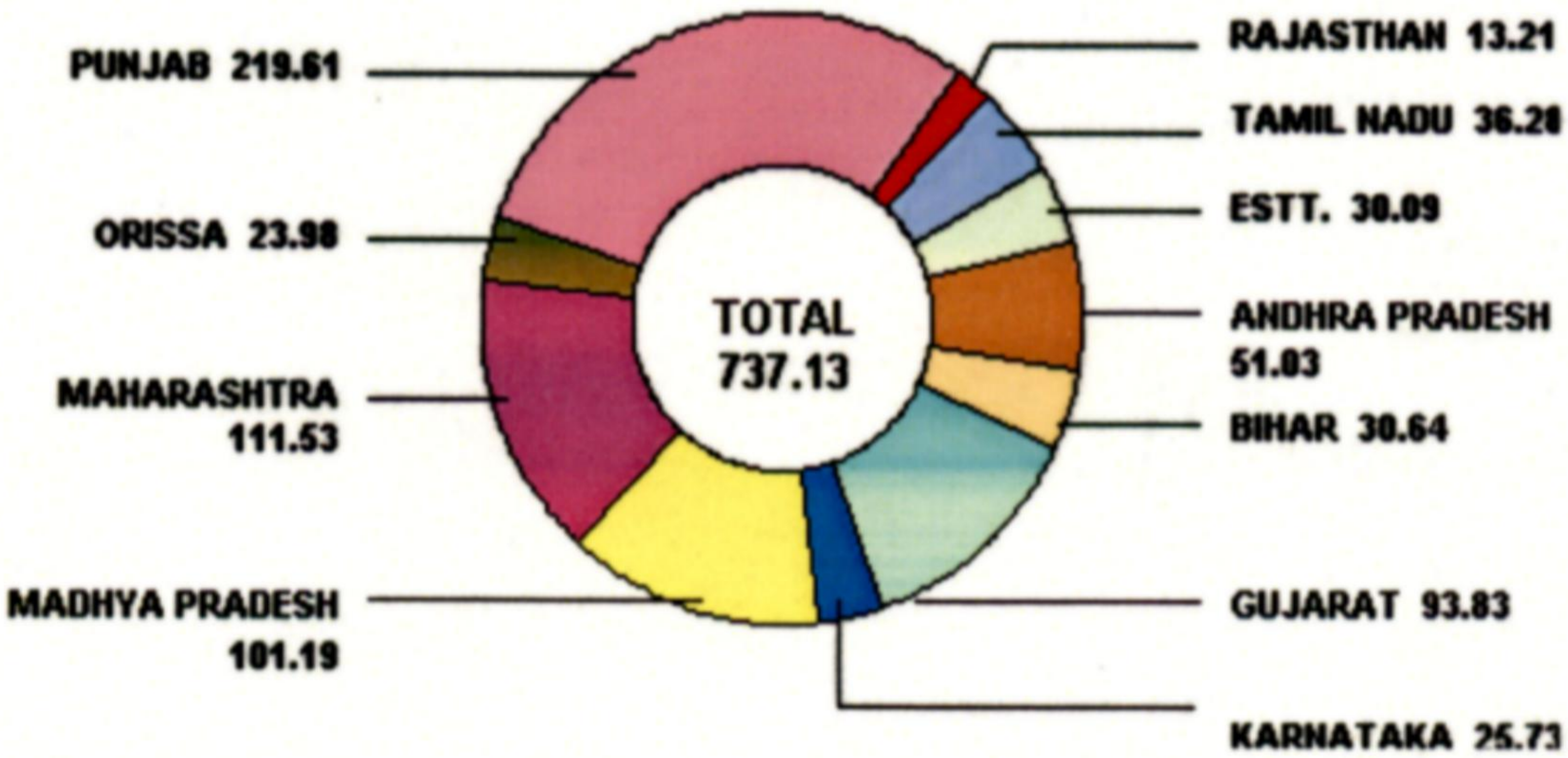

Fig.1.6: Distribution of sanction cost for conservation of river throughout the India

Source: NRCP

1.7.2 Polluted River Stretches Identification and Action Plan to Control of Water Pollution

For rational planning of any pollution control programme, complete knowledge of nature and magnitude of pollution is pre-requisite. To acquire such knowledge it is essential that a sound scientific water quality monitoring programme is established. The monitoring programme also helps prioritising pollution control efforts, establishing water quality trends and evaluating effectiveness of pollution control measures already in existence. Realizing this fact, CPCB in collaboration with concerned State Pollution Control Boards has initiated water quality monitoring at limited number of locations. The monitoring network was gradually augmented. At present there are 784 locations. The monitoring data are annually compiled, analysed and compared with desired water quality in different water bodies. Where-ever, gaps are observed especially with respect to pollution related indicators like Biochemical Oxygen Demand (BOD) the water body is identified as polluted. It is important to concentrate and prioritise pollution control efforts in order of merits. In 1988-89, CPCB identified 10 problem areas and 10 polluted river stretch to concentrate the pollution control efforts the list of polluted stretches formed the basis for formulation of River Action Plan of the National River Conservation Directorate. The list was further extended based on increasing pollution problem in our country. In the present exercise those water bodies having BOD more than 6 mg/l are identified as polluted water bodies. A list of such water bodies is attached. The respective State Pollution Control Boards/ Pollution Control Committee's were requested to formulate action plan to restore the water quality of the water bodies. This is for kind information of the Board.

Table 1.9: Polluted River Stretch over Godavari at Maharashtra

River	Polluted Stretch	Source/Town	Critical Parameters (in mg/l)
MAHARASHTRA			
Godavari	Nasik to (Raher) Nanded	Sewage from Nasik,Chandrapur,Nanded,Raher	BOD=6-66

Table 1.10: Status of wastewater generation, collection and treatment in class I cities and class II towns (MLD)

Type	Number of cities/town	Waste water generated (MLD)	Wastewater collected		Wastewater treated		
			MLD	% (of generated)	MLD	% (of collected)	% (of collected)
Class I cities	299	16662.5	11938.2	72	4037.2	33.8	24
Class II Towns	345	1649.6	1090.3	66	61.5	5.6	3.7
Total	644	18312.1	13028.5	71	4098.7	31.5	22.4

Source CPCB 2000

1.7.3 Domestic Pollution in Rural Environment

No figures are available about the non point source pollution due to domestic wastewater discharge in rural areas. According to the Central Statistical Organisation (CSO), 3.15 % of the rural population had access to sanitation services in 1993. This left around 563.6 million people living in rural areas had no access to toilets. Global numbers about this kind of pollution would not be very useful anyway, since the effect of such a pollution is essentially local, and intimately linked with the local practice of water fetching and hygiene.

1.7.4 Pollution by Industrial Effluents

Major Polluting Industries

The CPCB has laid down a list of major polluting industries in 1989. Those industries are subject to a special regime of inspection from the SPCBs and are subject to the water Cess. Those industries are :

1. Cement mills (above 200t/ day)

2. Sugar

3. Thermal Power plants

4. Distilleries

5. Fertilizers

6. Oil refineries

7. Caustic Soda Production

8. Petrochemicals

9. Zinc Smelting

10. Copper Smelting

11. Aluminum Smelting

12. Sulphuric acid

13. Integrated Iron and Steel

14. Pulp and Paper

15. Tanneries

16. Pharmaceuticals

17. Dye and Dye Intermediates

18. Pesticides

Source: CPCB 1989

1.7.5 Pollution by Large Industries

In 1992, the CPCB has launched a water pollution control program in order to tackle the problem of industrial pollution. It has identified 1551 large and medium industries, and given a time schedule for compliance with the prescribed standards. The progress report is presented in the following tables. According to these figures, a drastic reduction can be observed in the number of non-compliant industries. Doubts main remain, however, concerning the actual operation of the installed treatment units. There is indeed evidence that many industries only run their effluent treatment plant (ETP) during the inspections.

1.7.6 Pollution by Small Scale Industries

As mentioned in section 2, the toughest choice that Indian authorities have to face in term of industrial pollution control is posed by pollution small scale industries (SSIs). Indeed, the smallest facilities are the one for which adaptation to the environmental standard are less affordable. The number of SSIs is estimated to be over 0.32 million units, of which many are highly polluting. The share of the SSIs in term of wastewater generation among several of the major polluting industries was reported to be about 40%.

Table 1.11: Wastewater generation by SSIs in selected industrial sectors [12]

Industry	Wastewater generation (MLD)
Engineering	2125
Paper and board mills	1087
Textile	450
Organic Chemical	60
Tanneries	50
Pharmaceuticals	40
Dye and dye intermediate	32
Soaps,paints,varnishes and petrochemicals	10
Edible oils and vanapati	7

Source: CPCB, reported in Kathuria and Gundimeda (2001)

The following table provides some estimations of Pollution Load for the different industries.

Table 1.12: Estimated water pollution load (in tons) by industry.

Industry	**Estimates using Output Intensities**	**Ranking**	**Estimates using Employment Intensities**	**Ranking**
Aluminum	47469	3	0	16
Copper	16035	6	44495	9
Zinc	7737	8	22923	12
Iron and Steel	1639368	1	8093409	1
Cement	5168	11	28000	11

Oil Refinery	4340	12	16805	13
Drugs	5889	10	44736	8
Petrochemicals	1818	13	3805	14
Fertilisers	31480	4	106644	7
Pesticides	7366	9	37927	10
Caustic Soda	836	15	135691	5
Pulp and Paper	86245	2	801764	3
Leather	894	14	5316058	2
Dyes	0	16	1198	15
Distillery	7740	7	110334	6
Sugar	16747	5	217639	4

The WHO has defined a permissible limit of concentration of Nitrates of 45 mg/L of NO3, which is also accepted by the Indian Council of Medical Research (ICMR). The following chart shows the relation between N-Fertilizers in several states and the respective concentration of NO3 found in tube wells during a survey carried out in 1986. It can be observed that in states such as Haryana, the NO3 concentration was already exceeding by far the permissible limits in 1986. [12]

CHAPTER NO.2

REVIEW OF LITERATURE

2.1 The Godavari River Basin

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

Present status of River Godavari: Number of Researchers has monitored the river water quality in the past as discussed below.

1. Study carried out by the C.P.C.B (1995) on the Godavari River revels that the BOD values indicated in the river stretch from Gangapur to Nanded has been found polluted and the remaining stretch was found relatively clean in the year 1990 to 1999. The river water at Downstream of Nasik was grossly polluted and maximum BOD values were 8.9 mg/l during 1995.[13]
2. The work done by Dr. V.B Gaikwad and DR. V.R Gunale (1997-1998) on water quality of the Godavari River in and around Nasik region, "Pooled Pollution level"; a unique approach was implemented based upon pooling the rank of other pollutants. The fractional ranks due to individual pollutant 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: Godavari + Ahilya Sangram > Chikhali Nala (B.M.) > Underbridge > Gadage Maharaj Math >

Modakeshwar Temple > Godavari + Kapila sangam > Talkuteshwar temple > Gharpure Ghat (D.M.) > Ganagwadi Bridge > Eklahara (B.M.) > Eklahara (A.M.) >Hans Raj Yogashram > Pitrutirth > Kushawant > Ramtirth > Kashyapi River > Chikhali Nala (D.M.) > Dasak Bridge > Someshwar > Gharpure Ghat (A.M.) > Ramwadi Bridge > Ramkund > Kashyapi > Godavari sangam > K.T.H.M.Point > Chakratirth > Gangasager > Anandwali > Ganeshgaon bridge > Chikhali Nala (A.M.) >Dam Downstream. Physical parameters especially turbidity and colour, indicates 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 to be hazardous to create an impact; instead pooled pollution level makes vital impact on biological processes and hence it needs to be considered seriously. [16]

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

Table 2.1: Water quality of Godavari [17]

Sr.No.	Monitoring Station	PH	BOD	COD	DO
1	D/s of nasik (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	Dhanger Takli, Nanded	8.13	12.61	33.6	6.23
7	Dhalegaon (G)	8.07	10.32	25.11	5.94
8	Someshwar, Nasik	8.11	19.5	36.2	5.05
9	Anandawali, Nasik	8.3	10.0	38.5	4.78
10	Chikhali Nala, Nasik	8.2	10.8	39.7	4.77
11	Victoria Bridge	8.3	10.12	31.0	4.7
12	Saikheda village, Nasik	8.4	10.5	33.5	4.82
13	Nandur dam, Nasik	8.3	9.85	29.5	5.17
14	U/s of Paithan	7.6	8.2	24.9	19.2
15	D/s of Paithan	7.8	11.0	18.6	6.2

16	Wadwali Village	7.9	8.1	22.5	6.2
17	Shagad	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. Nanded is another major town on the bank of Godavari receives domestic waste. Islam SR, Gyananath G. (2002) from Swami Ramanand Teerth Marathwada University worked on contamination of chemical fertilizers in ground water and seasonal variations. Attempt was 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 physic-chemical parameters in groundwater.[14]
5. Tile (1998) analyzed water quality of the Godavari River from Someshwar to Panchak covering 12 km area. The physic-chemical analysis of water from various stations were as follows:

Table 2.2: Physico-Chemical Analysis of Godavari River [15]

Sr. No.	**Stations**	**Parameter**									
	Godavari	PH	DO Mg/l	BOD Mg/l	COD Mg/l	Hardness Mg/l	Ca Mg/l	Mg Mg/	Chloride Mg/l	Alkanity Mg/l	Oil & Grease Mg/l
1.	Someshwar	7.6	4.9	7.5	17.0	90.0	50	25	40.5	48	90
2.	Anandwali	7.5	5.0	12.0	31.0	75.0	37	24	56.19	55	75
3.	K.T.H.M.	7.8	5.1	7.4	15.0	52.0	24	1	39.15	65	56

Sulphate	53.5	55.8	69.4	59.4	58.6
Phosphate	0.172	0.1	0.269	0.258	0.175
Sodium	6	8	9	10	11
Potassium	1	1	2	3	2

6. The growth of civilization and subsequent needs for better living standard of human being has caused great impact on the environment. The various issues and challenges before the mankind for utilization of natural resources for a sustainable development have compelled to look back at various environmental problems at different levels. One of the major environmental problems is the pollution of surface water body due to discharge of domestic and industrial effluent. According to Odum (1971), "Pollution is an undesirable change in the physical, chemical or biological characteristics of our air, water and land that may or will harmfully affect human life or that of desirable species or industrial processes, living conditions and cultural assets, or that may or will waste or deteriorate our material resources". Human waste was historically the first pollution problem. In ancient times, people naturally settled near source of water and thus, communities grew besides lakes, along rivers, and in areas where spring or well water was available.
7. The environmental issues had dominated after Stockholm conference in 1972 and this has led to growing realization of the problem of water pollution, resulting in a rapid proliferation of hydro biological studies. As a result, rivers are being studied for the past several years by various departments and researchers of different discipline. Besides this, various conference were held to focus the attention of the Central and State Government and particularly of the public toward the deteriorating condition of our rivers. The growth of literature and data based on water pollution with special reference to urbanization and industrialization has been influenced after the implementation of the Ganga Action Plan, 1985. The growing population and subsequently urbanization and industrialization are unabatedly polluting the rivers. The quality of the river water starting from the sources to the sea is a mirror of the human activities. The water is drawn for use such as drinking, washing, agriculture, industries and other purposes and return to the river as an effluent along the flow path. As a result, due to increasing industrialization and urbanization and other anthropogenic activities, fresh water is becoming an increasingly scarce resource. As population and development pressure continue to grow, most of our water bodies have

become polluted (Saluja and Jain, 1998). Murugesan and Sukumaran (1999) noted that rapid population growth, increasing living standard, wide sphere of human activities, growing urbanization and industrialization have resulted in greater demand of good quality water, while on the other hand pollution of water resources is also increasingly steadily in the future days. The riverine resources of India containing 113 river basins out of which 14 are major, 44 medium and remaining 55 are minor rivers. The fourteen major river basin account for 83 % of the total area of the basin and contributes 85 % of the total surface flow and covers 80% of the total length (Nilay Chaudhuri, 1983) [7]. A river basin of 720000 km2 catchments area characterizes the major rivers (Rao, 1979; Jhingran, 1991 and Gopakumar et al., 2000). [18].

8. The main cause of river pollution is due to discharge of industrial effluent, domestic sewage, agrochemical and other human activities. Regarding to the human health, number of diseases affecting heart, kidney and bones are caused due to pollution of the aquatic system. Nearly 20 lakh people are dying annually due to polluted water in India. The polluted water takes the life of one child in every minute in India.

9. The Central Pollution Control Board (CPCB) has brought out the amount of deterioration of water quality over the years as per analysis of river water from 1986 to 1977. The Board also indicated that mean BOD values have gone up in the entire major river during the last two decades. Water quality assessment in respect of BOD values indicates that Kerala is at the bottom and Maharashtra at the top in 1997. Regarding to coliform bacteria, the most affected states are Assam, Uttar Pradesh, Gujarat and Tamil Nadu. In respect of chemical pollution, Gujarat ranks first and next followed by Maharashtra, Andhra Pradesh, Tamil Nadu, Uttar Pradesh and Punjab. Recent survey has revealed that almost all major river in India have become highly polluted (Mahajan, 1988). [19]

10. The World Health Organization (WHO, 1985) found that more than 1000 organic compounds are present in river water and effluents. The confluence of such effluents has great impact on the physico chemical and biological character of the river system. The nature and health of the aquatic communities indicate an expression of the quality of water. The gradual increasing high values of physico chemical parameters might have eliminated all the indigenous life leading to the formation of biological desert. (Rana and

Palria, 1982). The growth of civilization and subsequent needs for better living standard of human being has caused great impact on the environment. The various issues and challenges before the mankind for utilization of natural resources for a sustainable development have compelled to look back at various environmental problems at different levels. One of the major environmental problems is the pollution of surface water body due to discharge of domestic and industrial effluent. During the Industrial Revolution of the 19th century, cities in the United States and Western Europe grew at a tremendous rate. Refuse of all kinds including great quantities of horse manure ended up in the streets, open sewers and nearby rivers. Devastating epidemics of water borne diseases such as cholera, typhoid and dysentery were common in large cities. [20]

11. By the early part of the 20th century, the connection between diseases and sewage-borne microorganisms had been recognized. Luis Pasteur (1822-1895) and Robert Koch (1843-1910) postulated the Germ theory of disease. This focused attention of the scientific community to the safe disposal of domestic sewage and need to practice sanitation. Accordingly, safe water supplies were established in most industrialized nations. As a result, water borne diseases have been virtually eliminated in those countries; however, those are still very common in less developed countries, where waste disposal systems are often inadequate or non-existent. In industrialize nations; contamination with hazardous chemicals has become the main threat to the surface water body. Therefore, it becomes necessary to assess and monitor the water quality of the surface water body to determine its acceptability for the different uses as well as pollution status of the water body. If the level of pollution increases above the acceptance level, then necessary control measures have to be established. However, before setting any control measure, we should know the effectiveness of such measures and for this, water quality model has to be developed for the surface water body. Water quality model will help in predicting water quality responses of the water body in different load condition and allow us to choose alternative option. [9]

12. The Water Quality trend between year 2002 to 2006 in terms of BOD in river Ganga, Yamuna, Sabarmati, Mahi, Tapi, Narmada, Godavari, Krishna, Cauvery, Mahanadi, Brahmani, Baitarni, Subernarekha, Brahmaputra, Satluj, Beas, Amlakhedi and Kali (East) suggest:

Decreasing trend of BOD in river Ganga, Tapi, Narmada, Krishna, Cauvery, Mahanadi, Brahmani, Baitarni, Brahmaputra, Satluj, Beas and Amlakhedi.

Increasing trend of BOD in river Yamuna, Sabarmati, Mahi, Godavari and Kali (East).

13. The entire stretch of River Yamuna is being regularly monitored by Central Pollution Control Board at 21 locations. The water quality status of the river during the year 2006 in terms of Dissolved Oxygen (DO), Bio-chemical Oxygen Demand (BOD), Total Coliforms (TC) and Faecal Coliforms (FC) is depicted in figures below below. The river maintains good water quality from origin at Yamunotri till Delhi upstream at Palla and DO and BOD generally meeting the standards. At Sonepat & Palla, the annual BOD average has been slightly higher than the limit due to accidental pollution discharges in the river by the towns located upstream. The river water quality deteriorates from Delhi downstream till upstream Chambal confluence. The Delhi stretch is the most polluted stretch of the river where BOD generally exceeds the limits at all the locations.

The water quality data on rivers, lakes, ponds, tanks and groundwater locations being monitored under the network is evaluated against the water quality criteria and the monitoring locations in exceedence with respect to one or more parameters are identified as polluted, which requires action for restoration of water quality. The locations on rivers, lakes, ponds, tanks and groundwater not meeting the criteria are summarized ahead. [10]

14. The Biochemical Oxygen demand (BOD), one of the most important indicator of pollution, was observed highest in Amlakhadi river at Ankleshwar (947 mg/L) followed by Markanda river d/s Kala Aam, HP (855 mg/L), Khari river at Lali village, Ahmedabad (580 mg/L), River Sabarmati at Ahmedabad (380 mg/L), River Kalinadi at Gulauti, UP (165 mg/L), River Hindon at Binauli and Saharanpur (90-100 mg/L), River Satluj d/s Ludhiana (64 mg/L), River Khan at Kabitkhedi, Indore, MP (60 mg/L), River Musi at Hyderabad (42 mg/L), River Bhima at Pune (42 mg/L), River Damanganga d/s Daman (42 mg/L), River Bharalu at Guwahati, Assam (38 mg/L), River Yamuna between Delhi and Etawah (10-35 mg/L), River Kalana at Chandel, Goa (37 mg/L), River Tapi at Ajanad, Maharashtra (36 mg/L), River Dhadar at Kothala (30 mg/L). Because of high BOD, dissolved oxygen was observed either nil or very low most of the time in these stretches. [20]

15. Total numbers of observations having BOD less than 3 mg/l, 3 to 6 mg/l and above 6 mg/l were 68%, 18% and 14%, respectively. The total number of observations having Total Coliform number less than 500 MPN/100 ml was 46%, between 500-5000 MPN/100 ml was 31% and exceeding 5000 MPN/100 ml was 23% MPN/100 ml. Similarly the number of observations having Faecal Coliform bacterial count less than 500 MPN/100 ml was 60%, between 500-5000 MPN/100 ml was 28% and 12% observations were exceeding 5000 MPN/100 ml. [20]
16. Fecal coliform, another important indicator of pollution, was found highest in Yamuna River in Delhi (MPN 3.9 x107) followed by River Hindon after confluence with River Krishni (2.1x106), River Ganga at Dakshineshwar (7x105), Rabindrasarovar, Kolkata (8.5x105), River Damodar at Haldia (4x105), River Khari at Lali Village, Ahmedabad (2.8x105), River Sabarmati at Ahmedabad (2.4x105), River Bharalu, Assam (2.4x105), River Ganga at Varanasi ((1.1x105), River Satluj at Ludhiana (0.9x105), River Tapi at Bhusaval (9x104), River Kalinadi at Muzaffarnagar (9x104), River Ghaggar (9x104), River Sabarmati at Ahmedabad (7.5x104), River Gomti at Lucknow (7x104), River Godavari at Nasik (5x104) and River Musi at Hyderabad (4x104). [10]
17. Lakes and Tanks that have high concentration of organic matter and do not comply to the standard limits for BOD are Hussain Sagar lake, Dharamsagar tank, Bibinagar lake, Kistarareddypet tank, Saroornagar lake, Pulicate lake, Gandhigudem tank, Heballa Valley lake, Kayamkula lake, Kodungalloor lake, Osteri lake, Bahour lake, Udhagamandalam lake, Kodaikanal lake, Periyar lake, Vembanad lake, Ashthamudi lake and Paravur lake. Lakes and Tanks having very low DO and high BOD that does not meet the water quality criteria limits are Kankoria Lake, Chandola lake, Pichola Lake, Udaisagar lake, Fatehsagar lake, Kayalna lake, Nakki lake, Pushkar lake, Lower lake Bhopal, Renuka lake, Harike lake, Naini lake, Ramgarh lake, Rabindra Sarobar lake, Elangabeel System, Goy Sagar Tank, Loktak lake at Sendra, Umiam lake at Barapani, Ward Lake at Shillong, Thadlaskena lake and Laxminarayan Bari Place Lake.
18. The groundwater monitoring locations, where high conductivity exceeding water quality criteria for irrigation were observed at Ramagundam, Bollaram Panchayat Office, Pashamaylam, Vishakhapatnam (near Rama Temple) and Kakinada (near Pratap Nagar Bridge) in Andhra Pradesh; Nerol in Gujarat; Alwaye in Kerala; Circuit house, old police

Barracks, Ottavathilpalli, near Helipad, MPSAF Quarters and Government Press in Lakshadweep; along Chunamber river in Pondicherry; and Pali, Jodhpur and Vidhani Village (Jaipur) in Rajasthan. Groundwater locations with BOD levels higher than the criteria are at Vijayawada, NTPC ash pond- kundanpally, Bibi nagar Primary school, Rudravally, near Tungabhadra river in Kurnool and Nandyal in Andhra Pradesh; Karbianglong and Bongaigaon in Assam; Kala Amb, Barotiwala and Paonta Sahib in Himachal Pradesh; JB School, Kadatpalli, near SB School, Ottavathilpalli and Chakikilum in Lakshadweep; Collector Well in Thirupuvanam and along Chunamber river in Pondicherry; near Kansua Nallah in Kota, Pali town, Jodhpur in Rajasthan; IOC Refinery Haldia, Barasat municipality in north 24 Parganas in West Bengal. Total coliforms are exceeding the criteria limits in groundwater locations in Silcher, Barpeta, Bongaigaon, Sibsagar, Guwahati in Assam, Chekkillam, Government press and old Police Barrack in Lakshadweep. pH is observed in acidic range at Kundra in Kollam, Punkunnam in Trissur, Kalamassery in Ernakulam, Punalur and Kannur in Kerala; and Capital hospital in Bhubaneshwar Orissa.

CHAPTER NO.3

STUDY AREA

3.1 GODAVARI RIVER –THE STUDY AREA

The Godavari basin extends over an area of 3, 12,812 sq km which is nearly 10 percent of the total geographical area of the country. The basin lies between latitudes 16° 16' N and 22° 43' N and longitudes 73° 26' E and 83° 07' E.Godavari basin is shown in Fig 3.1. Over half of the river basin (18.6 million ha), is categorized as cultivable land. Godavari is second largest river in India which attaches considerable significance to the Hindu mythology; Godavari is often referred to as the Vriddh (Old) Ganga or the Dakshin (South) Ganga.

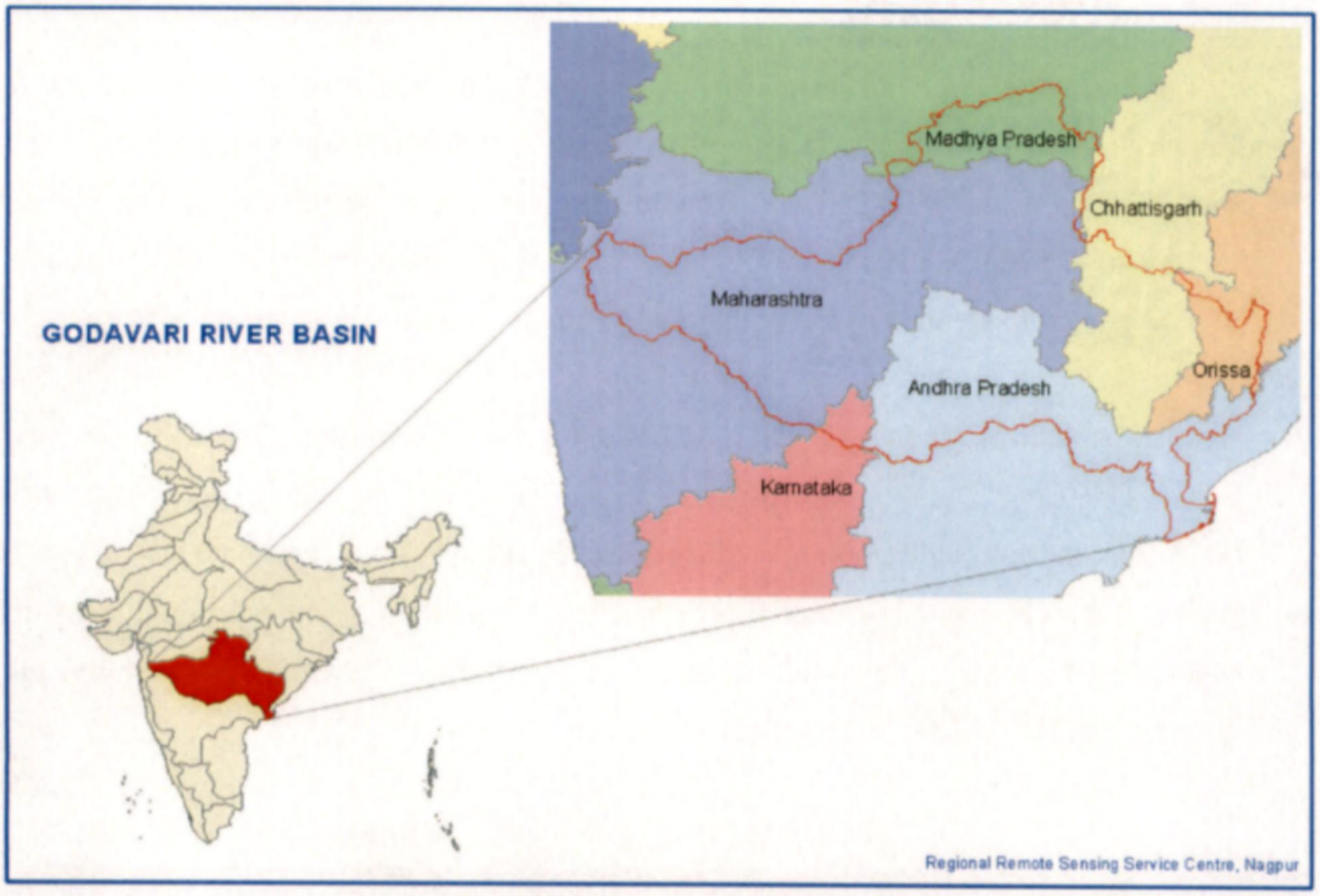

Fig 3.1: Godavari River Basin [10]

Godavari river stretch from the Nasik (i.e. from Gangapur Dam) to Aurangabad (up to shahagad) has been selected for the study. This stretch is in Maharashtra state affected by the effluent from industries. The most polluted stretch of Godavari in Maharashtra state is from Nasik to Nanded (Raher), as given in table 3.1.

Table 3.1: Polluted River Stretch over Godavari at Maharashtra [3]

River	**Polluted Stretch**	**Source/Town**	**Critical Parameters (in mg/lit)**
MAHARASHTRA			
Godavari	Nasik to (Raher) Nanded	Sewage from Nasik,Chandrapur,Nanded, Raher	BOD=6-66

The Godavari originates near Triambak in the Nasik district of Maharashtra, and flows through the states of Madhya Pradesh, Karnataka, Orissa and Andhra Pradesh. Although its point of origin is just 380 kms away from the Arabian Sea, it journeys 1,465 kms to fall into the Bay of Bengal. Pollution of Godavari river water from its source of generation i.e. Trimbakeshwar to Nanded to field input due to human activity.

The stretch of about 213 km is selected for the present study from the upstream of Nasik (Gangapur Dam) to downstream of Aurangabad City (Shahagad). Samples were taken from the selected sampling stations i.e seven stations from Nasik and six stations from Aurangabad. The reconnaissance survey has been carried out before selecting the sampling stations, sampling schedule and frequency of sampling. Following fig 3.2 shows all the sampling station which covers the study area.

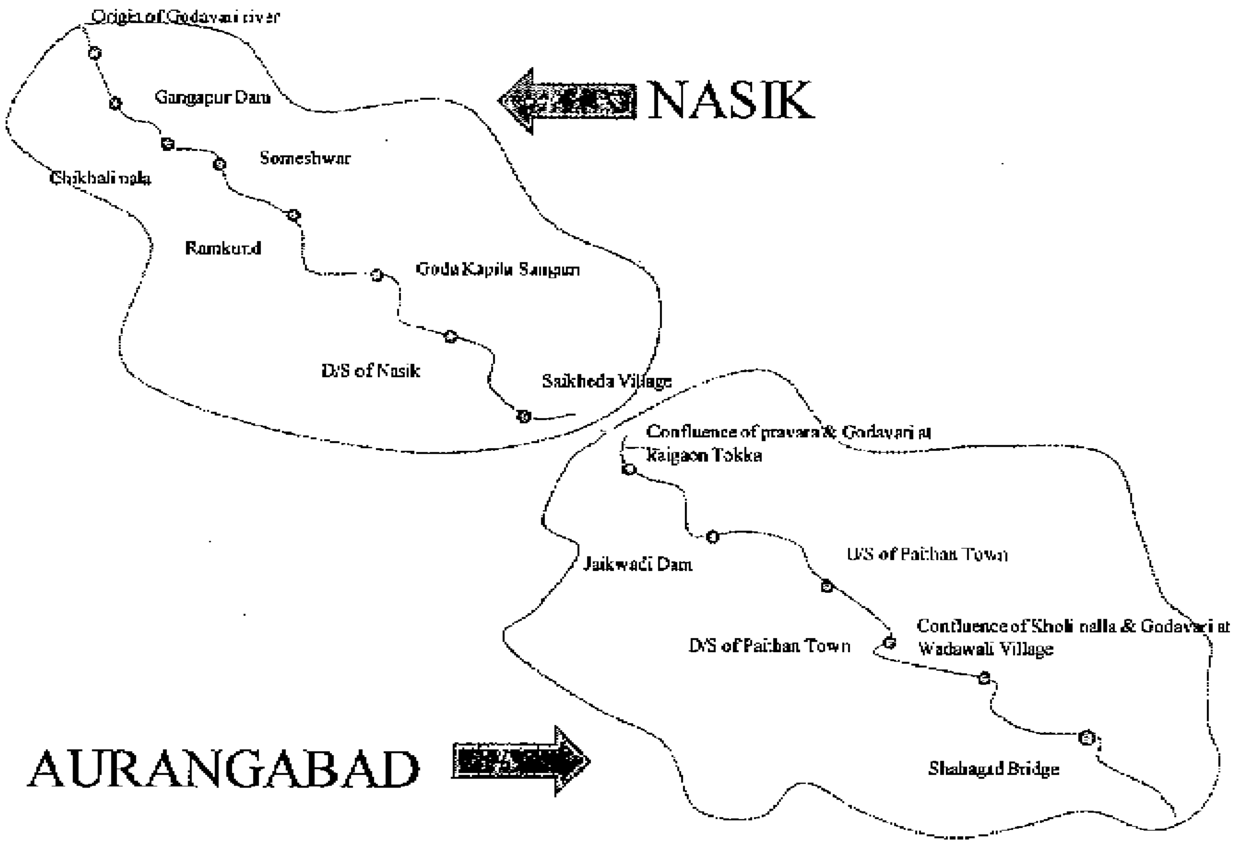

Fig. 3.2: .Sampling stations at Nasik and Aurangabad

The study area at Nasik stretch falling within the pilgrim place where has become dustbin for eventual disposal of all sorts of pollutants (waste water, debris etc.) due to the rapid and unplanned growth of human settlements along both sides of the river banks, insufficient sewage disposal and treatment facilitates lack of bathing ghats, Dhobi Ghats (place for washing clothes), Place for washing of animals, vehicles etc. During last Kumbhmela 2003-2004 period lot of work completed for conservation of Godavari River like 78 MLD Sewage Treatment Plant at Tapowan, Nasik, 7.5 MLD STP at Dasak Village and 12 MLD STP at Takali Village, apart from this Solid Waste Treatment Plant and Bio-medical waste treatment and disposal plant were installed.

The study area at Aurangabad stretch starts from the Kaigaon Toka and end at shahagad. There are about six sampling points which are selected for determining the pollution strength. The River is heavily polluted due to the Domestic and industrial activities. At Kaigaon Toka the river is polluted because of the Human activities and agricultural run-off. Next sampling point is Jaikwadi dam which is polluted due to Agricultural run-off, fertilizers and pesticides. Other sampling points are mainly polluted due to industrial and domestic wastes.

In this dissertation, the survey of area around river Godavari that contributes the discharge of sewage was carried out. Their pollution strength was determined by performing tests from the samples from these polluted sources. The tests were performed on the samples for 12 months to study the variation in the pollution strength due to variation in flow condition and seasonal change. The following tests were carried out:

1) pH	7) Electrical Conductivity
2) Dissolved Oxygen (DO)	8) Potassium
3) Biological Oxygen Demand (BOD)	9) Sulphates
4) Chemical Oxygen Demand (COD)	10) Phosphates
5) Total Hardness	11) Nitrate
6) Magnesium Hardness	12) Total Dissolved Solids

3.2 OBJECTIVES OF THE CONSERVATION PLAN FOR THE GODAVARI RIVER

1. To conserve the basic natural resource like soil and water from degradation in catchment area.
2. To impact stability crop to yield in agricultural fields through improved management practices.
3. To create the awareness among the local people activates with respect to soil, water and forest area and agricultural area and the impact on environment.
4. To develop alternative land use along the river basin.
5. To control flood, landslides, soil erosion and sediment travel in the upstream catchment area by implementing the soil conservation techniques.
6. To control the effluent from textile industries by introducing zero liquid discharge and recycling and reuse of waste water and solid generated in the industries.
7. To provide experience and educating to the farmers and the stakeholders by creating public awareness.

8. To check environment degradation and maintain ecological balance.
9. To implement land management and water management at micro level to improve the ground water recharge capacity.
10. To implement the ecological utilization of water such as drip irrigation and sprinkler irrigation.
11. To implement the indigenous techniques of proper bunding and terracing works to arrests the undefined waterways.
12. To conserve the good old trees and to promote the tree afforestation programme with community involvement.
13. To arrest the water losses in jungle streams by adopting indigenous techniques and communities involvement.

3.3 METHODOLOGY FOR STUDY

To complete any type of conservation work we have to follow specific path..For carrying out present study following methodology has been adopted for the Rapid EIA is given below.

1. Reconnaissance survey
2. Data Generation (Primary)
3. Data Collection (Secondary)
4. Establishment of the Baseline Environmental scenario
5. Environmental Impacts and Mitigation Measures
6. Suggesting an appropriate Environmental Management Plan
7. Risk Assessment and Vulnerability Analysis

The methodology for this dissertation work includes the reconnaissance survey before locating the sampling stations, sampling schedule and frequency of the sampling. In the reconnaissance survey, the identification of the point and non-point sources was done. Identification of point and Non-point sources is very important task because the sources which pollute the river have to be finding out and accordingly we have to take our further steps. After finding out the sampling stations, the sampling schedule was done. The monsoon affect the water quality of the river i.e. in post monsoon water quality is not so good but in pre monsoon the water quality is good .Next step was sample collection, After sample collection, testing was carried out. Based on the testing, sample analysis for conservation plan was carried out.

3.3.1 Reconnaissance Survey

The reconnaissance survey has been carried out before selecting the sampling station, sampling schedule and frequency of sampling. The following information was collected during the reconnaissance survey:

a. The industrial effluents confluence with the Godavari river water.
b. The domestic waste water is directly discharging into the river.
c. Two crematoria are used on the bank of Godavari river
d. The waste water including urine, sewage, bio-medical waste and solid wastes of the Nasik city are directly discharging into the river..
e. River water is being utilized for agricultural purposes at Nasik corporation area.

Sampling programmes designed to monitor physico-chemical characteristics were carried out at frequencies between weekly and monthly. However, such regular sampling be augmented by more detailed surveys, e.g. of 24-hour duration, carried out in the more important reaches at critical periods. The most important period is likely to be in the summer or autumn months when river flows are at their maximum, water temperatures are at their maximum and dissolved oxygen levels are at their lowest. The Central Pollution Control Board (CPCB) was constituted as Central Board for Prevention and Control of Water Pollution (CBPCWP) on 22nd September, 1974 under the provisions of The Water (Prevention & Control of Pollution) Act, 1974, and later under The Water (Prevention & Control of Pollution) Amendment Act 1988 (No. 53 of 1988) its name was amended as Central Pollution Control Board. The main functions of CPCB, as spelt out in The Water (Prevention and Control of Pollution) Act, 1974, and The Air (Prevention and Control of Pollution) Act, 1981, are:

(i) To promote cleanliness of streams and wells in different areas of the States through prevention, control and abatement of water pollution; and,

(ii) To improve the quality of air and to prevent, control or abate air pollution in the country.

The Central Pollution Control Board has been playing a key role in abatement and control of pollution in the country by generating relevant data, providing scientific information, rendering technical inputs for formation of national policies and programmes, training and development of manpower and through activities for promoting awareness at different levels of the Government and Public at large.

The Central and State Pollution Control Boards/ Pollution Control Committees in Union-Territories in India are responsible for restoration and maintenance of the wholesomeness of aquatic resources. To ensure that the water quality is being maintained or restored at desired level it is important that the pollution control boards regularly monitor the water quality. The water quality monitoring is performed with following main objectives.

i. Rational planning of pollution control strategies and their prioritization;
ii. To assess nature and extent of pollution control needed in different water bodies or their part;
iii. To evaluate effectiveness of pollution control measures already is existence;
iv. To evaluate water quality trend over a period of time;
v. To assess assimilative capacity of a water body thereby reducing cost on Pollution control;
vi. To understand the environmental fate of different pollutants.
vii. To assess the fitness of water for different uses.

3.3.2 Parameters Analyzed

Analyses of the following water quality parameters, carried out in order to detect pollution of Godavari river. Samples are to be collected from the drainage outfall point, river water as well as from the sediments of the river.

1. Physical parameters like PH, Temperature (^{0}C),Turbidity (NTU), TSS (mg/l), TDS(mg/l),Color, taste & odour, Electrical conductivity (μ-mho/cm), Radioactivity etc.
2. Chemical parameters like BOD, COD, DO (mg/l), Ca, Mg as $CaCO_3$, Oil & grease (mg/l), Sulphates, Chlorides etc.

3. Biological parameters like Total coliform (MPN/100ml), Faecal coliform (MPN/100ml)

3.3.3 Sampling Points and Sampling Schedule

Godavari River is the second largest river in India. 13 sampling stations were selected along along the basin of Godavari. 7 sampling points at Nasik City and 6 sampling points at Aurangabad city. The sampling Points were selected after the reconnaissance survey. Sampling Points and their Description for Nasik and Aurangabad city are as follows.

Table 3.2: Station code and date of sampling for Nasik City

Sampling station code and Name	**Date of Sampling**	**Description of station**
K_1 -Gangapur Dam	03/02/2010	Dam is sources of drinking water
K_2 -Chikhali Nala	03/02/2010	Heavy industrial waste is coming through it
K_3-Someshwar	03/02/2010	Bathing,washing activites and puja material thrown
K_4-Ramkund	03/02/2010	Mass bathing activities
K_5-D/s of nasik	03/02/2010	Treated waste water from sewage treatment plant
K_6-Goda- kapila sangam	03/02/2010	Kapila river meets, sewage water is added
K_7-Saikheda Village	03/02/2010	Remains/ashes of human dead bodies sewage waste water ,Hospital waste and over flow from septic tanks is discharged to the river

Table 3.3: Station code and date of sampling for Aurangabad City

Sampling station code and Name	**Date of Sampling**	**Description of station**
P_1-Kaigaon Toka	08/02/2010	U/s of Nat sager Reservoir

P_2-Jaikwadi Dam	08/02/2010	Pollution Through Agricultural Runoff ,Fertilizers & Pesticides
P_3-U/s of Paithan Town	08/02/2010	At Paithan Intake Pump House
P_4-D/s of Paithan Town	08/02/2010	Pollution Due to Domestic sewage & Human Activities At Pathegaon Bridge
P_5-Wadwali Village	08/02/2010	Domestic Pollution
P_6-Shahaghad	08/02/2010	Industrial & Domestic Pollution At Jalna Intake Water House

3.3.4 Sample collection Procedure

All samples were collected and tested, in the Maharashtra Pollution Control Board Laboratories. All samples were collected and conditioned to determine various parameters, as specified in following "Standard Methods". All samples were transferred to the laboratory within the four hours collection.

Sr. NO	Sample For	Preservation Method
1.	Dissolved Oxygen (DO)	D.O. fixed at site using $MnSO_4$, and Alkali Iodide Azide
2.	BOD, COD, solids etc.	Preservation in ice

The collection of samples has been shown in the figure from 3.3 to Figure 3.14.

Fig.3.3: Chikhali Nala

Fig.3.4: At Chikhali Nala

Fig.3.5:At Ramkund

Fig.3.6: At MPCB Laboratory

Fig.3.7:Samples Collected

Fig.3.8: Sample collected at Someshwar

	
Fig.3.9:Sample Collected	**Fig.3.10: At Tapovan**
	
Fig.3.11:At D/s of Nasik	**Fig.3.12: At Chikhali Nala**
	
Fig.3.13: Nala going in to Godavari river	**Fig.3.14: Nala Going in to Godavari River**

3.3.5 Sources of Human Pollution

A. Pollution by Domestic Wastewater

In the tenth plan document from the Indian planning commission sewage alone was reported to be responsible for 80% of the total water pollution in the country. Like most other rivers, domestic pollution is the biggest polluter of the river Godavari, accounting for 82 per cent of total pollution, whereas industrial pollution accounts for about 18 per cent.

B. Domestic Pollution in Urban Environment

Theoretically, the Indian cities and towns are accountable for their wastewater discharge. Therefore, they are supposed to collect and treat all their wastewater. They are also supposed to pay a water cess proportional to their water consumption to the local State Pollution Control Board (SPCB). In practice however, these rules are not applied. As it is illustrated by the CPCB statistics presented hereunder, even the class I cities, (the largest Indian cities) are treating a small part of their effluents, while the smaller towns practically don't have any treatment facilities. The SPCB do not feel they have enough authority to impose some pressure on the municipalities to have them comply with the regulation. In such a situation, the incentive for the municipal bodies to enhance the collection and treatment of wastewater comes from the local demand for better quality.

3.4 STATUS OF POLLUTION OF GODAVARI RIVER

Present status of Godavari River is not good at Nasik because it is a holy place and people come over there to take bath. They believe that one dip in Godavari river will make free from their sins. Pollution of the river starts from Kushawart where people take holy bath and wash cloths, which is a religious cum tourist spot. Domestic waste of Someshwar released in the river without any treatment. Chikalli nalla, which joins the river next to Someshwar and before Anandwali station, sometime release wastewater from Satpur and Ambad MIDC industrial areas. At Anandwali station everything, which is waste or unwanted, is dumped at the bank of the river and also the pollution in the river is due to the domestic sewage discharged in it. At Ramkund station large number of Pilgrims converges to take holy dip in its water and performs various religious rites besides worshiping and burning of dead bodies etc. While on the other hand it has become a dustbin for eventual disposal of all sort of pollutants (debries, wastewater, Nirmalya, Asthi and Raksha – Visarjan etc.) necessitated due to the rapid and unplanned growth of human settlements along both sides of the riverbank, inadequate sewage disposal and treatment facility, lack of bathing ghats and direct discharge of Waghadi nalla water. Like most other rivers, domestic pollution is the biggest polluter of the river Godavari, accounting for 82 per cent of total pollution, whereas industrial pollution accounts for about 18 per cent.

Present status at Aurangabad is also not good because rapid urbanization and industrialization the river water quality decreases day by day. The water quality at Kaigaon Toka is somewhat in the range of bad to medium due to domestic and industrial waste at upward of the Jaikwadi Dam i.e the point where the River water meets with the Nath sager Dam the water quality is medium.Upstream of Paithan the water quality is good but at the down-stream of pithan the water quakity is decreased due to increasing pollution load. It till increases to Wadvali village and Shahagad with additional industrial and agricultural run-off, pesticides and Pesticides.

Table 3.4: Classification of water body based on "Designated best use" [21]

Sr. No.	Designated Best Use	Quality Class	Primary quality criteria
1	Drinking water source without conventional treatment but with disinfections	A	PH 6.5–8.5; DO≥6.0; BOD< 2; MPN< 50
2	Organized outdoor bathing	B	PH 6.5–8.5; DO≥ 5.0;BOD≤3.0;MPN<500
3	Drinking water source with conventional	C	PH 6.5-8.5; DO≥6.0;

	treatment followed by disinfections		BOD≤5.0; MPN<5000
4	Propagation of wildlife and fisheries	D	PH 6.5–8.5; DO≥6.0; $NH_4^+ \leq 1.2$
5	Irrigation, Industrial cooling and controlled water disposal	E	PH6.5–8.5;Na absorption ratio max 20

3.5 DATA COLLECTION FROM NASIK AND AURANGABAD

The data related with the water quality of the Godavari River at Nasik and Aurangabad city were collected from the Government Authority i.e. Maharashtra Pollution Control Board (MPCB) Nasik and Aurangabad. Two industrial areas in Nasik namely Ambad and Satpur Industrial Areas have been developed under Nasik Municipal Corporation. Due to which the population of Nasik city has increased considerably in the short period. The population according to 2001 census has crossed the mark of 14, 00,000, leading to the development of large number of residential areas without considering drainage system. Nasik is an industrial and developed city in the state of Maharashtra and the Godavari River is flowing through the city. The development is growing after establishment of the industrial area of Satpur and Ambad MIDC. Industrial development in that area is mainly due to large and medium scale industries like Motor Industries Company Limited (MICO), Mahindra and Mahindra, VIP Industries, Ceat Limited, Carbon Corporation Limited, ABB Limited, BCL Forging Limited, Gloxo Limited, Siemens, Garware Polyester Ltd, Gabriel and so on, nearly 125 large scale and 350 medium scale units along with 2500 small scale units are presently running in these industrial estates. All these units are at the upper part of the City and on the bank of Godavari river. All this large scale, medium scale units and other small scale industrial units were set up under the private and public sectors. This has initiated the massive industrial growth in the area. Some tertiary industries such as laundry, hotel, restaurant, pathological laboratories and nursing home etc are growing in and around the Godavari river. The water of Godavari river is being used by people for domestic purposes such as drinking, bathing, cleaning and other aesthetics purposes.

Aurangabad is an industrial and developed city in the state of Maharashtra and Godavari river is flowing through it. Polluted water from the industries and domestic waste, pollute the river, Aurangabad encompasses 19 MIDC areas, which includes Chikhalthana, Waluj, and Paithan MIDC area. In Aurangabad, there are 2447 industries including small, medium scale and large scale industries. In Aurangabad Shendra is emerging as five star industrial estates. The industries are rapidly developing and occupying private lands including Aurangabad – Paithan high-way. This industry produces medicines, beverages, cold-drinks, chemicals etc. in addition to large place occupied by sugar industries.

The present study is concerned towards waste water quality management of river Godavari in Nasik city. From Kushawart Trimbakeswar (source of water) to the Saikheda village, within which the several activities like washing of cloths, washing of vehicles, washing of animals, Bathing activities, sewage disposal of nallas causing the pollution meets the river in the area only. The work also included identification of pollution sources based on the survey of area around river Godavari contributing the discharge of sewage. The sampling points were located in the stretch considered for the study. The CPCB as well as MPCB data considered as secondary data where as data collected for testing the pollution load of these locations were processed to compute the NSF water quality indices. The samples were taken these locations in the month of February 2010. The main parameters analyzed were carried out like pH, total suspended solids, total dissolved solids (TDS), dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), total hardness, nitrate, phosphates, electrical conductivity, faecal coliform, chlorides, and sulphates etc.

3.6 RAINFALL AT NASIK

Though average rainfall of the Nasik district is between 2600 and 3000 mm, there is wide variation in the rainfall received at various blocks. Most of the rainfall is received from June to September. The maximum temperature in summer is 42.5 degree centigrade and minimum temperature in winter is less than 5.0 degree centigrade. Relative humidity ranges from 43% to 62%. Climate of the Nasik is generally comparable with that of Bangalore and Pune because of its pleasant nature. However in recent years, it is noticed that the temperature is increasing and the rainfall is decreasing due to industrialization and fast deforestation. Rainfall for Nasik city is given in Table 3.6.

3.7 RANFALL AT AURANGABAD

Aurangabad district has only one rain gauge station at Aurangabad with records available for last 70 years. The details of rainfall at this station and for the district are given in Tables 2 and 3. The average annual rainfall in Aurangabad is 725.8 mm (28.57"). Seven other rain gauge stations were started in 1951. The average annual rainfall in the district, taking into consideration all the stations (based on 9 years' data from 1951), is found to be slightly lower than the rainfall at Aurangabad. The description that follows is based on the rainfall data of Aurangabad only. About 83 per cent of the annual rainfall is received during June to September. July is the rainiest month. Some amount of rainfall occurs during May, October and November and is mainly in the form of thundershowers. The variation in the annual rainfall from year to year is large. During the forty-nine year period from 1902 to 1950 the highest annual rainfall which was 161 per cent of the normal occurred in 1916 while the lowest annual rainfall which was only 37 per cent of the normal occurred in 1920. During the same forty-nine years the rainfall was less than 80 per cent of the normal in 12 years; such low rainfall has been recorded once each on two, three and even four consecutive years. The annual rainfall at Aurangabad was between 500 and 1000 mm (19.69 and 39.37") in 36 years out of forty-nine. Rainfall for Aurangabad city is given in annexure no.5.On an average there are 46 rainy days (i.e., days with rainfall of 2.5 mm-10 cents-or more) in a year at Aurangabad.

3.8 SOURCES OF POLLUTION

The sources of pollution of the Godavari River are classified as;

- Point sources

Table 3.5: RAINFALL DATA FOR NASIK AND AURANGABAD (From 2004 to 2008) [34]

State	District	Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Decr	Annual Total
Nasik city rainfall Data															
MAHARASHTRA	NASIK	2004	0	0	0	0	24.1	173.5	240.6	584.1	214.4	85.6	2	0	1324.3
MAHARASHTRA	NASIK	2005	0.5	0	0	2.2	3.3	388.3	395.4	260.8	394.4	45.8	0	0	1490.7
MAHARASHTRA	NASIK	2006	0	0	0.9	0.1	2.1	155.3	516.7	615.4	217.1	55.6	10.7	0	1573.9
MAHARASHTRA	NASIK	2007	0	0	0	2.8	0.1	270.3	349.5	330.7	237.3	0	5	0	1195.7
MAHARASHTRA	NASIK	2008	0	0	0	1	0	53.2	246.2	353.7	475.5	53.8	0.2	0.5	1184.1
Aurangabad city Rainfall Data															
MAHARASHTRA	AURANGABAD	2004	1.1	0	0	0	3.7	97	190.9	99.3	750.8	68.8	3.4	0	715
MAHARASHTRA	AURANGABAD	2005	0.2	0.1	0.9	0	1.4	43	254.2	106.3	224.7	68.7	0	0	699.5
MAHARASHTRA	AURANGABAD	2006	0	0	3.2	0	15.6	214.7	200.7	282.7	233	56.2	7.8	0	1013.9
MAHARASHTRA	AURANGABAD	2007	0	0	0	1.8	0	134.1	162.8	123	156	0	9.1	0	586.8
MAHARASHTRA	AURANGABAD	2008	0	0	39	1.8	0	73.5	88	123.9	314.4	40	3	0.6	684.2

- Non point sources.

A. Point Sources:

Point sources involve discharge or wastes from identifiable points. The sources are:

1. **Drainage System:** The sewage from Nasik city municipal area is going to the Godavari river with treatment after 78 MLD sewage treatment plant. The domestic sewage of some parts of the municipal area not treated and same is discharging directly in to the river. The Nasik Municipal Corporation is trying to collect all sewage from the municipal area for treatment and proper disposal in to the river, Present river area is highly polluted by the sewage water.

2. **Industrial Plants:** At Aurangabad industries such as M/s. Ajanta Pharma Ltd., M/s. Atra Pharma Ltd, M/s. Baxter (I) Ltd., M/s. Concept Pharma Ltd., M/s. Universal Prophylatic Pvt. Ltd., M/s. Encore Health care Pvt. Ltd., M/s. FDC Ltd, M/s. Herman Finochem Ltd., M/s. Johnson & Johnson Ltd., M/s. Navketan Pharma, M/s. Orchid Chemical & Pharmace. Ltd., M/s. Indoco Remedies and other small and medium industrial units which treated their industrial and domestic waste water as per Maharashtra Pollution Control Board norms and used for gardening in their own premises no waste water directly discharges in to the Godavari River.

   At Nasik, industries such as Motor Industries Limited (MICO), Mahindra and Mahindra, Ceat Limited, Graphite India Limited, Siemens, Garware Polyester Limited, Kirloskar Oil Engines, Gabriel, Taj Residency, Atlas Capco, Asian Electronocs, Pferd Tools, Caprihans Limited, Jyoti Structures Limited, Jyoti Ceramics Limited and other medium and small industrial units which treated their industrial and domestic waste water as per Maharashtra Pollution Control Board norms and used for gardening in their own premises no waste water directly discharges in to the Godavari River.

3. **Storm Water Runoff:** The storm water confluence directly with the Godavari river water through the drain. It increases the siltation and BOD level in the Godavari river.

B. Non Point Sources:

Non point sources involves the diffuse discharge wastes from land run off, atmospheric washout and other sources that are difficult to identify and control.

3.8.1 Pollution by Industries

As already discussed the Godavari River is less polluted by the above major industrial units and these sources not dominate major portion of pollution load in respect of the Godavari river. Mainly the sewage of the Municipal area is the cause in regards of the Godavari River Pollution.

3.8.2 Bio-Medical Waste

There are thirty large hospitals and more than 500 nursing homes and fifty pathological labs performing their functions in the entire Nasik city area. The total bed of nursing home and hospitals are about 2000. For this, one common Bio- Medical Waste Treatment and Disposal Facility is working under Nasik Municipal Corporation, but presently 60 – 70 % hospitals are giving their BMW regularly to this facility.

3.8.3 Automobile Waste Water

There are 50 numbers of motor garages and 30 numbers of servicing centre operating in the Nasik Municipal area. Consequently, the waste water is discharged to their respective drain which is ultimately going to the Godavari river. Some large service stations are having their own treatment plants whereas; some small units are in process to establish the treatment plants as per pollution control board norms.

3.8.4 Industrial Estate, Satpur and Ambad

There are 50 plastic industries and few small chemical industrial units in the estate but their effluent is very negligible and other industries also show similar nature in respect of such effluent discharge.

3.8.5 Pollution by Agricultural Chemicals

The fertilizers and agricultural chemicals such as pesticide, weedicide and insecticides may be ignored along the flow path of the Godavari river in rural area under the catchments area of the Godavari river. There are no pesticides; weedicide and insecticide found in the water analysis. Besides, use of fertilizers is also very less with respect to the other parts of the country. Average 8.6 kg of fertilizers are used in a bigha (0.13387 hectares) in the state which is very small quantity as compared to the required amount of the soil. Godavari river is less than the state average because of this area is less agricultural developed with respect to the other parts of the state. Therefore, the adverse affect of fertilizers and agricultural chemicals can be ignored with compare to the water pollution load in the Godavari river.

3.8.6 Organic Pollution

All the sources carry pollutants as organic nature. Both industries and domestic activities are responsible for polluting river. Basically, industrial pollution is more Complex than the domestic pollution.

3.8.7 Oil Pollution

The Godavari river receives very less amount of oil and grease mainly from various servicing stations. Both pollutant are important and affect adversely on the Godavari river ecosystem. Analysis results show that both the parameters are under permissible limits but water quality of the river is gradually deteriorated due to the pollutants

3.8.8 Pollution by Domestic Sources

Both urban and rural area discharges waste water into the neighboring area ultimately which goes to the Godavari river.

3.8.9 Pollution by Agricultural Run-offs:

Pollution by agricultural run-offs also affects the environment. Pesticides are responsible for poisoning. They are very difficult to remove from freshwater, and thus, can be found in municipal or bottled water, even after conventional treatment. A study from the CSE recently drew the alarm about the concentration of pesticides such as organochlorines and organophosphaters that was exceeding the WHO standards in almost all the Indian brands of bottled water. (Down to earth, February 2003, www.caeindia.org/html/lab/bottled water result.htm). As for the fertilizers, they have an indirect adverse impact on the water resources. Indeed, by increasing the nutritional content of the water courses, fertilizers allow organisms to proliferate. These organisms may be disease vectors, or algae. The proliferation of algae may slower the flow in the water courses, thus increasing again the proliferation of organisms and sedimentation.In spite of these well known adverse effects, and the worrying growth of fertilizer and pesticide use in the India agricultural sector, these products are still subsidised by the government. The following table 3.5 shows the increasing use of fertilizer and pesticide in the country.

Table 3.6: Evolution of fertilizer and pesticide use in India. [22]

Fertilizer Use (Million of tones)	
Year	
1984	7.7
1995-96	13.9 (80 % increase)
Pesticide Use (tones)	
Year	
1971	24305
1994-95	85030 (240% increase)

Source: Central Statistical Organization, 1999 (reported in IGIDR, 2000)

3.9 Rural Area

There are about 50 thousand people live in and around the Godavari river along its 65 km distance of flow path in the rural area. Depending upon the habits and standards of living of the people, about 75 liter of water is used by a person in a day. Due to large disposal area and diverse nature, nearly 20 % of its use of water is going to the Godavari river as sewage water. The adverse affect of this sewage water is negligible due to its diverse nature and favorable natural factors of self purification process of the Godavari River (as referred from the project report, studies on the water quality analysis of Godavari river, August, 2004).The BOD contribution of rural area has been considered as 15 grams per person in a day into the Godavari river due to the divergence nature of disposal system. This assumption has been generally used to estimate pollution load in Brahmaputra river as referred from "The Brahmaputra Basin" which is published by the CPCB, October, 2000 [Assessment and development study of river basin series : ADSORBS/33/2000-2001]. The BOD load is also contributed by the rural people to the Godavari river. This organic load is distributed as a divergent nature and easily removed their adverse affect by the self purification process of the river.

3.10 Urban Area

The total population of Nasik municipal area and new developing area is 15 Lacs. The water is used per day for domestic purpose is based on of a gross of per capita average demand of 150 lpcd. About 60-70 % waste water generated from the municipal area is treated through various sewage treatment plants. For remaining water, corporation work is in progress. Therefore, the water quality of the Godavari river has been gradually increasing regularly.

The total populations of Nasik Corporation area is 15 Lacs and contribute more BOD load in a day into the river. This amount concentrates as a point source in a close area. Consequently, it affects the entire ecosystem of the Godavari river.

3.11 Water Quality Assessment Authority

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

3.12 National Water Policy: 1987 and 2002

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

3.13 11th Five Year Plan Focus

The 11th Five Year Plan (2007-12) lays down provisions for efficient management of water resources in the country. These are, (GOI, 2006): With efficient management of resources three major projects namely Mahi, Bisalpur and Ratanpura distributory, four medium projects Panachana, Chaapi, Chauli, Bethali and 139 minor irrigation projects are likely to be completed by the end of Tenth Five-year Plan, which would create additional irrigation potential of 299.16 thousand hectare;

The Jal Abhiyan Programme was launched in December 2005 for mass awareness among the stakeholders about scarcity of water, method for recharging of ground water, management of surface and ground water for efficient utilization, which covered about

20,000 villages, developed 1 lakh water harvesting structures and revamped canal system. Focus on water harvesting structures and improving water use efficiency through better maintenance of irrigation system and promoting efficiency through drip/ sprinklers; State Water Policy is under consideration with main objective of utilizing all available water resources (surface and groundwater), in a judicious, equitable and economic manner; Water Users Associations are being formed for maintenance, distribution and revenue collection; Rural infrastructure: The Bharat Nirman Programme launched in 2005 identifying seven major areas where infrastructure gaps need to be addressed. The programme currently extends into initial two years of the 11th Plan. Bharat Nirman was a time-bound business plan for action in rural infrastructure over the four year period (2005-2009). Under Bharat Nirman, action is proposed in the areas of irrigation (to create 10 million hectares of additional irrigation capacity), rural roads, rural housing, rural water supply, rural electrification and rural telecommunication connectivity. [10]

The main objectives of the XI Plan, as pointed out in the MoWR working group report (GOI, 2006 are: a) Creation of additional potential of around 16 mha; b) Reducing gap between Potential created & its utilization; c)) Mitigation of flood damages; d) Promotion of mass awareness on water related issues. In order to achieve these objectives, the group recommended a few strategies viz., completion of ongoing irrigation projects and extension, renovation & modernization of old schemes; improvement in the efficiency of irrigation system; command area development and water management; participatory irrigation management; sustainable groundwater development and management; research and development activities on priority areas; establishment of river Basin organizations; information, education and communication for mass awareness. The plan emphasizes the creation of irrigation potentials and thereby highlights the need to close the gap between irrigation potential created and irrigation potential utilized so as to ensure effective 'development' and 'management'.[10]

CHAPTER NO.4

WATER QUALITY ASSESSMENT OF GODAVARI RIVER

4.1 GENERAL

Water is most essential but scarce resource in our country. Presently the quality and the availability of the fresh water resources are the most pressing of the many environmental challenges on the national horizon. The stress on water resources is from multiple sources and the impacts can take diverse forms. Geometric increase in population coupled with rapid urbanization, industrialization and agricultural development has resulted in high impact on quality and quantity of water in our country. The situation warrants immediate redressal through radically improved water resource and water quality management strategies. The present study highlights the steps involved in preparation of a water quality management plan in a rational manner.

4.2 WATER QUALITY OF RIVERS IN GODAVARI BASIN

The Godavari basin extends over an area of 3, 12,812 sq km which is nearly 10 percent of the total geographical area of the country. The basin lies in the Deccan plateau, and covers large areas in the States of Andhra Pradesh, Madhya Pradesh, Chattisgarh and Maharashtra, in addition to smaller areas in Karnataka and Orissa. The Satmala Hills, the Ajanta Range and the Mahadeo Hills, on the South and East by the Eastern Ghats and on the West by the Western Ghats, bound the Godavari basin on the North. The Godavari is the largest river of the Peninsular India; Inspite of its massive catchment area, the discharge is not very impressive because of moderate annual average rainfall in the basin. Its four important tributaries are the Manjira, the Pranhita, the Indravati and the Sabari. The wastewater generation from domestic (both rural and urban) and the industrial sector are the main sources of pollution in the river basin. Amongst the five states, Orissa State is least industrialized followed by M.P. and Karnataka, which Maharashtra having the high urban and industrial pockets. Most of the industrial activities are centred mainly at Aurangabad and Nasik in Maharashtra, East and West Godavari in Andhra Pradesh. Sugar and distillery units are large in number in Maharashtra followed by pharmaceuticals, leather, pulp and paper and pesticide units. Whereas in Andhra Pradesh sugar and distillery units are large in number followed by Pulp & Paper and fertilizer industries. These industries are massive water consuming by nature and the deterioration in water quality in the river cannot be ruled out particularly from Nashik to Nanded in Maharashtra and at Baster, in Chattisgarh and Burganpad in Andhra Pradesh. The important urban centers in this basin are Nagpur, Ambejogai, Ballarpur, Bhandara, Buldhana, Chalisgaon, Hinganghat, Hingoli, Manmad Nandurbar Osmandabad Parli Pusad Shrirampur Udgir Latur Kamptee Ahmadnagar Parbhani Aurangabad Wardha Bid Nashik Chandrapur Jalna Nanded Yavatmal, Amalner and Gondiya in Maharashtra; Jagdalpur in Chhatisgarh, Chiklikalan Parasia ,Chindwara Seoni Balaghat in Madhya Pradesh, Rajahmundry Nizamabad Ramagundam Eluru Warangal Khammam Kothagudem Karimnagar Bhimavaram Kakinada Adilabad , Bellampalle Bodhan Jagtial Kagaznagar Mancherial Mandamarri Narsapur Nirmal Palacole Palwancha Sangareddy Siddipet Siricilla Tadepalligudem and Tanuku in Andhra Pradesh; Bidar in Karnataka; and Jeypur in Orissa. [20]

The river Godavari from downstream of Nashik to Nanded and Nanded city limits in Maharashtra and upstream of Bhadrachalam at Mancheral and Ramgundam in A.P. have been identified as the polluted river stretches to be taken up under the proposed National River Action Plan. The major sources of pollution in the polluted stretches are from domestic and industrial wastewater generated from the Nashik and Nanded cities in Maharashtra and Mancherial, Ramgundam and Bhadrachalam cities in Andhra Pradesh. Depletion of dissolved oxygen has been reported due to addition of high organic load into the river besides bacteriological pollution has also been reported. To maintain the desired water quality uses of the Godavari River in these stretches, the municipalities need to treat their wastewater and the industries to install effluent treatment plants (ETP) before discharging into the rivers for sustaining the desired level of water quality. The water quality of river Godavari on eleven locations indicates that the DO value ranges from 1.1-9.6 mg/l. The minimum value of 1.1 mg/l of DO is observed at Rajahmundry D/s at Andhra Pradesh. The BOD values ranges from 0.4-32 mg/l and the highest value is observed at Nasik downstream (32 mg/l), Panchavati at Ramkund (32 mg/l) and U/s of Gangapur Dam at Nasik (22 mg/l) in Maharashtra. The Faecal Coliforms ranges from 2-6000 MPN/100ml whereas the Total Coliform ranges from 2- 39,000 MPN/100 ml. The maximum number of

Total Coliform is observed at Rajahmundry D/s and U/s and Polavaram in Andhra Pradesh which can be attributed to the proximity of large city. [20]

4.2.1 Water Quality Monitoring in Godavari Basin

The water quality monitoring of the river Godavari are being done in the basin by the State Pollution Control Boards of Maharashtra, Andhra Pradesh, Madhya Pradesh and Orissa at 28 locations. The monitoring locations are on main stream of river Godavari (12 and tributaries Manjeera(2), Maner(2), Nira(1), Wainganga(4), Kolar(1), Kanhan(1), Purna(1), Karanja(1), Indravati(2), Shankhni(1) and Wardha (1). The ranges of water quality observed in Godavari basin with respect to pH, Conductivity, DO, BOD, COD, Total Coliform (TC) and Faecal Coliform (FC) are presented as minimum, maximum and mean value to assess the extent of water quality variation throughout the year.

4.3 STEPS FOR WATER QUALITY MONITORING

A. Step-I Setting Water Quality Goal

1. For preparation of water quality management plan the first step is to identify water quality goal for the water body in question.
2. To set the water goal one has to identify use of water in the given water body or its part in question.
3. If the water body is used for more than one use than identify the use, which demands highest quality of water called "designated best use".
4. Identify the water quality requirements for that "designated bast use" in terms of primary water quality criteria.

B. Step-II Water Quality Monitoring

1. Water quality monitoring is to be carried to acquire the knowledge on existing water quality of the water body.
2. Water Quality Assessment Authority has notified a "Protocol for Water Quality Monitoring".
3. This protocol should be followed to monitor the water quality.

4.4 WATER QUALITY TESTS

To determine the water quality following terms should be carried out.

A. **Temperature:** Can determine the rate of biochemical reactions in the aquatic environment or whether they can occur at all.

B. **pH:** Scale used to measure the acidity of water. Most aquatic organisms have a limited pH range with most surface water between 6 and 8 units

C. **Chloride and Salinity:** Chloride, Cl-, is usually present in fresh water as well as salt water. Sources include dissolving minerals and industrial pollution. Salinity is the total of all non-carbonate salts dissolved in water.

D. **Dissolved Oxygen:** A measure of how much oxygen is dissolved in water. It is vital to aquatic life as a necessary component of cellular respiration. Most aquatic organisms have an optimal range of dissolved oxygen and it is a key indicator of water quality.

E. **Turbidity:** A measure of the water's lack of clarity. Highly turbid water reduces light penetration therefore affecting levels of photosynthesis, warming is increased due to absorption of sunlight, and it is generally aesthetically unpleasing. Stormwater ontributes to increased turbidity because of sediments and phytoplankton suspended in it.

F. **Nitrate:** Is an essential nutrient for aquatic plants and animals and is the form in which plants utilize nitrogen, therefore can have a great influence on the amount of plant growth in water.

G. **Phosphates:** Phosphorus is an essential nutrient for aquatic plants and animals. Excess phosphorus in water can be harmful by stimulating plant and algal growth. Sewage, detergent use and fertilizer runoff are Common sources.

H. **Calcium and Water Hardness:** Calcium ions, $Ca2+$ are introduced into water as it flows over calcium containing rock such as limestone. Magnesium ions, $Mg2-$, also contribute to hard water. "Hard" water contains excess $Ca2+$ and $Mg2+$.

I. **Ammonium ion:**

$NH4+$ is a byproduct of animal waste, decaying organic matter, and fertilizers.

J. **Total Dissolved Solids:**

Many important components of healthy aquatic ecosystems are in the form of dissolved solids. Nutrients such as nitrates and phosphates, and dissolved salts such as sodium chloride, contribute to total dissolves solids. [21]

4.5 GUIDELINES FOR ASSESSMENT OF POLLUTION SOURCES AND ESTIMATION OF POLLUTION LOAD IN A POLLUTED STRETCH [10]

1. **Identification of Sources of Pollution**

   Demarcate location of cities and towns and industrial units on the identified polluted stretches.

2. **Industrial Pollution**

   (A) Large & Medium Industries

   i. Listing of polluting industries

   ii. Pollution load from those industries covering the following parameters

   a) Volume of Waste water generated from each industrial unit.

   b) Influent and Effluent Quality of wastewater from each industrial unit in terms of wastewater from each industrics unit in terms of BOD, COD, Conductivity, Heavy Metals,Toxic Chemicals, Pesticides etc.

   iii. Treatment Technology adopted and Process

   iv. Utilisation of Wastewater

   (B) Small Scale Industries

   i. Listing of polluting industries and volume of wastewater generated from luster of small scale industries

   ii. Quality of effluents generated from each small-scale industries in terms of. BOD, COD, Conductivity, Heavy Metals, Toxic Chemicals, Pesticides etc.

   iii. Possibility of application of Common Effluent Treatment Plants for such clusters.

3. **Domestic Pollution**

   i. Identification of Major outfall points with their locations

ii. Quality and quantity of municipal wastewater discharging in a water body.

iii. Identification of extent of pollution control needed in view of critical flow conditions and comparing with desired quality criteria

iv. Utilisation of wastewater and Volume of wastewater used for . Agriculture

4. River Water Quality

i. River flow in the identified stretches.

ii. Quality of river water with critical parameter in the identified stretches

iii. Projected quality of river water in those stretches if effluents are either diverted or discharged after adequate treatment only

iv. Assessment of the fraction of Industrial Pollution load contributing towards municipal wastes

v. Compare water quality with desired classes of water for beneficial uses

5. Treatment of Municipal Wastewater

Identification of land for construction of STP's and Treatment technology to be adopted. [10]

4.6 WATER QUALITY ASSESSMENT PROCESS [8]

Water quality assessment is the overall process of evaluation of the physical, chemical and biological nature of the water, whereas water quality monitoring is collection of the relevant information. The main reason for the assessment of the quality of the aquatic environment has been, traditionally, the need to verify whether the observed water quality is suitable for intended uses. The use of monitoring has also evolved to help in determining trends in the quality of the aquatic environment and how that quality is affected by the release of contaminants, other anthropogenic activities, and/or by waste treatment operation (impact monitoring). Water quality management objective is to control the discharge of pollutants so that water quality is not degraded to an unacceptable extent below the natural background level. However controlling waste discharges must be quantitative endeavors.

We must be able to measure the pollutants, predict the impact of the pollutant on water quality, determine the background water quality which would be present without human invention and decide the levels acceptable for intended uses of the water.

Pollution is the introduction of any substances or energy (chemicals, noise, heat, light, energy and others) into the environment which results in deleterious effects of such a nature as to endanger human health, harm living resources and ecosystems, and impair or interfere with amenities and other legitimate uses of the environment. The simplest definition of water pollution is "the loss of any of the actual or potential beneficial uses of water caused by any change in its composition due to human activity".

Rivers are the surface water bodies characterized by the unidirectional current with a high average flow velocity (ranging from 0.1 to 1 m/s). The flow is highly variable in time depending on the climatic situation and drainage pattern. Through and continuous vertical mixing is achieved due to prevailing current and turbulence. They transport sediment from continental highlands to lakes, alluvial fans, and ultimately the ocean.Towns and factories are built near rivers so that they can use water from the river. But often the water is not cleaned before it is put back into the river. This dirtying of river water (also air and soil) is called river pollution.

India's 14 major, 55 minor and several hundred small rivers receive millions of liters of sewage, industrial and agricultural wastes. Most of these rivers have been degraded to sewage flowing drains. There are serious water quality problems in the towns and villages using these rivers as a source of their water. It means the assessment of water quality & thereby to define the pollution status of a particular river for a particular stretch or for the whole stream along with its all tributaries, if necessary in the basin area of the identified or suspected location.

Generally both quantitative and qualitative assessment of the pollutants at the outfalls, river water at upstream and downstream monitoring stations as well as sediment is carried out to depict the pollution profile of that river. Several factors are to be considered such as pollution load, river discharge, mixing nature, carrying capacity, sampling techniques and the method of quantification. Results are generally expressed in the form of table, graph or indices.

4.7 OBJECTIVES OF WATER QUALITY ASSESSMENT [8[

No assessment programme should be started without scrutinizing critically the real need for water quality information (i.e. the "need to know" as opposed to "it would be nice to know"). Consequently there are two different types of monitoring programme, depending on how many assessment objectives have to be met:

1. **Single-Objective Monitoring**: This may be set up to address one problem area only.
2. **Multi-Objective Monitoring**: This may cover various water uses and provide data for more than one assessment programme, such as drinking water supply, industrial manufacturing, fisheries or aquatic life, thereby involving a large set of variables.

The water quality monitoring is performed with following main objectives.

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

One way to express the quality of water is by listing out the concentrations of everything that the water contains. This list will be as long as the number of constituents analyzed and can be anything from twenty common constituents to hundreds. Comparing the quality of different samples of water is thus, almost an impossible task. For example, a sample of water having six parameters – pH, hardness, chloride, sulphate, iron and sodium – 5% above the permissible limits may not be as bad for drinking as another sample with just one constituent – e.g. mercury– at 5% higher than permissible. The quest for determining the quality of water has led to the collection of a large volume of data in the past four to five decades. With the development of technology, this volume of data has been increasing at a very fast pace and it is challenging man's ability to understand and assimilate it [24]. This vast volume of data has to be analyzed and presented in such a way that everyone from the policy and decision makers and layman can understand it. Water quality data is very difficult to present in a simple way but the concept of "water quality index" has been found as the easiest way of expressing it.

4.8 CHECKLIST FOR SAMPLING [27]

The following is a list of items, which should be checked before starting on a sampling mission.

1. Itinerary for the trip (route, stations to be covered, start and return time)
2. Personnel and sample transport arrangement
3. Area map
4. Sampling site location map
5. Icebox
6. Weighted bottle sampler
7. DO sampler
8. Rope
9. BOD bottles
10. Sample containers
11. Special sample containers: bacteriological, heavy metals, etc.
12. DO fixing and titration chemicals and glassware
13. Thermometer
14. Other field measurement kit, as required
15. Sample identification forms
16. Labels for sample containers
17. Field notebook
18. Pen / pencil / marker
19. Soap and towel
20. Torch
21. Drinking water

4.9 WATER QUALITY ASSESSMENT AUTHORITY (WQAA) [41]

Ministry of Environment and Forests (MoEF), Govt. of India, has issued a notification (Notification No. S.O.583 (E)) in exercise of powers conferred by sub-section (1) and (3) of Section 3 of the Environment (Protection) Act,1986 in the Gazette of India dated 22 June 2001, constituting the Water Quality Assessment Authority (WQAA) with effect from 29th May 2001, The WQAA is responsible for standardization of methods for water quality monitoring and to ensure quality of data generation. During the year 2005, 4th Meeting of Water Quality Assessment Authority was held under the Chairmanship of Secretary, MoEF and 6th and 7th meeting of Water Quality Monitoring Committee (WQMC) was held under the chairmanship of Additional Secretary, MoEF. As per the decision taken by WQAA and WQMC, CPCB extended the support and provided documents on the accreditation of laboratories of CWC and CGWB for evaluation & assessment of environmental laboratories for recognition for water analysis under The Envoironment (Protection) Act 1986 and for development of Referral Laboratory at Central Ground Water Board and Central Water Commission. Two training programmes were organized to train 30 scientists of Central Water Commission to develop the skill for bacteriological analysis of water samples. CPCB appraised the WQMC about the status of operation and maintenance CETPs and STPs in the country and prepared an Approach Paper on management of water quality in the country.

CHAPTER NO.5

WATERSHED MANAGEMENT AND SOLID WASTE MANAGEMENT

5.1 Watershed

A watershed can be defined as the area of land that drains to a particular waterbody. Watersheds come in all shapes and sizes. They cross county, state, and national boundaries. No matter where you are, you're in a watershed.

A watershed is an area of land that feeds all the water running under it and draining off of it into a body of water. It combines with other watersheds to form a network of rivers and streams that progressively drain into larger water areas.

5.1.1 Types of Watershed

Watersheds could be classified into a number of groups depending upon the mode of classification. The common modes of categorization are the size, drainage, shape and land use pattern. The categorization could also base on the size of the stream or river, the point of interception of the stream or the river and the drainage density and its distribution. The All India Soil and Land Use Surveys (AIS&LUS) of the Ministry of Agriculture, Government of India, have developed a system for watershed delineation like water resource region, basin, catchment, sub-catchment, and watershed. The usually accepted five levels of watershed delineation based on geographical area of the watershed are the following;

1) Macro watershed (> 50,000 Hect)
2) Sub-watershed (10,000 to 50,000 Hect)
3) Milli-watershed (1000 to 10000 Hect)
4) Micro watershed (100 to 1000 Hect)
5) Mini watershed (1-100 Hect)

5.1.2 Components of Watershed Management

The three main components in watershed management are land management, water management and biomass management.

Topography is the key element affecting this area of land. The boundary of a watershed is defined by the highest elevations surrounding the stream. A drop of water falling outside of the boundary will drain to another watershed.

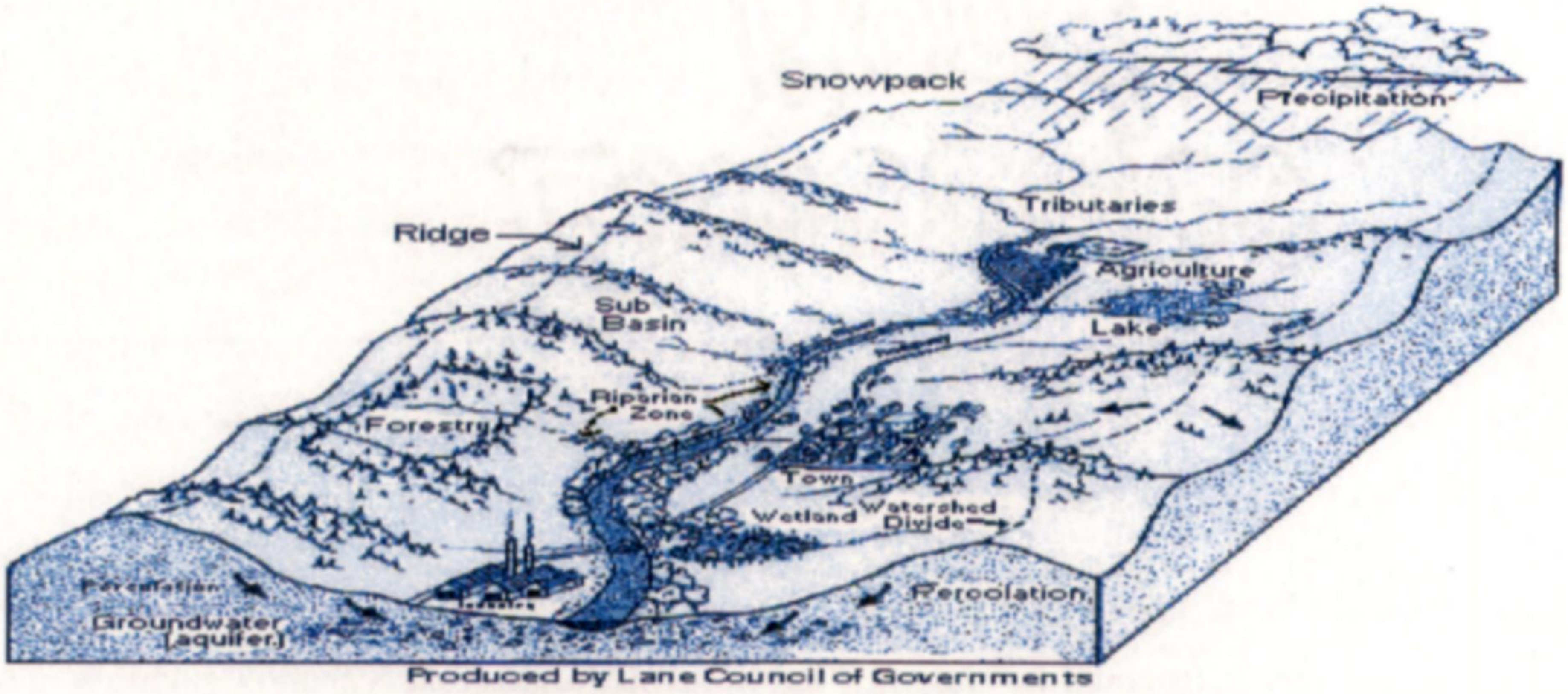

Fig.5.1: watershed behavior.

There are a number of watersheds in Albany County that drain either to the Hudson River or Mohawk River.

5.1.3 Watersheds Work

Surely you've spent time cooped up at home during a rainstorm. Hours later, the land, streets and buildings outside look completely dry. Have you ever wondered where all that rain goes? We know that much of the water gets absorbed by the ground and by plants, but where does the rest of it end up. It eventually drains into the surrounding lakes and rivers, but it must get there via **watersheds**.

Topography determines where and how water flows. Ridge tops surrounding a body of water determine the boundary of a watershed. Imagine turning an open umbrella upside down in the rain. Rain that hits anywhere within the umbrellas surface area would go to the bottom at the center of the umbrella. Any rain that didn't hit the umbrella would fall to the ground. The umbrella is like a watershed; it collects everything that falls into it.

Watersheds are just one part of a hierarchical system. **Catchments** are any natural or manmade structure designed to capture water. A group of catchments make up a **sub-watershed,** which is simply a smaller watershed. A collection of sub-watersheds forms a watershed, and a group of watersheds forms a **basin.** Basins are huge land masses. For example, the Amazon Basin in South America, the largest in the world, boasts an area of over 6 million square kilometers in five different countries. It also contains 16 large cities (of over 100,000 residents) and 3,000 different species of fish within its borders [source: Water Resources eAtlas].

5.1.4 Pollution of watershed can destroy an entire aquatic ecosystem, including its inhabitants

Watersheds directly affect water quality, whether it's for drinking or recreation. For example, algae blooms from fertilizer runoff draining into water harm watershed health, as do mercury and lead seeping into the water supply due to pollution. As states and cities try to find new sources of uncontaminated drinking water, keeping watersheds healthy becomes increasingly vital to finding clean water [source: Environmental]. Unhealthy watersheds affect wildlife. The polluted water supply that results can become harmful to humans. Aquatic life quickly suffers the effects of watershed pollution, while new pollutants introduced into ecosystems alter wildlife habitats. This reduces biodiversity by eliminating some species and introducing new, invasive ones that destroy the native species. That, in turn, can affect the food chain, from microbial organisms that feed birds and animals to fish that feed humans.

The threat of erosion also exists. Water flowing to a stream picks up dirt along the way. If the water picks up enough soil over time, the land along that stream will become unstable and eventually erode away. If you live along a river bank, this could mean losing your backyard. For wildlife that lives in this area, it means a loss of their habitat.

The sharp increase in development around the world may contribute to some of the problems affecting watersheds today. Development in the Amazon Basin has threatened the Amazon River dolphin with extinction [source: Water Resources eAtlas]. Urban development often involves removing plants, artificially changing the surface topography and altering naturally formed drainage networks. All of these factors affect an area's watershed. In addition, manmade land covers, such as asphalt roads or buildings, act as what the United States Geological Survey calls a "fast lane" for rainfall. Rainwater that would have been absorbed by soil and plants instead is sent directly into streams. These fast lanes increase the chances for flooding because more water pools in that area than a stream can hold [source: U.S. Geological Survey].

5.2 WATERSHED ATLAS OF INDIA

The watersheds are natural hydrological entities that cover a specific aerial expanse of land surface from which the rainfall runoff flows to a defined drain, channel, stream or river at any particular point. The terms region, basin, catchment, watershed etc are widely used to denote hydrological units. Even though these terms have similar meanings in popular sense, technically they are different. Size of a watershed is governed by the size of the stream occupied by it. Size of the watershed is of practical importance in development programmes. For example, size of irrigation cum hydel project has its watershed size several thousands of square kilometers but for a farm pond the size may be few hectares only. In deserts and flat terrains with little incipient drainage, it may be difficult to delineate small sized watersheds whereas in undulating and hilly terrains smaller sized watersheds could be easily delineated. Hence the aerial extent of watersheds vary widely in the various attempts made earlier for demarcation of watersheds.

Subsequently it was realized that there is a need for systematic delineation of the rivers systems at a national level on a convenient working scale. In this context, Ministry of Agriculture, Government of India had assigned the work of preparation and codification of River Systems of India to Mansinghal consultants. In 1970, the Mansinghal Consultants suggested / published the methodology based on the area concept. The suggested hydrological units are : Water resource region, river basins, river sub-basin, watershed, sub watershed, mini-watershed and micro watershed. The recommended size of the watershed is from 250-750 Sq. Km..Increasing thrust in water sector demanded finer details of hydrological units for implementation of various watershed management schemes . One of the major landmarks in this direction was by the All India Soil and Land Use Survey

(AISLUS) Organization of the Dept. of Agriculture and Cooperation by publishing the National level watershed atlas on **1: 1 million** scales using the base map from Irrigation Atlas of India in the year 1990. In this Atlas, the entire river systems of the country have been divided into 6 Water Resources Region, which has been further, divided into 35 basins and 112 catchments. These catchments have been further divided into 500 sub-catchments and 3237 watersheds. The atlas consists of 17 sheets on 1:1 million scales along with a Compendium of watersheds giving details of other related information such as area within the basin, sharing states and stream names etc. This atlas is being extensively used for various purposes.

5.3 WATERSHED MANAGEMENT

It is the process of creating and implementing plans, programs, and projects to sustain and enhance watershed functions that affect the plant, animal, andhuman communities within a watershed boundary. Features of a watershed that agencies seek to manage include water supply, water quality, drainage, stormwater runoff, water rights, and the overall planning and utilization of watersheds. Landowners, land use agencies, stormwater management experts, environmental specialists, water use purveyors and communities all play an integral part in the management of a watershed.The geographical area that collects all the water that falls on it into a single stream or river is called a 'watershed'. A watershed is thus a natural demarcation of the land, and the appropriate unit for many development activities. 'Watershed development' is a critical intervention in low-rainfall areas of India to make the land more productive. In urban areas, mismanagement of the urban watershed has led to pollution and degeneration of lakes, flooding and other problems. Since all rivers arise from watersheds proper management of watersheds is needed to maintain the health of our rivers. The watershed prioritization for Nasik and Aurangabad district is shown in Fig. 5.2 and Fig.5.3

5.4 PREVENTION OF SOIL EROSION AND SOIL CONSERVATION

1. **Terrace Farming:** - On hilly slopes, terraces act as bunds and prevent the soil from being washed away.

2. **Contour Ploughing**: Ploughing along contourson a slope prevents soil being washed away by rainwater or by surface run off. Contours act like bunds. Terraces are levelled into step like small fields with even slope.

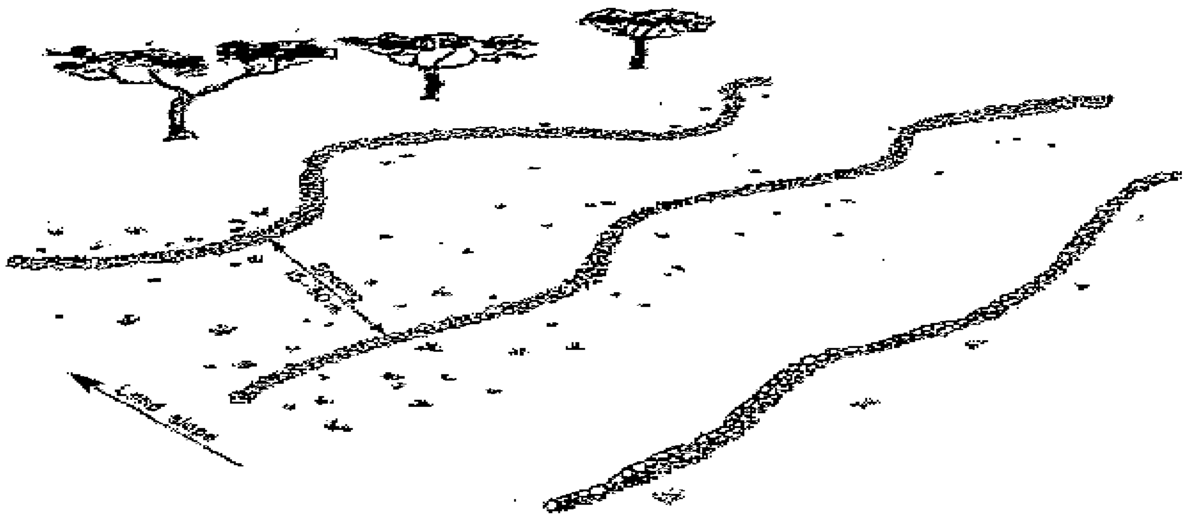

Fig 5.4: Contour ploughing

3) **Afforestation**: planting of trees along the edges of the fields, the waste land and on steepy slopes to prevent soil erosion as wellas to enahnce the capacity of the soil to retain water. increase area under forests and indiscriminate felling of trees must stop.

4) **Shelter Belts**: Farmers plant trees in several rows to check wind erosion. Known as wind breaks.

5) **Strip cropping**: Crops are grown in alternate strips of land to check the impact of the Winds.

6) **Construction of dams**: Rivers cause soil erosion. Dams are built in the upper course of rivers to control erosion of soil. This would check the speed of water and thereby save soil from erosion

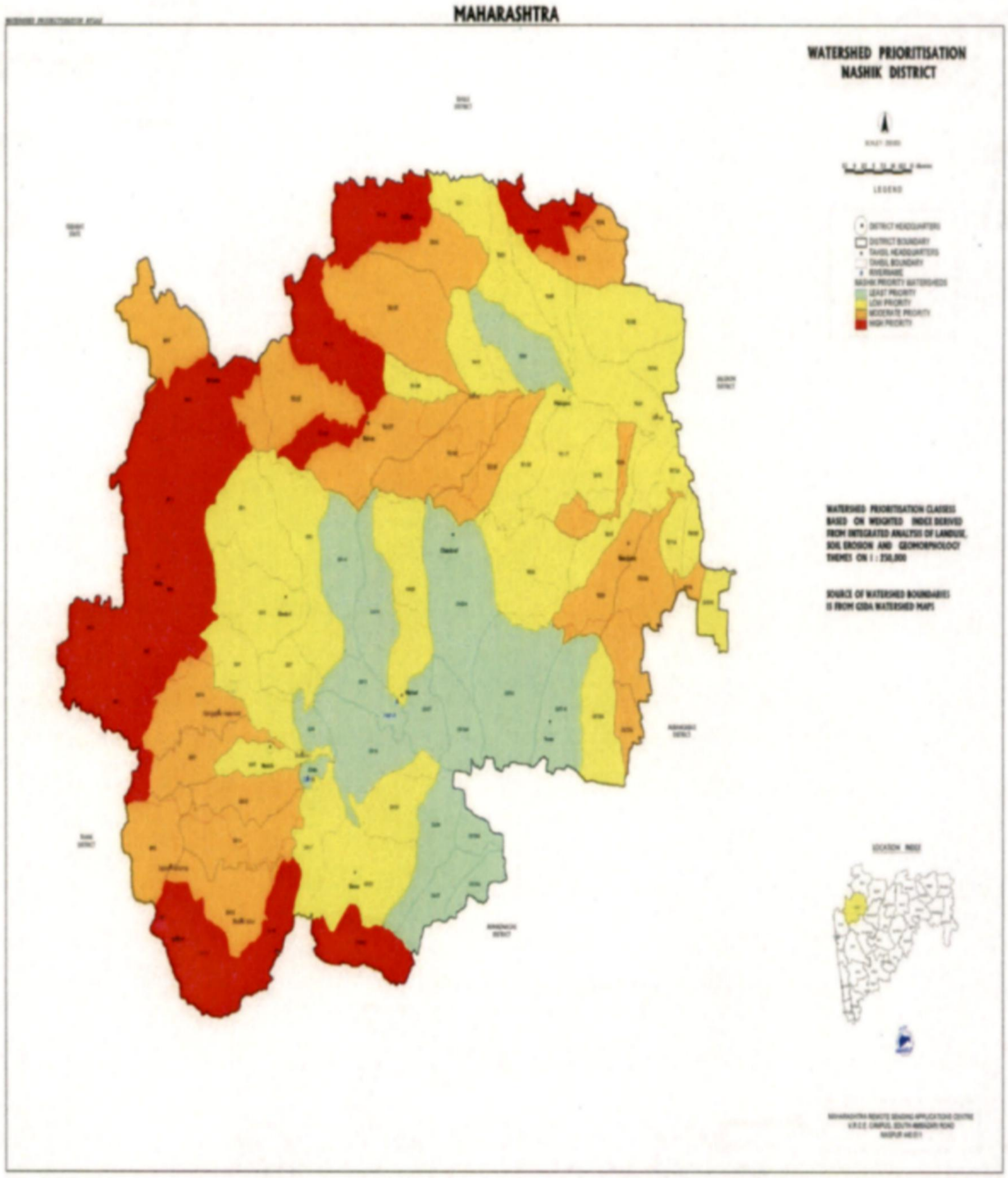

Fig. 5.2: Watershed Prioritization for Nasik District

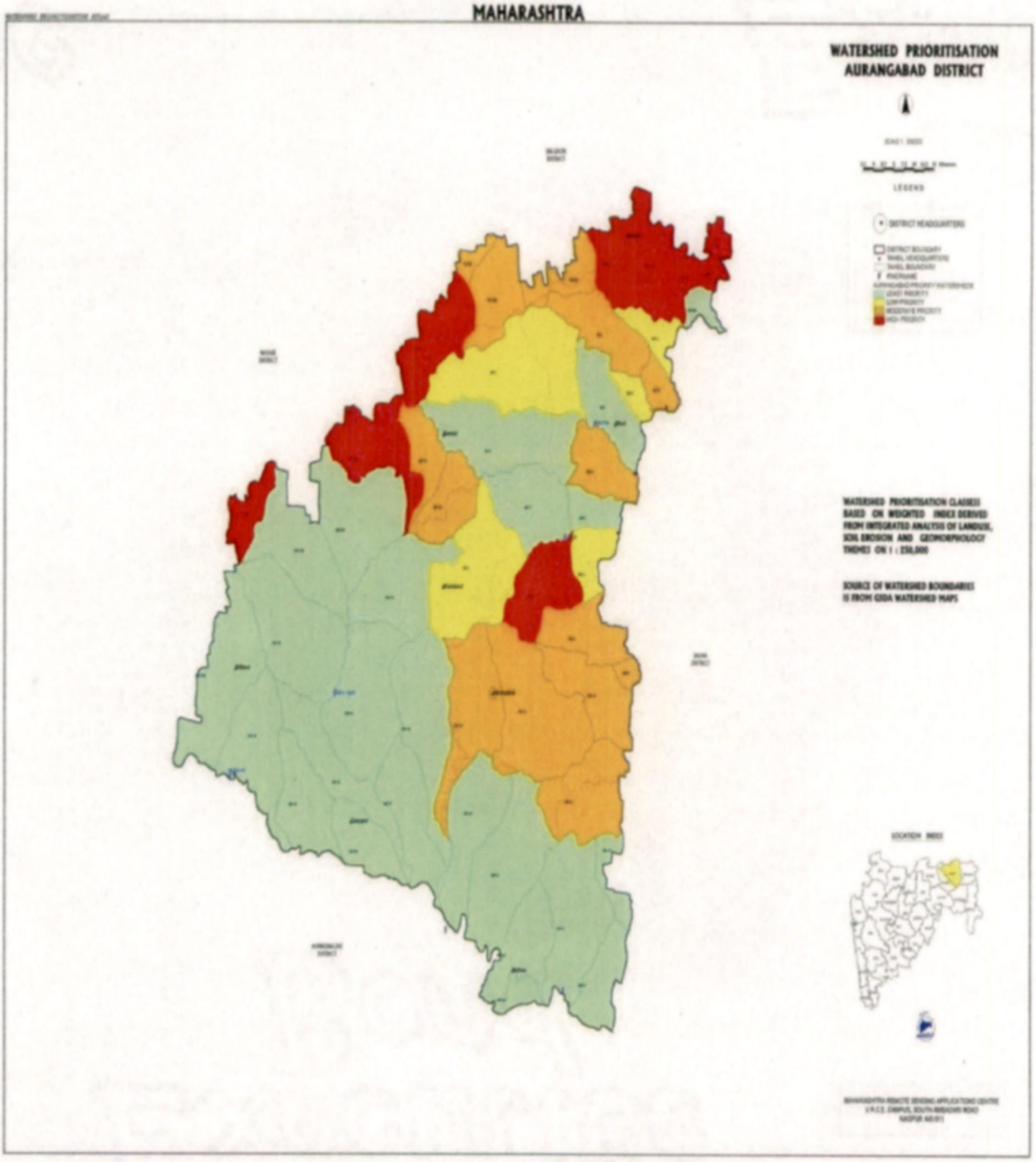

Fig.5.3: Watershed Prioritization for Aurangabad District

7) **Ploughing Gullies:** The gullies made in the soil are plugged with deposition of silt during heavy rains.

Watershed prioritization for Nasik City and Aurangabad city is enclosed with the Annexure No 1 and 2 respectively.

5.5 SOLID WASTE MANAGEMENT

A. Municipal Solid Waste Management

Presently solid waste collected by the Nasik Corporation from major part of the city, the focus should be require on management of solid waste in the adjoining areas of the city. The most effective method to manage waste in these semi-urban areas is by localizing the collection and treatment of the waste, i.e. waste generated within one locality is collected and treated within that locality itself. In the commercial areas, it shall be the responsibility of the traders to collect their own waste and store it at sites designated by the Nasik Municipal Corporation for collection or transport it themselves to the treatment sites. The cheapest methods of waste treatment are heap composting and vermin composting. The organic fertilizer produced from composting can be sold off to generate money.

Finally, solid waste management depends on the people's attitude and co-operation. If the entire community shows willingness to manage their waste, there is nothing that can stop them from doing it. To create this willingness, it takes a lot of hard work on the part of the experts to educate and spread awareness about solid waste and its management required by the Nasik Municipal Corporation and various government authorities.

Table 5.1: Data regarding the solid waste management at Aurangabad is as follows [10]

Sr. No	City (Revenue Division)	Classification	Population	Waste (Tone/day)	Estimated cost (Per ton) of waste treatment & Disposal)

1.	Aurangabad	Corporation	1000000	300	191.73
2.	Latur (Aurangabad)	Class I	299828	120	289.71

5.5.1 DISPOSAL OF BIO-MEDICAL WASTE

A. Conservation Measures taken for Bio-Medical Waste

The daily quantity of bio- medical waste collected and treated presently is 1500 to 2000 kgs/day, almost all the major hospitals are attached to this common bio- medical facility run by water grace products on BOOT basis. Collection of BMW waste in Biodegradable & incinerable bags. Waste collected in specially designed vehicles. The major units of the treatment process in this plant are-

i) Incineration

ii) Autoclaving

iii) Shredding.

Biomedical waste Management Plant at Nasik: At Nasik biomedical waste plant is operating nicely. Daily all the bio medical waste is collected by the vehicle of Nasik Municipal Corporation. After collection it is sorted out and then Incineration process is used for its disposal. Some of the Photographs were shown as follows.

Fig.5.5:BMWM -NASHIK

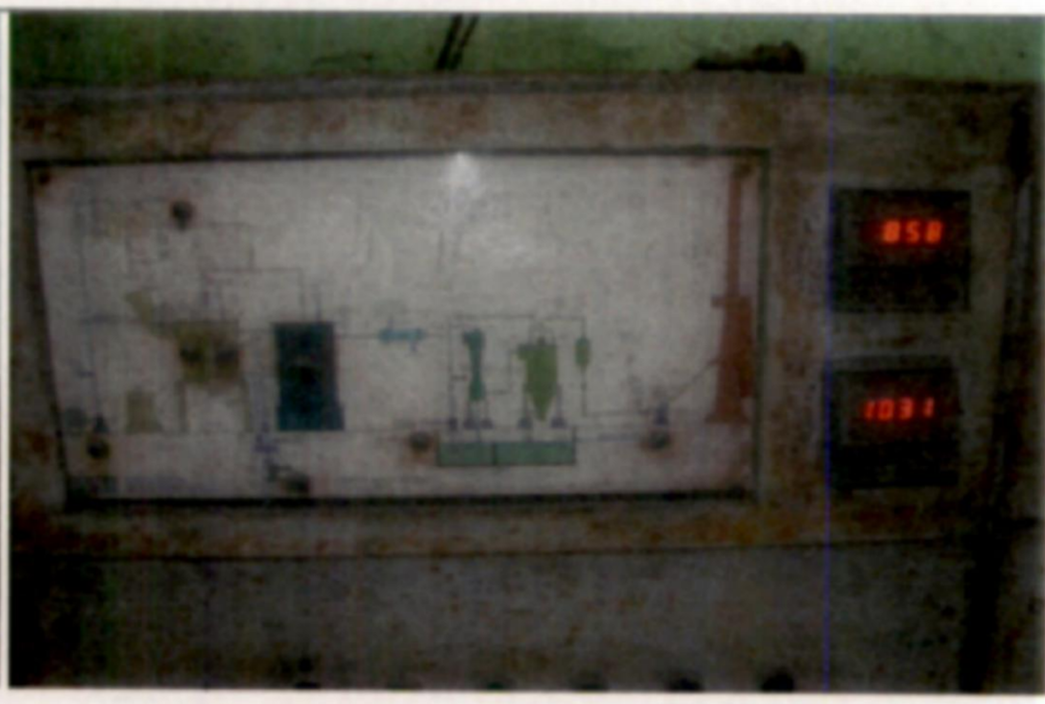

Fig 5.6:OPERATING TEMPERATURE

Fig 5.7: MEDICAL WASTE (NEEDLES)

Fig 5.8: CRUSHER

Fig 5.9: MEDICAL WATE (SALINE BOTTLE)

Fig 5.10:CRUSHER

Fig. 5.11:INCINARATOR(IN-SIDE VIEW)

Fig. 5.12:INCINARATOR (OUTSIDE VIEW)

5.5.2 Municipal Solid Waste Management

In the year 2001 municipal solid waste plant at pathardi, Nasik was installed by Nasik Municipal Corporation on BOOT basis. The capacity of the plant for treatment of solid waste is 300 MT/Day, but presently waste collected by the corporation is 250 MT/day from the city area only as the total population of Nasik Corporation is 15 Lacs but total solid waste generated is not collected and treated. The collection system is door to door on contract basis by tractor trolleys called as Ghanta Gadis. Segregation process on the site is done be 40-50 rag pickers manually. Three stage segregation with composting process is working effectively on 23 acres land area, out of that 7 acre area is for land filling. Sufficient tree plantation is done by the corporation in the premises. From this process final product compost is manufactured 20 MT/day which is sold to farmers for use as a manure. Some photographs of the plant are enclosed.

5.5.3 Sewage Treatment

At Tapowan 78 MLD sewage treatment plant is installed in the year 2003 by the Nasik Corporation during the Kumbhmela. Presently the plant is working at full capacity; all the results are within limits as per CPCB norms. The plant is based on UASB technology. Foaming problems are observed in final polishing pond at site because of the more washing activities and detergent use. New CCT (Chlorine Contact Tank) Unit installed in last month to reduce faecal count, Aeration outlet channel construction work was in progress to reduce foaming, with the help of these channels water will discharge smoothly in the final polishing ponds instead of pressurized disposal. Incoming flow observed is as per plant capacity. In addition of that 7.5 MLD ASP based treatment plant at panchak village, Nasik and 22 MLD plant of UASB based at chehadi village were also working satisfactorily. New proposed 52 MLD UASB technology based sewage treatment plant construction work is in progress.

A. Sewage Treatment Plant at Nasik

In Nasik we visited to 75 MLD sewage treatment plant which is of UASB type and Bio-medical waste management palnt. UASB process followed by facultative aerated lagoons and polishing ponds has been provided to treat 78 mld of wastewater under NRCP in the year 2003. It was observed that STP has been receiving an average of about 90 mld of sewage and is thus overloaded. O&M of the plant is being done through contract. Mechanical fine (Jash) screens of 6 mm size have been installed in the screen chamber which is working effectively. Bio-gas produced from the STP is being used for generation for electric power through 2 nos. of DFGs (63 KVA each). However, DFGs are only run during power cut, being uneconomical due to excess consumption of diesel (40 %). Accumulation of sludge/scum on the surface of reactor is being regularly removed. In addition to 2 nos. of polishing ponds, 2 nos. of facultative aerated lagoons (with six aerators in each lagoon) have been provided ahead of the polishing ponds for improved efficiency and due to land constrain. It was observed all the aerators are being run simultaneously in the lagoon without observing the quality of sewage. Aerators can be run alternatively in installments to meet design standards so as to save power. Formation of foam in the treated effluent was observed due to presence of detergents in the influent to the STP which can be controlled by providing sprinklers. Sludge from sludge drying beds is being sold for use as manure. Treated effluent is discharged to river Godavari nearby. Sampling/testing of the influent/effluent is being done by CPCB approved lab fortnightly. No testing is being done for fecal coliform. Chlorination plant is under construction for removal of fecal coliform. Treated effluent is having good quality and meeting the design standards for BOD & SS.

Table 5.2: Silent Feature for the Tapovan STP [20]

S. No.	Particular	Value
1	Flow	
a	Average Design Flow	75 MLD
b	Design Peak flow	100 MLD
2.	Raw Sewage Characteristics	
a.	PH	6.7
b.	BOD_5 at 20^0 C	97 mg / l

c.	COD	278 mg / l
d.	TSS	130 mg / l
3.	Required Treated Waste Water Quality	
a. b.	BOD_5 at 20^0 C COD	= 15 mg / l =50 mg / l
c.	TSS	= 18 mg / l
4.	Screen	
a.	Mechanical Screen	2 Nos.
b.	Manual Screen	2 Nos.
5.	UASB REACTOR	
a.	UASB Reactor (6 Nos of 13 mld each)	78 MLD
b.	Angle of Deflector Beam	45 deg
c.	Angle of Gas Collector	50 deg
d.	Effluent HRT	10 hrs
6.	Final Polishing Pond	3 Nos.
a.	Min Detention Time at Average Flow	1 Day
b.	Number of Compartment in each Pond	3 Nos.
c.	Liquid Depth Provided	1.50 m
7.	Gas Holder	1 Nos.
a.	Storage capacity	6 hrs.

8.	Sludge Drying Beds	
a.	Thickness of Sludge layer	0.20 m
b.	Minimum Cycle for Sludge Drying & Removal	10 Days
c.	Number of Cycle in a Year	30 Nos.

B. Observation of Existing Plant

1. Existing sewage treatment plant was working properly
2. All units were working in order as per pollution control board norms
3. Analysis results and all relevant data were available on site
4. Foaming problem observed in final polishing pond
5. Photographs of all units are taken.
6. New CC T (Chlorine Contact Tank) Unit installed in last month to reduce faecal count.
7. Aeration outlet channel construction work was in progress to reduce foaming, with the help of these channels water will discharged smoothly in the final polishing ponds instead of pressurized disposal.
8. New proposed 52 MLD UASB technology based sewage treatment plant construction work was in progress.
9. Incoming flow observed is as per plant capacity.

5.5.4 Hazardous Waste Management

Compliance of Hon'ble Supreme Court Directives in W. P (C) No. 657 of 1995: As per the Directives of Hon'ble Supreme Court of India, dated October 14, 2003 in the matter of Writ Petition No. (C) of 657 of 1995, Central Pollution Control Board (CPCB) is required to prepare and comply with the following directives:

i) Preparation & Issuance of Check list and Ensuring its Compliance;

ii) Preparation of Guidelines on Hazardous Waste Incinerators;

iii) Preparation of Guidelines for Proper Functioning & Up keep of Disposal Sites;

iv) Preparation of Guidelines for Transportation of Hazardous Waste;

v) National Policy Document on Management of Hazardous Waste;

vi) Random Checks on Inventory of Hazardous Waste Generation submitted by the PCBs/PCCs;

vii) Random Checks on Inventory on Hazardous Waste Dump sites submitted by the SPCBs/PCCs and Evaluation of the Rehabilitation Plans of Dump Sites;

viii) Preparation of Comprehensive Report on Inventory of HW Generation and HW Dump Sites and Rehabilitation Plans of Dump Sites;

ix) To do R & D Work on Phasing out of Dirty Technologies

x) Co-ordination with Ministry of Environment & Forests w.r.to preparation and finalization of the draft Amendment to Hazardous Waste (M & H) Amendment Rules.

The Central Pollution Control Board (CPCB) in compliance of aforesaid directives, finalized and published the following guidelines:

i) Uniform Testing Procedures to be followed by the Labs.

ii) Guidelines for Common Hazardous Waste Incinerators.

iii) Guidelines for Transportation of Hazardous Waste.

iii) Pre-requisites for Issuing Authorization by the SPCBs/PCCs.

iv) Guidelines for Proper Functioning and Upkeep of Disposal Sites.

As per the Order of Hon'ble Supreme Court of India, dated October 14, 2003 in Writ Petition (C) No. 657 of 1995, the Ministry of Environment & Forests (MoEF) either itself or through Central Pollution Control Board (CPCB) or any other agency is required to draft a policy document on hazardous waste management, keeping in view recommendations of High Power Committee (HPC).CPCB co-ordinated with the Ministry of Environment & Forests (MoEF), in preparation of 'National Policy Document on Management of Hazardous Waste' and revision of Schedule 3 (list of wastes applicable for import & export for reprocessing, Schedule 4 (list of wastes, the reprocessing of which need registration from Central Pollution Control Board) and Schedule 8 (list of wastes prohibited for import and export of hazardous wastes) of the Hazardous Waste (Management & Handling) Rules, 1989 as amended in 2003. The final draft of 'National Policy Document on Management of Hazardous Waste' and proposed draft amendments to

Schedule 3, Schedule 4 and Schedule 8 of the Hazardous Waste (Management & Handling) Rules has already been forwarded to MoEF for consideration.

5.5.5 PLASTICS WASTE MANAGEMENT

Indicative Operational Guidelines on Utilization of Plastics in Road Construction: Granite aggregates used in road construction have great affinity for water due to inherent wetting nature of the aggregate. Bitumen has very poor water wetting property. This results in the penetration of water between aggregate and Bitumen layer if water is stagnated over the surface. Thus bitumen film is often stripped off the aggregates because of the penetration of water, which results in pothole formation. This is accelerated during the movement of vehicle. When polymer is coated over aggregate, the coating reduces its affinity for water due to non-wetting nature of the polymer and this resists the penetration of water. Polymers are not soluble in water or acids and even in most of the organic solvents. Therefore polymer will not leach out of the bitumen layer, even after laying the road using waste plastics-bitumen-aggregate mix. Besides, waste polymer-bitumen blend reduce the bleeding of bitumen during the summers. The polymer materials used are polyethylene, polypropylene and polystyrene. Use of polyvinyl chloride is not suggested. There is no possibility of dioxins formation during the use of waste polymer for road construction because chlorine is not present and temperature is not favourable. Addition of waste plastics, generally improves the strength of the road. The addition of fly ash to the polymer aggregate bitumen mix improves the strength of the flexible pavement. It is also observed that the fly ash does not leach from this mixture. Above all, for 1000m x 3.5m road nearly 10 to 15 tons of fly ash is used. Disposal of fly ash becomes easy by this process. Process of road lying using waste plastics is being implemented successfully for the construction of flexible roads at various places in India. The increase in fertilizers consumption reported in the right part of the chart leads us to assume that those concentrations are now exceeding the limits in several other states.

CHAPTER NO.6

WATER QUALITY ANALYSIS FOR GODAVARI RIVER

6.1 WATER QUALITY INDEX

"Water quality" is a technical term that is based upon the characteristics of water in relation to guideline values of what is suitable for human consumption and for all usual domestic purposes including personal hygiene. Components of water quality include microbial, biological, chemical, and physical aspects.

6.1.2 Classification of Water Quality Indices

There are two general types of water quality index forms.

a. Increasing scale form – those in which the index numbers increase with increasing pollution level.

b. Decreasing scale form – those in which the index numbers decrease with increasing pollution level.

Some specialists in the field refer to the former as "Water Pollution Indices" and later as "Water Quality Indices". In an increasing scale form, an index of zero indicates no pollution, while, in a decreasing scale form, index of zero indicates maximum polluted or 100% polluted water. Both the terms are inter-related and therefore, both types of indices are practically called "Water Quality Indices". To present many indices found in the literature in an orderly fashion, Wayne Ott. (1978) has classified the different water quality indices developed into four general categories:

i. General water quality indices,
ii. Specific-use indices,
iii. Planning indices, and
iv. Indices based on statistical approach.

General conditions to be satisfied by Water Quality Index (WQI) are as follows -

a. It should change with the changes in the values of each of the water quality variables.

b. The change should be greater due to a variable, which produces the more important quality impact.
c. It should approach the poorest designated value when a critical variable, whose concentration beyond the permissible levels cannot be compromised, exceeds the permissible limits.
d. It should remain unchanged when a variable's concentration changes within its permissible limits.

Criteria for formulation of WQI as given by Council of Environmental Quality (CEQ) are:

i. It should facilitate communication of environmental quality information to the public.
ii. It should be readily derived from available monitored data.
iii. It should strike a balance between over simplification and complex technical conceptualization.
iv. It should impart an understanding of significance of data represented.
v. It should be objectively designed but amenable to comparison with expert judgment so that their validity can be assed.

6.2 NSFWQI WATER QUALITY INDEX [25]

NSFWQI index value is used to find out the water quality of the Godavari river at Nasik and Aurangabad city. The NSFWQI water quality index was calculated for Nasik and Aurangabad city. The NSFWQI index values calculated for Nasik are shown in Table 6.1 to Table 6.7 and NSFWQI index value for the Aurangabad are shown in Table 6.8 to Table 6.13.

A commonly-used water quality index (WQI) was developed by the National Sanitation Foundation (NSF) in 1970 (Brown and others, 1970). The NSF WQI was developed to provide a standardized method for comparing the water quality of various bodies of water. 142 water quality scientists were surveyed about 35 water quality tests and asked to consider which tests should be included in an index (Brown and others, 1970; Mitchell and Stapp, 2000). Nine water quality parameters were selected to include in the index. These parameters are:

NSFWQI Index Data for Nasik city

Table 6.1: At Gangapur Dam (K_1)

Godavari at Nasik		For year 2005											
Sr. No.	**Date / Parameter**	08.01.05	05.02.05	06.03.05	07.04.05	07.05.05	03.06.05	09.07.05	07.08.05	07.09 .05	02.10.05	06.11.05	09.12.05
1	**PH**	7.7	8.0	7.9	8.4	7.9	7.3	7.7	7.7	7.9	8.7	7.6	8.1
2	**DO**	6.9	7.1	7.1	7.2	7.0	5.6	7.2	5.8	6.6	7.1	7.2	6.6
3	**B.O.D**	8.0	6.0	5.0	5.0	6.0	9.4	5.5	15.5	5.0	9.0	5.0	8.0
4	**Total Coliform**	21.0	150.0	30.0	24.0	9.0	197.0	1800.0	45.0	275.0	17.0	6.0	20.0
5	**Temperature**	28.0	29.0	28.0	29.0	30.0	29.0	23.0	22.0	20.0	23.0	24.0	22.0
6	**C.O.D**	20.4	20.6	20.2	51.0	58.0	21.5	19.4	42.0	19.0	28.9	22.5	22.5
NSFWQI index Value		37	38	40	36	39	37	39	31	38	30	40	34
Avg. NSFWQI index Value		36.58 (But 25-50=Bad water quality)											
		For year 2006											
Sr. No.	**Date / Parameter**	10.01.06	07.02.06	09.03.06	12.04.06	10.05.06	09.06.06	10.07.06	09.08.06	07.09.06	08.10.06	09.11.06	09.12.06
1	**PH**	7.9	7.8	8.0	7.3	8.1	8.6	7.8	7.2	7.9	7.9	7.9	7.0
2	**DO**	6.6	8.0	7.8	7.1	5.7	6.6	7.3	7.9	7.1	4.6	7.2	6.9
3	**Conductivity**	118	171	157	160	191	142	165	158	143	162	133	168
4	**B.O.D**	8.0	4.0	3.0	5.0	22.0	20.0	5.0	5.5	6.5	5.0	8.5	8.0
5	**Nitrate**	0.51	0.77	0.473	0.15	0.11	0.412	0.475	0.81	0.473	0.473	0.315	0.411
6	**Total Coliform**	25.0	7.0	2.0	9.0	14.6	6.0	25.0	17.0	25.0	25.0	16.0	25.0
7	**Turbidity**	21.0	17.0	11.0	41.0	43.0	30.0	31.0	35.0	32.0	32.0	30.0	25.0
8	**Phosphate**	0.04	0.031	0.34	0.015	0.019	0.31	0.30	0.65	0.34	0.34	0.31	0.295
9	**Temperature**	22	32	29.2	31	31	29.3	28.7	37	29.5	29.4	29.5	31.0
10	**C.O.D**	7.5	14.0	22.0	12.0	14.0	22.0	12.5	15.0	17.0	12.5	18.5	21.0
11	**Sulphate**	3.97	4.82	-	3.01	3.28	10.1	11.0	30.0	12.0	11.9	11.2	11.9
12	**T.D.S**	157	151	201	161	201	203	158	205	205	209	200	208
NSFWQI index Value		56	61	58	58	50	46	56	54	54	55	53	55
Avg. NSFWQI index Value		54.66 (But 50-70=Medium water quality)											

For year 2007													
Sr. No.	Date / Parameter	10.01.07	07.02.07	08.03.07	04.04.07	08.05.07	03.06.07	04.07.07	06.08.07	04.09.07	04.10.07	05.11.07	10.12.07
1	PH	7.8	7.4	7.3	8.51	7.1	7.3	7.7	7.8	8.1	7.28	7.84	7.94
2	DO	7.0	6.1	6.58	6.4	5.8	4.1	5.2	6.6	7.2	6.0	7.5	6.6
3	Conductivity	198	190	177	157.8	140	159	131	188	121	280.7	-	-
4	B.O.D	5.0	5.9	5.3	5.4	7.9	31.0	9.7	4.4	2.0	9.0	4.0	5.0
5	Nitrate	0.016	0.484	0.15	0.459	0.473	0.371	0.392	2.52	0.981	0.740	2.16	0.908
6	Fecal Coliform	2.0	-	-	4.0	-	-	-	-	-	2.0	12.0	7.0
7	Turbidity	3.0	4.9	12.5	1.0	30.0	29.1	31.0	3.0	41.0	-	-	-
8	Phosphate	1.18	1.89	0.015	-	0.31	0.30	0.291	1.18	0.54	0.04	0.015	-
9	Temperature	18	32	31	33	29.2	29.5	30.4	21.0	32.0	30.0	31.0	-
10	C.O.D	12.5	13.8	13.5	12.0	41.0	52.0	38.0	20.0	24.0	24.0	24.0	-
11	Sulphate	5.01	28.6	3.28	26.8	9.98	10.9	12.0	32.0	19.2	4.82	3.28	-
12	T.D.S	259	239	166	205.0	201	195.4	188.9	258	368.0	159	165	-
NSFWQI index Value		58	52	60	62	54	56	53	57	50	58	61	60
Avg. NSFWQI index Value		52.58 (But 50-70=Medium water quality)											

For year 2008											
Sr. No.	Date / Parameter	02.01.08	01.02.08	08.03.08	01.04.08	07.05.08	03.06.08	09.07.08	07.08.08	04.09.08	02.10.08
1	PH	7.27	8.39	8.26	8.32	7.8	8.2	8.36	8.31	6.0	7.56
2	DO	6.23	9.9	7.2	6.6	6.4	6.8	6.42	6.57	6.59	6.50
3	Conductivity				141.0						311.0
4	B.O.D	7.0	5.0	4.0	4.8	4.0	4.0	4.0	4.0	4.0	4.0
5	Nitrite										
6	Nitrate	1.29	0.27	0.41	0.253	0.29	0.59	1.13	3.05	2.52	1.38
7	Fecal Coliform	9.0	6.0	4.0	2.0	2.0	4.0	3.0	4.0	2.0	2.0
8	Temperature	28	29	29	30	31	30	32	33	34	30
NSFWQI index Value		53	54	56	59	60	56	56	55	54	60
Avg. NSFWQI index value		56.3 (But 50-70=Medium water quality)									

For year 2009

Sr. No.	Date / Parameter	05.02.09	02.03.09	08.04.09	07.05.09	03.06.09	05.07.09	07.08.09	03.09.09	02.10.09	06.11.09	07.12.09
1	PH	8.78	7.60	8.15	8.17	7.79	7.99	8.16	7.48	8.08	7.82	7.44
2	DO	5.9	5.8	5.91	6.10	5.4	6.7	5.4	5.1	6.40	5.9	5.2
3	Conductivity	-	-	-	214.0	-	-	-	251.3	203.7	198.2	152.5
4	B.O.D	6.5	4.9	5.6	6.0	8.0	4.0	5.0	5.00	3.20	3.7	4.0
5	Nitrate	2.59	0.05	0.09	0.2	0.2	0.1	0.1	0.73	0.12	0.16	0.14
6	Fecal Coliform	4.0	2.0	7.0	9.0	2.0	4.0	6.0	6.00	5.0	15.0	30.0
7	Colour	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless
8	Adour	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless
9	Temperature	29	31	34	31	32	30	29	31	27	26	25
10	C.O.D	-	-	-	12.0	-	-	-	12.0	12.0	-	12.0
NSFWQI index Value		50	59	54	53	55	58	55	55	57	53	52
Avg. NSFWQI index Value		54.41 (But 50-70 =Medium water quality)										

For year 2010

Sr. No.	Date / Parameter	07.01.2010	05.02.2010
1	PH	8.10	8.09
2	DO	6.8	6.9
3	Conductivity	141.0	141.6
4	B.O.D	4.0	4.0
6	Nitrate	1.59	0.19
7	Fecal Coliform	2.0	2.0
8	Total Coliform	10.0	8.0
9	Turbidity	1.0	1.0
10	Colour	Colourless	Colourless
11	Temperature	24	25
12	C.O.D	12.0	12.0
NSFWQI index Value		61	61
Avg. NSFWQI index Value		61 (But 50-70 =Medium water quality)	

Table 6.2: At Chikhali Nala (K_2)

For year 2008

Sr. No.	Date / Parameter	01.02.08	08.03.08	07.05.08	03.06.08	09.07.08	07.08.08	04.09.08
1	PH	7.01	7.99	6.32	4.61	7.21	7.7	7.38
2	DO	2.42	7.5	1.8	1.08	0.86	4.60	2.41
3	B.O.D	38.0	4.0	16.0	40.0	56.0	24.0	21.0
4	Nitrate	0.616	0.847		4.93	1.60	4.4	4.19
5	Fecal Coliform	17.0	25.0	32.0	38.0	32.0	20.0	22.0
6	Colour & Intensity	colourless	colourless	colourless	colourless	colourless	colourless	colourless
7	Adour	odourless	odourless	odourless	odourless	odourless	odourless	odourless
8	Temperature	28	29	32	34	33	31	29
NSFWQI index Value		45	52	34	29	44	42	42
Avg. NSFWQI index Value		41.14 (But 25-50 =Bad water quality)						

For Year 2009

Sr. No.	Date / Parameter	07.01.09	05.02.09	02.03.09	08.04.09	07.05.09	03.06.09	05.07.09	07.08.09	03.09.09	02.10.09	06.11.09	07.12.09
1	PH	6.37	7.24	8.90	6.8	8.11	8.17	7.9	8.44	8.2	7.44	6.00	8.20
2	DO	5.05	5.9	3.9	6.2	3.17	5.4	5.4	5.3	4.7	4.9	5.2	4.4
3	B.O.D	18.0	16.0	19.0	60.0	44.0	23.0	30.0	7.0	7.0	20.0	18.0	8.0
4	Nitrate	0.8	0.70	9.74	2.38	0.4	0.3	0.8	0.1	1.47	0.34	0.52	0.58
5	Fecal Coliform	22.0	14.0	5.0	-	-	5.0	5.0	4.0	6.0	8.0	20.0	17.0
6	Total Coliform	-	-	-	-	-	-	-	-	20.0	30.0	40.0	8.0
7	Temperature	28	29	31	30	33	34	31	30	31	29	28	25
8	C.O.D	-	-	60.0	17.4	-	-	-	-	12.0	12.0	-	12.0
NSFWQI index Value		43	48	38	39	39	48	49	52	53	50	41	48
Avg. NSFWQI index Value		45.66 (But 25-50=Bad Water quality)											

For Year 2010			
Sr. No.	Date / Parameter	07.01.2010	05.02.2010
1	PH	8.17	7.99
2	DO	5.6	5.2
3	Conductivity	210.0	892.6
4	B.O.D	12.0	12.0
5	Nitrate	4.31	3.32
6	Fecal Coliform	14.0	17.0
7	Temperature	25	25
8	C.O.D	12.0	12.0
NSFWQI index Value		48	51
Avg. NSFWQI index Value		49.5 (But 25-50=Bad water quality)	

Table 6.3: At Someshwar temple (K_3)

For Year 2006													
Sr. No.	Date / Parameter	10.01.06	07.02.06	09.03.06	12.04.06	10.05.06	09.06.06	10.07.06	09.08.06	07.09.06	08.10.06	09.11.06	09.12.06
1	PH	8.4	7.8	8.39	7.89	7.99	8.45	8.31	7.7	8.53	8.51	7.5	8.0
2	DO	7.7	5.5	6.7	7.4	6.1	6.1	6.9	6.1	6.2	6.6	6.2	5.98
3	Conductivity	101	195	340	248	257	389	383	186	367	390	378	362
4	B.O.D	5.1	6.2	6.5	5.7	6.7	6.77	9.0	5.7	6.57	6.55	6.75	6.192
5	Nitrate	0.71	0.41	0.451	0.9	0.915	0.459	0.399	0.15	0.451	0.541	0.451	0.345
6	Total Coliform	10.0	120.0	7.0	126.0	129.0	7.0	7.0	189.0	71.0	7.0	7.0	12.0
7	Turbidity	17.0	25.0	40.0	49.0	41.0	40.0	39.0	41.0	29.0	29.9	45.0	37.0
8	Phosphate	0.04	0.8	0.19	0.5	0.59	0.19	0.175	0.015	0.19	0.91	0.187	0.798
9	Temperature	23	28	29	28	29	29	30	31	29	29	29	29
10	C.O.D	7.1	39	28	19	19	28	28	28	28	21	28	28
11	Sulphate	4.852	12.5	4.0	27.0	29.0	4.0	4.0	28.0	4.0	4.0	4.0	4.0
12	T.D.S	161	222	309	147	150	309	209	199	308	310	307	318
NSFWQI index Value		56	57	52	50	50	52	51	56	52	50	52	53
Avg. NSFWQI index Value		52.58	(But 50-70=Medium water quality)										

For Year 2007

Sr. No.	Date / Parameter	10.01.07	07.02.07	08.03.07	04.04.07	08.05.07	03.06.07	04.07.07	06.08.07	04.09.07	04.10.07	05.11.07
1	PH	7.1	7.7	7.94	8.35	8.53	8.03	7.99	7.1	8.00	8.3	7.78
2	DO	5.7	6.4	7.4	6.2	6.2	5.98	5.92	4.5	5.91	6.7	4.9
3	B.O.D	28.0	27.0	5.9	6.2	6.57	6.71	6.99	27.0	2.98	5.8	4.7
4	Nitrate	0.471	0.49	0.9	0.512	0.451	0.099	0.553	0.37	0.277	0.41	0.9
5	Total Coliform	18.0	17.0	126.0	5.0	7.0	7.0	9.0	18.0	2.0	120.0	126.0
6	Phosphate	1.89	1.98	0.5	0.178	0.19	0.09	0.21	1.27	0.558	0.8	0.5
7	Temperature	33	31	25	29	29	30	29	32	31	27	25
8	C.O.D	24.0	23.0	19.0	28.0	27.0	28.0	26.0	24.0	44.0	30.0	19.0
9	T.D.S	368.0	386.0	149	301	298	322	345	398	268	221	148
NSFWQI index Value		40	40	51	52	53	54	54	49	51	50	53
Avg. NSFWQI index Value		49.72 (But 25-50=Bad water quality)										

For Year 2008

Sr. No.	Date / Parameter	01.02.08	08.03.08	07.05.08	03.06.08	09.07.08	07.08.08	04.09.08
1	PH	7.19	8.1	7.05	8.09	7.89	8.7	7.78
2	DO	6.1	7.1	6.2	5.9	4.79	6.5	4.8
3	B.O.D	5.0	3.0	4.5	5.0	7.0	4.0	6.40
4	Nitrate	0.012	0.26	0.17	0.57	0.76	3.9	4.02
5	Colour & Intensity	colourless	colourless	colourless	colourless	colourless	colourless	colourless
6	Adour	odourless	odourless	odourless	odourless	odourless	odourless	odourless
7	Temperature	29	30	31	33	30	30	28
NSFWQI index Value		52	54	57	55	54	49	48
Avg. NSFWQI index Value		52.71 (But 50-70=Medium water quality)						

For Year 2009													
Sr. No.	Date / Parameter	07.01.09	05.02.09	02.03.09	08.04.09	07.05.09	03.06.09	05.07.09	07.08.09	03.09.09	02.10.09	06.11.09	07.12.09
1	**PH**	7.89	7.68	8.41	7.2	8.07	8.44	7.91	7.22	7.48	7.23	7.44	7.89
2	**DO**	6.81	5.3	5.3	6.2	5.4	5.9	6.0	5.6	5.1	5.0	4.7	5.4
3	**B.O.D**	5.8	4.8	10.0	6.5	7.0	7.0	7.0	6.0	5.0	4.0	4.0	9.0
4	**Nitrate**	0.8	0.76	1.87	0.1	0.1	0.1	0.2	0.1	0.73	0.11	0.77	0.7
5	**Fecal Coliform**	4.0	9.0	7.0	8.0	5.0	7.0	6.0	8.0	6.0	14.0	12.0	11.0
6	**Colour**	colourless	colourless	colourless	colourless	colourless	colourless	colourless	colourless	colourless	colourless	colourless	colourless
7	**Adour**	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless
8	**Temperature**	28	29	28	30	33	31	30	29	30	31	28	26
9	**C.O.D**	-	-	32.0	16.0	-	-	-	-	12.0	16.0	-	-
NSFWQI index Value		56	55	49	54	54	51	54	55	56	52	53	50
Avg. NSFWQI index Value		53.25	(But 50-70=Medium water quality)										

Table 6.4: At Ramkund (K_4)

For Year 2005													
Sr. No.	Date / Parameter	8.01.05	05.02.05	06.03.05	07.04.05	07.05.05	03.06.05	09.07.05	07.08.05	07.09 .05	02.10.05	06.11.05	09.12.05
1	**PH**	7.2	7.7	7.8	7.4	7.9	7.3	7.9	7.8	7.9	8.0	8.1	7.9
2	**DO**	7.0	7.1	5.8	7.2	6.5	5.2	6.2	5.6	6.6	6.9	7.0	4.8
3	**B.O.D**	3.0	4.0	7.0	6.0	4.0	9.0	10.0	12.0	6.0	8.0	4.0	9.0
4	**Total Coliform**	280.0	250.0	300.0	1100.0	130.0	225.0	900.0	350.0	12.0	140.0	25.0	110.0
5	**Colour & Intensity**	colourless	colourless	colourless	colourless	colourless	colourless	colourless	colourless	colourless	colourless	colourless	colourless
6	**Adour**	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless
7	**Temperature**	23.0	21.0	25.0	30.0	27.0	29.0	25.0	24.0	24.0	29.0	28.0	25.0
8	**C.O.D**	16	24	26	22	70	26	32	29	23	26	18	23.5
NSFWQI index Value		42	41	38	41	41	38	35	34	40	36	40	37
Avg. NSFWQI index Value		38.59	(But 25-50 =Bad water quality)										

For Year 2006

Sr. No.	Date / Parameter	10.01.06	07.02.06	09.03.06	12.04.06	10.05.06	09.06.06	10.07.06	09.08.06	07.09.06	08.10.06	09.11.06	09.12.06
1	**PH**	7.2	7.9	7.6	6.7	8.1	7.4	7.6	7.5	7.8	7.2	7.4	7.1
2	**DO**	7.1	7.3	7.2	5.5	3.4	3.5	6.8	8.1	6.7	5.4	5.7	6.8
3	**B.O.D**	3.0	14.0	6.0	14.0	24.0	32.0	4.0	8.0	13.0	10.0	7.5	8.6
4	**Nitrate**	1.01	1.21	0.15	0.9	0.96	0.879	0.15	0.789	0.7356	0.9	0.87	0.134
5	**Total Coliform**	250.0	30.0	500.0	1600.0	110.0	250.0	25.0	65.0	35.0	55.0	17.0	1800.0
6	**Turbidity**	52	52	45	51	48	51	45	51	51	51	37	45
7	**Phosphate**	0.099	0.98	0.015	0.5	0.50	0.495	0.015	0.49	0.398	0.5	0.64	0.518
8	**Temperature**	20	29	31	30	33	25	31	25	25	26	30	31
9	**C.O.D**	27	42	41	29	58	71	12.5	15.2	12.5	12.5	21.5	18.5
10	**T.D.S**	361	362	165	149	156	149	165	149	149	149	158	165
NSFWQI index Value		55	43	57	47	45	46	58	51	50	51	50	50
Avg. NSFWQI index Value		50..25 (But 50-70=Medium water quality)											

For Year 2007

Sr. No.	Date / Parameter	10.01.07	07.02.07	08.03.07	04.04.07	8.05.07	3.06.07	4.07.07	6.08.07	4.09.07	4.10.07	5.11.07
1	**PH**	5.9	7.5	7.2	7.94	7.3	8.1	7.9	6.8	7.0	7.78	7.7
2	**DO**	6.3	6.4	5.9	5.7	7.1	5.7	4.6	7.1	6.7	4.7	5.1
3	**B.O.D**	7.0	6.2	6.3	6.25	5.0	22.0	5.0	9.3	7.88	12.0	15.0
4	**Nitrate**	0.484	0.599	0.47	0.484	0.484	0.54	1.82	0.844	2.19	3.04	0.97
5	**Fecal Coliform**	-	-	-	17.0	-	-	-	-	-	14.0	-
6	**Turbidity**	46.0	51.0	41.0	1.0	46.0	31.0	56.0	46.0	25.0	52.0	41.0
7	**Phosphate**	1.913	0.319	-	-	1.93	0.39	0.67	1.39	0.542	0.09	-
8	**Temperature**	34	31	24	27	30	31	31	34	29	34	24
9	**C.O.D**	21	18	15	16.0	12.0	14.0	12.5	18.5	21.0	12.5	27.0
10	**T.D.S**	238	149	156	238.0	238	440.0	540.0	238.0	209.0	361.0	158.0
NSFWQI index Value		42	54	51	57	49	46	46	45	51	53	46
Avg. NSFWQI index Value		49.09 (But 25-50=Bad water quality)										

For Year 2008			
Sr. No.	Date / Parameter	01.04.08	02.10.08
1	PH	7.35	8.14
2	DO	5.5	5.99
3	Conductivity	231.6	362.1
4	B.O.D	8.0	6.0
5	Nitrate	0.412	3.7
6	Fecal Coliform	8.	20.0
7	Turbidity	1.0	1.0
8	Temperature	29	28
NSFWQI index Value		51	53
Avg. NSFWQI index Value		52 (But 50-70–medium water quality)	

For Year 2009				
Sr. No.	Date / Parameter	07.05.09	02.10.09	07.12.09
1	PH	8.44	8.21	8.14
2	DO	4.7	4.90	4.8
3	Conductivity	291.4	468.1	476.0
4	B.O.D	8.0	7.50	16.0
5	Nitrate	0.1	0.34	0.30
6	Fecal Coliform	14.0	20.0	45.0
7	Total Coliform	30.0	45.0	17.0
8	Turbidity	1.0	1.0	1.0
9	Temperature	26	24	
10	C.O.D	16.0	16.0	16.0
NSFWQI index Value		50	54	48
Avg. NSFWQI index Value		50.67 (But 50-70–Medium water quality)		

For Year 2010			
Sr. No.	**Date** / **Parameter**	07.01.2010	05.02.2010
1	**PH**	8.31	8.31
2	**DO**	4.6	4.9
3	**Conductivity**	151.0	451.5
4	**B.O.D**	18.0	16.0
6	**Nitrate**	3.09	3.01
7	**Fecal Coliform**	11.0	20.0
8	**Total Coliform**	40.0	40.0
9	**Turbidity**	1.0	1.0
10	**Temperature**	25	25
11	**C.O.D**	12.0	12.0
NSFWQI index Value		50	49
Avg. NSFWQI index value		49.5 (But 25-50=Bad water quality)	

Table 6.5: At Kapila and Godavari Confluence (K_5)

For Year 2008								
Sr. No.	**Date** / **Parameter**	01.02.08	08.03.08	07.05.08	03.06.08	09.07.08	07.08.08	04.09.08
1	**PH**	7.22	7.33	7.0	7.21	7.35	7.79	7.78
2	**DO**	7.82	5.2	4.1	2.94	2.33	5.2	4.54
3	**B.O.D**	6.00	15.0	16.0	24.0	14.0	8.0	6.0
4	**Nitrate**	1.36	2.54	0.978	0.75	1.45	4.17	3.53
5	**Fecal Coliform**	30.0	30.0	14.0	35.0	14.0	25.0	15.0
6	**Colour**	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless
7	**Adour**	odourless	odourless	odourless	odourless	odourless	odourless	odourless
8	**Temperature**	29	30	33	31	30	32	29
NSFWQI index Value		51	46	48	45	49	47	51
Avg. NSFWQI index Value		48.14 (25-50 is Bad water quality)						

For Year 2009

Sr. No.	Date / Parameter	07.01.09	05.02.09	02.03.09	08.04.09	07.05.09	03.06.09	05.07.09	07.08.09	03.09.09	02.10.09	06.11.09	07.12.09
1	**PH**	7.84	7.76	8.81	6.6	8.2	8.1	8.17	7.5	7.48	8.0	7.48	8.790
2	**DO**	5.85	5.9	5.0	5.1	5.9	5.9	5.4	5.2	3.9	5.0	5.2	5.3
3	**Conductivity**	-	-	-	-	-	-	-	-	500.6	-	-	642.2
4	**B.O.D**	5.7	4.8	14.0	10.	6.0	12.0	9.0	18.0	16.00	7.0	22.0	6.0
5	**Nitrate**	0.7	0.6	2.16	0.2	0.1	0.2	0.1	0.2	0.89	0.18	0.9	0.84
	Temperature	28	29	30	31	32	34	30	31	31	28	27	25
7	**C.O.D**	-	-	48.0	28.0	-	-	-	-	44.0	-	-	36.0
N8SFWQI index Value		48	50	37	43	47	43	47	43	50	47	42	49
Avg. NSFWQI index Valu		45.33 (But 25-50 =Bad Water quality)											

For Year 2010

Sr. No.	Date / Parameter	07.01.2010	05.02.2010
1	**PH**	8.61	8.03
2	**DO**	6.3	5.9
3	**Conductivity**	234.0	752.5
4	**B.O.D**	6.0	8.0
5	**Nitrate**	1.20	3.41
6	**Fecal Coliform**	5.0	
7	**Total Coliform**	25.0	5.0
8	**Turbidity**	1.0	11.0
9	**Colour**	Colourless	Colourless
10	**Adour**	Odourless	Odourless
11	**Temperature**	25	25
12	**C.O.D**	36.0	16.0
NSFWQI index Value		56	47
Avg. NSFWQI index Value		51.5 (But 50-70 =Medium water quality)	

Table 6.6: At D/S of Nasik (K_6)

For Year 2005													
Sr. No.	Date / Parameter	08.01.05	05.02.05	06.03.05	07.04.05	07.05.05	03.06.05	09.07.05	07.08.05	07.09.05	02.10.05	06.11.05	09.12.05
1	PH	6.9	7.2	7.7	7.5	7.8	7.6	7.7	7.4	7.9	7.8	8.2	7.8
2	DO	6.9	6.9	4.1	6.5	5.9	5.2	4.5	4.9	7.0	5.2	6.4	6.2
3	B.O.D	14.0	10.	20.0	8.01	10.0	14.0	13.0	14.0	11.0	13.0	9.0	7.0
4	Total Coli form	300.0	170.0	400.0	900.0	175.0	225.0	1600.0	425.0	20.0	1600.0	1600.0	550.0
5	Colour & Intensity	colourless	colourless	colourless	colourless	colourless	colourless	colourless	colourless	colourless	colourless	colourless	colourless
6	Adour	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless
7	Temperature	32	24	29	30	32	28	23	26	20	23	24	22
8	C.O.D	30	29	28	32	29	38	36	32	32	36	29	22
NSFWQI index Value		32	36	31	38	36	34	34	34	35	33	33	38
Avg. NSFWQI index Value		34.5	(But 25-50=Bad Water quality)										

Year 2006													
Sr. No.	Date / Parameter	10.01.06	07.02.06	09.03.06	12.04.06	10.05.06	09.06.06	10.07.06	09.08.06	07.09.06	08.10.06	09.11.06	09.12.06
1	PH	7.5	7.7	7.4	7.6	8.2	7.1	7.5	7.6	7.4	7.5	7.7	7.7
2	DO	4.2	6.5	6.3	7.2	3.7	2.5	6.4	7.6	6.3	4.8	5.78	6.6
3	Conductivity	550	515	248	389	196	204	250	251	198	188	179	209
4	B.O.D	15.0	20.0	12.0	12.0	20.0	32.0	4.0	10.0	10.5	9.0	9.2	5.3
5	Nitrate	0.96	0.91	0.9	0.92	0.87	0.89	0.56	0.89	0.91	0.87	0.24	0.9
6	Total Coliform	50.0	17.0	500.0	116.0	25.0	50.0	45.0	115.0	45.0	85.0	18.0	1200
7	Turbidity	31.0	39.0	18.0	34.0	37.0	45.0	51.0	56.0	43.0	37.0	28.0	55.0
8	Phosphate	0.224	0.226	0.5	0.71	0.64	0.87	0.824	0.98	0.63	0.64	0.72	0.5
9	Temperature	23	21	25	31	37	32	25	24	24	37	35	25
10	C.O.D	57	64	18	32	56	64	18	32	31	24	22	11.4
11	T.D.S	378	389	149	167	158	187	149	244	204	158	324	149
NSFWQI index Value		50	48	51	49	45	44	52	49	49	50	48	52
Avg. NSFWQI index Value		48.91	(But 25-50 =Bad water quality)										

For Year 2007

Sr. No.	Date / Parameter	10.01.07	07.02.07	08.03.07	04.04.07	08.05.07	03.06.07	04.07.07	06.08.07	04.09.07	04.10.07	05.11.07
1	PH	7.8	7.6	7.3	7.80	8.6	7.8	7.2	7.9	7.9	7.98	7.0
2	DO	7.2	5.8	5.4	4.2	6.2	7.3	7.9	7.1	4.6	4.6	6.9
3	Conductivity	198	141	619	382.4	130	189	251	231	157	215.4	605
4	B.O.D	4.9	9.7	7.9	7.25	20.1	5.0	5.5	6.5	5.0	19.0	8.0
5	Nitrate	2.53	0.9	0.99	0.515	0.49	0.78	1.97	0.49	3.1	2.82	0.99
7	Total Coliform	900.0	1800.0	1600.0	350.0	6.0	25.0	17.0	25.0	35.0	14.0	35.0
8	Turbidity	52.0	51	50	1.0	51.0	67	34	52	36	59	51
9	Phosphate	1.19	0.5	0.04	2.05	1.98	0.23	0.63	1.98	0.62	0.224	0.04
10	Colour & Intensity	colourless	colourless	colourless	colourless	colourless	colourless	colourless	colourless	colourless	colourless	colourless
11	Adour	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless
12	Temperature	35	25	21	34	35	22	28	35	26	27	21
13	C.O.D	12.5	26.0	21.0	16.0	22.0	12.5	15.0	17.0	12.5	18.5	21.0
14	T.D.S	367	149	597	251.0	367	463	274	367	474	378	597
NSFWQI index Value		47	50	51	53	37	51	52	45	48	50	50
Avg. NSFWQI index Value		48.54 (But 25-50 =Bad water quality)										

For Year 2008

Sr. No.	Date / Parameter	1.04.08	02.10.08
	PH	6.90	8.19
1	DO	4.8	5.80
2	B.O.D	10.4	6.1
3	Nitrate	0.597	3.43
4	Fecal Coliform	17.0	32.0
5	Temperature	27	28
6	C.O.D	36.0	-
7	T.D.S	280.0	-
NSFWQI index Value		52	44
Avg. NSFWQI index Value		48 (But 25-50 =Bad water quality)	

For Year 2009

Sr. No.	Date / Parameter	07.05.09	02.10.09	07.12.09
1	PH	8.87	8.17	7.84
2	DO	4.9	4.5	5.2
3	Conductivity	305.7	489.7	539.2
4	B.O.D	9.0	7.90	14.0
5	Nitrate	0.1	0.22	0.20
6	Fecal Coliform	17.0	20.0	45.0
7	Total Coliform	40.0	50.0	25.0
8	Turbidity	1.0	1.0	1.0
9	Colour	colourless	colourless	colourless
10	Adour	odourless	odourless	odourless
11	Temperature	26	24	25
12	C.O.D	12.0	12.0	12.0
NSFWQI index Value		47	54	51
Avg. NSFWQI index Value		50.66 (But 50-70 =Medium water quality)		

For Year 2010

Sr. No.	Date / Parameter	07.01.2010	05.02.2010
1	PH	8.4	8.40
2	DO	5.4	5.8
3	Conductivity	189.0	483.8
4	B.O.D	14.0	12.0
6	Nitrate	3.53	2.9
7	Fecal Coliform	12.0	14.0
8	Turbidity	1.0	1.0
9	Temperature	25	25
10	C.O.D	12.0	12.0
NSFWQI index Value		49	51
Avg. NSFWQI index Value		50.00 (But 50-70 =Medium water quality)	

NSFWQI Index Data for Aurangabad city

Table 6.8: Kaigaon Toka (P_1)

For Year 2005

Sr. No.	Date / Parameter	08.01.05	05.02.05	06.03.05	07.04.05	07.05.05	03.06.05	09.07.05	07.08.05	07.09 .05	02.10.05	09.12.05
1	PH	7.77	8.43	8.17	8.22	8.52	7.342	7.34	8.26	8.29	8.25	7.97
2	DO	7.03	6.4	6.6	6.2	7.6	7.0	6.9	-	6.94	6.62	8.50
3	B.O.D	2.0	3.0	2.5	2.6	2.4	4.0	4.2	4.0	4.0	3.4	2.8
4	Nitrate	0.058	0.33	0.02	-	-	-	-	-		1.74	
5	Temperature	26	28	28	30	31	30	29	29	28	27	26
6	Calcium	92.8	17.6	16.0		26.4	39.2	64.0	32.0	48.8	56.8	16.8
7	Magnesium	45.0	29.74	18.46		7.67	49.76	48.6	24.30	46.46	61.04	18.27
8	C.O.D	8.0	12.0	8.0	8.0	8.0	20.0	16.0	12.0	16.0	12.0	8.0
9	T.D.S	580.0	320.0	284.0	216.0	384.0	420.0	556.0	2970.0	212.0	158.0	173.0
NSFWQI Index Value		54	48	50	44	41	43	39	36	42	56	52
Avg. NSFWQI Index Value		45.90 (But25-50=Bad so the water quality in this Year is bad)										

For Year 2006

Sr. No.	Date / Parameter	10.01.06	07.02.06	09.03.06	12.04.06	10.05.06	09.06.06	10.07.06	09.08.06	07.09.06	08.10.06	09.11.06	09.12.06
1	PH	7.35	8.32	9.62	8.14	8.85	8.5	8.19	7.96	8.61	7.8	7.8	8.1
2	DO	7.08	6.80	6.24	8.24	7.24	-	6.4	7.0	6.08	7.18	6.88	7.21
3	B.O.D	2.0	2.7	1.84	3.98	2.46	4.8	3.8	3.8	3.2	7.92	4.2	3.8
4	Nitrate	-	0.03	-	-	-	0.370	-	0.701	1.230	0.230	0.91	0.208
5	Turbidity	3.3	-	1.01	6.04	0.776	0.52	-	14.6	5.39	2.10	0.981	0.342
6	Temperature	25	26	27	27	30	32	33	30	29	30	28	26
7	C.O.D	8.0	8.0	8.0	8.0	8.0	32.0	16.0	16.0	18.0	24.0	12.0	8.0
8	T.D.S	502.0	232.0	331.0	250.0	204.0	278.0	210.0	2020	280.0	300.0	312.0	444.0
NSFWQI Index Value		49	51	43	48	48	53	44	49	52	54	56	54
Avg. NSFWQI Index Value		50.08 (But 50-70 =Medium water quality, so water quality for this Year is medium)											

For Year 2007													
Sr. No.	Date / Parameter	10.01.07	7.02.07	8.03.07	4.04.07	8.05.07	3.06.07	4.07.07	6.08.07	4.09.07	4.10.07	5.11.07	10.12.07
1	PH	8.20	8.21	8.06	8.55	8.28	8.37	7.83	7.87	8.41	8.71	8.31	8.01
2	DO	6.99	-	6.89	6.94	7.11	5.74	6.84	5.80	5.56	8.52	-	7.14
3	Conductivity	-	642.0	804.6	-	-	-	-	-	-	-	-	-
4	B.O.D	5.0	4.8	7.2	11.4	7.4	3.6	3.2	14.8	6.6	6.4	-	-
5	Nitrate	-	-	0.016	-	-	0.0005	0.0070	0.0039	0.0296	0.0111	0.0143	0.0154
6	Turbidity	0.511	0.783	1.77	0.436	0.422	3.29	-	-	0.946	-	-	1.10
7	Hardness	176.0	180.0	180.0	200.0	198.0	156.0	142.0	150.0	180.0	270.0	136.0	108.0
8	Temperature	27	29	28	29	31	32	33	32	30	31	28	26
9	Calcium	64.8	-	64.0	72.8	70.6	-	46.6	40.2	38.3	56.1	32.3	-
10	Magnesium	111.2	-	116.0	127.2	128.4	-	92.3	100.0	141.6	214.4	104.1	-
11	C.O.D	20.0	120	16.0	26.0	16.0	8.0	8.0	32.0	16.0	16.0	8.0	32.0
12	T.D.S	612.0	536.0	582.0	460.0	446.0	440.0	360.0	340.0	510.0	58/0.0	480.0	421.0
NSFWQI Index Value		43	43	49	38	43	52	52	45	48	41	45	52
Avg. NSFWQI Index Value		45.9 (But 25-50= Bad so the water quality in this Year is Bad)											

For Year 2008												
Sr. No.	Date / Parameter	02.01.08	01.02.08	08.03.08	01.04.08	03.06.08	09.07.08	07.08.08	04.09.08	02.10.08	05.11.08	06.12.08
1	PH	8.16	8.22	7.73	9.4	7.5	8.4	7.8	7.63	8.39	7.82	7.14
2	DO	6.63	6.20	6.23	7.29	6.31	6.45	6.68	6.87	2.06	9.02	7.86
3	B.O.D	3.10	3.20	3.60	14.80	3.26	14.25	4.04	3.44	7.22	6.80	10.20
4	Nitrate	0.955	0.120	0.140	0.110	-	0.0389	0.0453	0.0389	0.976	1.11	0.821
5	Turbidity	0.467	0.473	0.485	0.315	-	0.815	0.662	0.918	1.19	0.509	0.474
6	Temperature	27	29	28	30	32	33	32	30	29	28	26
7	C.O.D	8.0	4.0	8.0	32.0	8.0	32.0	8.0	8.0	16.0	16.0	8.0
8	T.D.S	480.0	1010.0	1380.0	554.0	684.0	940.0	780.0	781.2	340.0	560.0	500.0
NSFWQI Index Value		53	52	53	39	41	45	53	54	47	51	50
Avg. NSFWQI Index Value		48.9 (But 25-50 is Bad quality water so that this Year water quality is Bad)										

For Year 2009-2010											
Sr. No.	Date / Parameter	07.01.09	05.02.09	02.03.09	08.04.09	07.05.09	03.06.09	05.07.09	07.08.09	03.09.09	6.02.2010
1	PH	7.12	8.64	8.60	8.22	8.32	8.18	8.04	8.13	8.45	7.72
2	DO	7.27	7.06	6.77	6.67	5.54	5.58	4.02	3.73	4.48	4.03
3	B.O.D	3.20	3.21	3.0	7.20	2.80	2.71	3.14	2.0	2.09	2.59
4	Nitrate	0.372	0.139	0.434	-	0.4909	0.7908	2.1233	1.7507	1.2791	1.047
5	Turbidity	0.312	0.254	0.286	0.231	0.298	0.802		0.125	0.240	0.894
6	Temperature	27	29	30	32	33	32	31	30	28	28
7	Calcium	22.4	22.4	22.4	22.6	31.5	30.8	80.4	88.2	61.019	21.7
8	Magnesium	101.6	207.9	263.1	205.6	235.6	2307	86.0	272.015	87.0	105.4
9	C.O.D	8.0	8.0	8.0	24.0	8.0	8.0	8.0	8.0	16.0	8.0
10	T.D.S	412.0	548.0	812.0	680.0	500.64	1040.26	4400	1180.67	1200.65	415.9
NSFWQI Index Value		56	50	50	42	52	53	47	54	52	56
Avg. NSFWQI Index value		50.66 (But 50-70 is Medium water quality so this Year water quality is Medium)									

Table 6.9: **Jaikwadi Dam at Paithan (P_2)**

For Year 2005													
Sr. No.	Date / Parameter	10.01.05	10.02.05	09.03.05	08.04.05	10.05.05	08.06.05	07.07.05	08.08.05	09.09.05	10.10.05	10.11.05	09.12.05
1	PH	8.30	8.22	8.22	8.12	8.44	8.19	7.80	7.88	8/92	8.26	8.37	8.30
2	DO	6.87	6.70	7.15	6.03	7.42	7.32	6.20	6.82	6.85	6.78	8.48	8.15
3	Conductivity	350.0	370.0	350.0	380.0	329.0	345.0	332.0	277.0	235.0	247.0	456.50	257.7
4	B.O.D	2.0	4.40	5.40	4.40	4.0	4.20	4.0	3.80	3.80	2.30	2.36	3.76
5	Nitrite	0.06	0.03	-	0.40	0.50	0.06	-	0.74	0.23	0.54	2.81	0.05
6	Ammonical nitrogen	0.25	0.51	0.42	0.40	0.30	0.80	0.28	0.23	0.41	0.42	0.43	0.210
7	Fecal Coliform	6.0	4.0	5.0	5.0	5.0	4.0	5.0	5.0	5.0	7.0	5.0	7.0
8	Total Coliform	175.0	175.0	170.0	180.0	170.0	160.0	189.0	210.0	175.0	200.0	460.0	170.0
9	Temperature	27	29	28	29	30	31	30	29	28	28	27	26
NSFWQI Index Value		57	55	54	55	54	56	54	55	55	56	56	55
Avg. NSFWQI Index Value		55.16 (But 50-70 water quality is medium so that this Year water quality is medium)											

For Year 2006

Sr. No.	Date / Parameter	10.01.06	07.02.06	09.03.06	12.04.06	10.05.06	09.06.06	10.07.06	09.08.06	07.09.06	08.10.06	09.11.06
1	PH	8.45	8.38	8.10	7.94	7.41	8.4	8.19	7.65	8.08	7.90	7.80
2	DO	9.02	8.60	7.01	6.34	6.87	6.7	6.4	7.2	6.70	7.60	7.54
3	Conductivity	267.3	274.4	269.7	N.A.	333.0	280.0	208.8	220.6	246.5	285.3	376.4
4	B.O.D	2.66	2.46	5.12	3.24	3.64	3.6	3.5	3.8	4.9	4.2	4.6
5	Ammonical Nitrogen	0.340	0.360	0.240	0.270	0.40	0.440	0.005	0.270	0.43	0.62	0.46
6	Nitrate	0.15	BDL	BDL	0.412	0.540	0.280	0.040	0.350	0.110	0.660	0.180
7	Fecal Coliform	30.0	17.0	4.0	4.0	7.0	27.0	11.0	14.0	8.0	14.0	14.0
8	Total Coliform	500.0	170.0	175.0	140.0	200.0	500.0	280.0	170.0	110.0	240.0	220.0
9	Temperature	27	28	28	29	30	32	31	30	29	28	28
NSFWQI Index Value		51	53	55	58	58	56	54	55	53	54	53
Avg. NSFWQI Index Value		54.54 (But 50-70 water quality is medium so that this Year water quality is medium)										

For Year 2007

Sr. No.	Date / Parameter	10.01.07	07.02.07	08.03.07	08.05.07	04.07.07	06.08.07	04.09.07	04.10.07	05.11.07	10.12.07
1	PH	7.84	7.852	8.01	7.82	8.21	8.23	8.59	8.58	8.45	8.40
2	DO	6.59	7.62	7.49	7.42	6.38	5.99	6.28	6.62	6.48	6.64
3	Conductivity	3.92.2	378.4	385.9	380.7	372.0	378.0	355.5	334.0	356.3	371.7
4	B.O.D	4.0	2.8	4.0	3.5	3.60	4.0	4.8	5.0	4.8	4.60
5	Ammonical Nitrogen	0.05	0.32	0.44	0.060	0.16	2.80	0.056	0.056	0.056	0.064
6	Nitrate	0.160	0.180	0.18	0.220	0.4278	0.5777	0.5763	0.5098	0.3941	1.023
7	Fecal Coliform	17.05	11.0	6.0	7.0	9.0	8.0	8.0	70	7.0	8.0
8	Total Coliform	280.0	220.0	170.0	170.0	350.0	280.0	240.0	220.0	280.0	300.0
9	Temperature	28	29	30	30	31	30	29	28	28	27
NSFWQI Index Value		54	56	56	56	55	56	55	54	53	52
Avg. NSFWQI Index Value		54.7 (But 50-70 water quality is Medium so that this Year water quality is Medium)									

For Year 2008										
Sr. No.	Date / Parameter	02.01.08	08.03.08	01.04.08	07.05.08	03.06.08	09.07.08	07.08.08	04.09.08	02.10.08
1	PH	7.2	8.2	8.0	7.9	7.01	7.4	7.5	6.96	7.41
2	DO	6.8	6.2	6.8	6.1	6.89	6.92	6.62	6.71	5.63
3	B.O.D	4.4	4.0	4.1	6.5	4.22	4.76	4.58	4.28	4.00
4	Nitrate	0.46	0.37	0.4	0.38	0.416	0.3845	0.412	0.1965	0.2813
5	Fecal Coliform	7.0	6.0	8.0	7.0	8.0	7.0	7.0	6.0	6.0
6	Colour & Intensity	colourles	colourles	colourles	colourles	colourles	colourles	colourles	colourles	colourles
7	Adour	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless
8	Temperature	27	29	29	30	32	31	30	29	29
NSFWQI Index Value		56	55	54	53	56	55	54	50	52
Avg. NSFWQI Index Value		53.88 (But 50-70 water quality is medium so that this Year water quality is Medium)								

For Year 2009-2010											
Sr. No.	Date / Parameter	07.01.09	05.02.09	02.03.09	08.04.09	07.05.09	03.06.09	05.07.09	07.08.09	03.09.09	8.02.2010
1	PH	7.48	7.32	7.26	7.71	7.47	7.62	8.27	7.86	7.82	7.51
2	DO	7.1	6.92	7.0	7.2	7.08	6.65	6.31	4.4	4.22	3.37
3	B.O.D	3.4	3.2	3.4	4.8	4.8	3.8	2.0	2.4	5.0	2.1
4	Nitrate	1.3	1.3	1.0	1.53	0.824	0.54		0.6	0.76	0.70
5	Fecal Coliform	4.0	6.0	5.0	5	4.0	5	8.0	6.0	9.0	8.7
6	Colour & Intensity	colourles	colourles	colourles	colourles	colourles	colourles	colourles	colourles	colourles	colourles
7	Adour	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless
8	Temperature	28	28	28	29	30	32	31	29	28.4	28
NSFWQI Index Value		59	58	58	57	56	58	55	56	55	58
Avg. NSFWQI Index Value		56.88 (But 50-70 water quality is Medium so that this Year water quality is medium)									

Table 6.10: Upstream of Paithan (P_3) town

For Year 2005

Sr. No.	Date / Parameter	08.01.05	05.02.05	06.03.05	07.04.05	07.05.05	03.06.05	09.07.05	07.08.05	7.09.05	02.10.05	09.12.05
1	PH	7.51	8.3	8.55	7.46	7.15	7.675	8.08	8.05	8.36	7.7	8.30
2	DO	6.76	6.6	6.2	7.4	7.1	6.5	6.58	6.52	-	4.54	8.41
3	B.O.D	4.2	1.2	3.2	4.2	4.0	4.2	12.2	4.0	1.92	3.5	8.44
4	Hardness	138.0	100.0	128.0	72.0	142.0	156.0	114.0	104.0	120.0	360.0	140.0
5	Temperature	27	28	28	29	30	31	31	30	29	29	27
6	Calcium	36.8	23.2	27.2	48.0	48.0	63.2	24.8	32.0	31.2	72.8	28.8
7	Magnesium	24.59	18.66	24.49	5.83	22.84	22.55	21.67	17.49	21.57	69.78	28.55
8	C.O.D	12	4.0	8.0	12.0	12.0	16.0	20.0	16.0	8.0	8.0	28.0
9	T.D.S	284.0	236.0	368.0	392.0	232.0	307.0	236.0	190.0	216.0	198.0	60.0
NSFWQI Index Value		44	48	38	43	46	44	36	44	45	46	46
Avg. NSFWQI Index Value		43.09 (But 25-50 water quality is Bad so water quality is Bad)										

For Year 2006

Sr. No.	Date / Parameter	10.01.06	07.02.06	09.03.06	12.04.06	10.05.06	09.06.06	10.07.06	09.08.06	07.09.06	08.10.06	09.12.06
1	PH	8.59	8.01	8.10	8.99	8.27	8.51	8.19	8.8	8.03	7.6	7.90
2	DO	8.88	6.62	6.68	6.47	6.23	6.50	6.79	7.2	6.92	7.74	7.30
3	B.O.D	1.16	4.0	2.0	5.98	2.0	5.40	4.4	4.6	3.2	5.22	3.8
4	Nitrate	-	-	-	-	-	-	-	-	0.480	-	-
5	Turbidity	-	-	5.81	-	-	1.0	-	7.43	4.38	3.77	0.446
6	Temperature	27	27	29	30	30	31	31	29	29	28	27
7	Calcium	25.6	52.8	47.2	-	25.6	23.2	-	-	25.8	40.0	49.6
8	Magnesium	26.34	17.78	8.94	-	64.4	22.8	-	-	58.4	72.0	78.4
9	C.O.D	4.0	12.0	8.0	12.0	4.0	28.0	20.0	24.6	8.0	16.0	12.0
10	Sulphate	7.0	8.0	24.0	12.0	19.0	8.0	34.0	6.0	17.0	25.0	29.0
11	T.D.S	210.0	386.0	133.0	44.0	25.0	25.0	26.0	29.0	44.0	58.0	37.5
NSFWQI Index Value		46	41	53	37	48	48	44	45	58	52	53
Avg. NSFWQI Index Value		47.72 (But 25-50 water quality is Bad so That this Year water quality is Bad)										

For Year 2007

Sr. No.	Date / Parameter	10.01.07	07.02.07	08.03.07	04.04.07	08.05.07	03.06.07	04.07.07	06.08.07	04.09.07	04.10.07	05.11.07	10.12.07
1	PH	7.69	8.22	8.32	8.37	8.66	8.41	8.44	8.44	8.15	8.53	8.42	8.04
2	DO	7.20	7.04	6.49	7.04	6.90	6.0	7.50	6.34	7.13	6.62	6.79	7.21
3	B.O.D	8.0	13.6	8.2	4.9	3.7	5.1	3.2	5.0	7.0	5.0	-	-
4	Nitrate	0.53	0.04	0.37	-	0.33	0.6537	0.5337	0.8253	0.6723	0.5803	0.4218	1.165
5	Turbidity	3.85	1.41	0.898	-	-	1.72	5.52	-	7.89	1.74	-	1.11
6	Hardness	130.0	140.0	122.0	158.0	124.0	156.0	136.0	146.0	224.0	130.	112.0	114.0
7	Temperature	26	27	28	28	30	29	29	28	28	27	27	26
8	Calcium	36.8	-	44.0	56.0	24.0	48.0	25.6	40.8	54.4	28.0	36.0	25.6
9	Magnesium	93.2	-	78.0	102.0	100.0	108.0	110.4	105.2	169.6	102.0	76.0	88.4
10	C.O.D	28.0	28.0	20.0	12.0	8.0	20.0	8.0	8.0	16.0	8.0	8.0	8.0
11	T.D.S	360.0	358.0	454.0	320.0	312.0	300.0	260.0	360.0	540.0	500.0	400.0	360.0
NSFWQI Index Value		52	48	49	39	47	47	50	46	43	43	46	50
Avg. NSFWQI Index Value		46.67 (But 25-50 water quality is Bad so that this Year Water quality is Bad)											

For Year 2008

Sr. No.	Date / Parameter	02.01.08	01.02.08	08.03.08	01.04.08	07.05.08	03.06.08	09.07.08	07.08.08	04.09.08	02.10.08	05.11.08	06.12.08
1	PH	8.16	8.06	8.27	7.56	8.24	7.2	7.6	6.8	7.81	8.39	7.44	7.13
2	DO	7.64	6.20	6.38	7.33	5.47	6.45	6.68	6.71	6.81	5.75	8.63	6.02
3	B.O.D	3.80	6.60	3.80	2.8	11.80	7.24	3.50	5.62	4.06	13.28	25.80	3.20
4	Nitrate	0.474	0.012	0.540	0.090	-	-	0.1836	0.1723	0.2052	0.527	1.33	0.775
5	Turbidity	1.040	0.917	0.973	0.929	0.524	-	0.414	0.502	0.712	0.429	0.322	0.392
6	Temperature	27	28	29	30	31	31	30	29	29	28	27	27
7	Calcium	28.6	40.0	24.8	25.6	30.4	27.4	52.8	34.4	40.0	32.8	30.0	22.4
8	Magnesium	89.2	62.0	69.2	140.4	165.6	144.6	195.2	139.6	218.0	181.2	218.6	192.0
9	C.O.D	12.0	8.0	8.0	8.0	-	16.0	8.0	16.0	8.0	32.0	64.0	8.0
10	T.D.S	360.0	480.0	1100.0	652.0	632.0	508.0	900.0	520.0	960.0	836.0	460.0	402.0
NSFWQI Index Value		54	51	51	55	38	36	54	51	53	44	47	56
Avg. NSFWQI Index Value		49.16 (But 25-50 water quality is Bad So water quality in This Years Is Bad)											

		For Year 2009-2010								
Sr. No.	Date / Parameter	07.01.09	05.02.09	02.03.09	08.04.09	07.05.09	03.06.09	05.07.09	03.09.09	5.02.2010
1	PH	8.35	7.32	8.77	7.97	7.74	8.25	7.92	8.41	7.39
2	DO	8.0	6.96	6.78	6.87	6.69	6.21	3.72	4.45	4.52
3	Conductivity	540.8	391.3	666.5	789.6	355.1	347.3	377.0	-	399.59
4	B.O.D	3.20	7.40	4.80	2.80	4.80	2.60	6.44	2.2	5.09
6	Nitrate	0.62	0.372	0.279	0.873	0.638	0.3974	0.5531	0.8283	0.427
7	Turbidity	0.339	0.321	0.297	0.274	0.291	0.365	2.02	0.770	0.497
8	Temperature	26	27	28	29	30	31	31	30	27
9	Magnesium	117.6	109.2	163.2	151.6	159.2	118.0	100.0	120.0	101.3
10	C.O.D	8.0	16.0	16.0	8.0	16.0	8.0	24.0	16.0	16.0
11	T.D.S	478.0	312.0	540.0	710.0	320.0	340.0	320.0	310.0	307.5
NSFWQI Index Value		52	54	47	53	56	56	54	55	56
Avg. NSFWQI Index Value		53.37 (But 50-70 water quality is Medium so that this Year water quality is Medium)								

Table 6.11: **Down-stream of Paithan (P_4) town**

		For Year 2005											
Sr. No.	Date / Parameter	01.01.05	08.02.05	05.03.05	07.04.05	04.05.05	09.06.05	05.07.05	01.08.05	07.09 .05	02.10.05	06.11.05	08.12.05
1	PH	8.21	8.21	8.51	7.88	7.03	7.779	8.27	7.90	8.34	8.38	8.21	7.32
2	DO	6.4	6.74	6.3	7.4	7.0	6.6	6.46	6.25	5.11	4.53	5.26	8.52
3	B.O.D	2.5	2.0	4.0	4.8	4.2	4.8	11.5	5.0	3.42	6.5	10.5	7.9
4	Nitrate	-	2.19	-	-	-	-	-	-	-	7.75	8.8	3.7
5	Turbidity	-	-	-	-	-	-	-	-	3.98	1.73	13.10	4.9
6	Phosphate	-	-	0.01		0.22	0.09	0.10	0.09	-	-	0.17	-
7	Hardness	94.0	200.0	124.0	54.0	144.0	144.0	114.0	108.0	114.0	392.0	436.0	402.0
8	Temperature	27	28	28	29	30	31	31	30	29	29	28	27
9	C.O.D	8.0	8.0	12.0	16.0	16.0	20.0	24.0	20.0	16.0	16.0	44.0	27.0
10	T.D.S	290.0	396.0	242.0	416.0	126.0	490.0	1344.0	1528.0	680.0	178.0	254.0	230.0
NSFWQI Index Value		47	51	49	43	53	49	40	46	42	47	48	51
Avg. NSFWQI Index Value		47.16 (But 25-50 water quality is Bad so that this Year water quality is Bad)											

For Year 2006

Sr. No.	Date / Parameter	8.01.06	05.02.06	03.03.06	8.0 4.06	3.05.06	09.06.06	1.07.06	08.08.06	07.09.06	03.10.06	05.11.06	09.12.06
1	**PH**	8.68	8.47	8.18	8.03	8.04	8.10	8.15	8.1	8.20	7.9	8.2	7.80
2	**DO**	8.62	8.52	5.92	-	6.99	5.85	-	8.2	6.1	7.82	6.92	7.46
3	**B.O.D**	2.12	2.82	5.0	6.4	4.6	7.10	8.6	4.8	5.2	5.38	4.0	10.0
4	**Turbidity**	-	-	18.0	-	-	-	-	5.14	5.43	3.65	1.79	-
5	**Phosphate**	-	-	-	-	-	0.4	0.16	0.64	-	0.24	1.02	0.59
6	**Temperature**	25	27	29	29	31	31	30	29	28	28	27	26
7	**Calcium**	22.4	28.8	51.2	-	26.4	28.8	-	-	31.2	36.0	100.0	94.4
8	**C.O.D**	8.0	8.0	20.	16.0	8.0	32.0	24.0	30.0	12.0	16.0	15.0	24.0
9	**T.D.S**	230.0	170.0	434.0	353.0	110.0	186.0	182.0	182.0	164.0	196.0	580.0	380.0
NSFWQI Index Value		42	43	41	39	45	46	48	49	47	49	48	44
Avg. NSFWQI Index Value		45.08 (But 25-50 water quality is Bad So that this Year water quality is Bad)											

For Year 2007

Sr. No.	Date / Parameter	4.01.07	03.02.07	08.03.07	04.04.07	01.05.07	03.06.07	07.07.07	05.08.07	09.09.07	04.10.07	05.11.07	2.12.07
1	**PH**	7.82	8.0	7.83	8.29	8.72	8.34	8.62	8.50	8.60	8.51	8.20	8.06
2	**DO**	6.59	-	6.93	7.29	6.96	5.15	6.21	6.49	6.59	6.50	6.76	6.80
3	**B.O.D**	4.0	8.5	5.2	5.4	5.8	6.2	5.2	7.0	5.0	6.8	-	-
4	**Nitrate**	0.45	0.11	0.14	-	0.90	0.93	0.07816	0.8163	0.7139	1.0055	0.0323	0.462
5	**Turbidity**	5.96	3.51	0.997	0.580	-	9.33	-	-	-	-	-	-
6	**Phosphate**	-	-	0.01	-	0.22	-	-	-	0.013	0.015	-	0.012
7	**Temperature**	28	29	29	29	30	31	31	30	29	29	28	27
8	**C.O.D**	16.0	20.0	12.0	12.0	12.0	16.0	12.0	16.0	8.0	16.0	8.0	12.0
9	**T.D.S**	360.0	366.0	438.0	380.0	268.0	780.0	360.0	300.0	580.0	320.0	420.0	380.0
NSFWQI Index Value		57	51	59	53	51	50	51	49	48	47	48	46
Avg. NSFWQI Index Value		50.58 (But 50-70 ŵater quality is medium so that this Year water quality is Medium)											

For Year 2008

Sr. No.	Date / Parameter	02.01.08	01.02.08	08.03.08	01.04.08	07.05.08	03.06.08	09.07.08	07.08.08	04.09.08	02.10.08	05.11.08	06.12.08
1	PH	8.02	8.06	8.49	7.99	8.49	7.6	7.0	6.5	8.44	8.53	7.34	7.18
2	DO	6.94	6.20	6.04	7.26	5.94	5.68	6.79	6.79	6.86	5.31	7.38	6.20
3	B.O.D	4.66	6.60	6.40	2.15	3.72	14.80	7.86	4.18	4.24	6.72	15.60	3.0
4	Nitrate	1.119	0.012	0.119	0.230.	-	-	0.1404	0.1620	0.2376	0.310	4.07	0.759
5	Turbidity	-	-	-	-	-	-	0.828	0.114	0.450	0.056	-	-
6	Hardness	110.0	102.0	100.0	182.0	364.0	226.0	254.0	206.0	254.0	154.0	284.0	238.0
7	Temperature	27	27	29	29	30	31	31	30	29	29	28	26
8	Calcium	24.8	40.0	27.2	33.8	36.0	46.4	52.0	38.4	41.6	30.4	32.0	32.0
9	C.O.D	20.0	8.0	12.0	4.0	8.0	48.0	16.0	8.0	8.0	16.0	40.0	8.0
10	T.D.S	380.0	480.0	920.0	680.0	710.0	536.0	560.0	840.0	1020.0	1000.0	500.0	414.0
NSFWQI Index Value		55	45	42	50	44	42	51	51	50	49	37	49
Avg. NSFWQI Index Value		47.08 (But 25-50 water quality is Bad So that this Year water quality is Bad)											

For Year 2009-2010

Sr. No.	Date / Parameter	07.01.09	05.02.09	02.03.09	08.04.09	07.05.09	03.06.09	05.07.09	07.08.09	03.09.09	11.02.2010
1	PH	8.12	7.18	8.67	7.91	7.70	8.22	8.21	8.36	8.21	7.52
2	DO	8.22	7.12	6.77	6.87	5.69	6.80	4.7	4.51	5.03	4.02
3	B.O.D	3.0	3.60	4.80	3.0	12.0	2.60	6.04	2.0	3.92	3.5
4	Nitrate	0.558	0.248	0.864	0.962	0.493	0.4289	0.3865	0.7021	0.983	0.4921
5	Turbidity	0.354	0.366	0.267	0.268	0263	0.682	2.80	0.825	0.915	0.731
6	Phosphate	-	-	0.025	-	0.0455	0.1914	0.0679	0.1815	0.035	0.0981
7	Temperature	27	29	29	30	31	31	30	29	29	29
8	C.O.D	4.0	6.8	5.1	8.0	5.5	7.8	24.0	8.0	12.0	12.0
9	Sulphate	25.0	23.0	63.0	20.0	33.0	29.0	24.0	29.0	24.9	27.4
10	T.D.S	474.0	290.0	620.0	680.0	360.0	350.0	386.0	300.0	258.3	207.5
NSFWQI Index Value		54	58	48	54	57	60	57	61	63	62
Avg. NSFWQI Index Value		56.12 (But 50-70 water quality is medium so that this Year water quality is Medium)									

Table 6.12: **Wadwali Village (P_5) town**

		For Year 2005											
Sr. No.	Date / Parameter	01.01.05	08.02.05	05.03.05	07.04.05	04.05.05	09.06.05	05.07.05	01.08.05	7.09 .05	02.10.05	06.11.05	08.12.05
1	PH	7.8	8.56	8.26	7.41	7.657	7.92	7.18	7.35	8.92	8.2	8.29	8.38
2	DO	5.1	4.12	6.9	5.29	6.012	-	-	-	-	-	-	-
3	B.O.D	4.0	4.015	3.2	3.0	6.5	3.44	4.4	3.334	3.9	2.98	3.09	5.9
4	Turbidity	-	-	-	-	-	-	-	-	3.79	1.31	1.70	
5	Temperature	27	28	28	30	31	31	30	29	29	28	27	26
6	Magnesium	40.19	43.58	43.64		46.65	62.59	22.93	22.4	21.38	35.992	9.33	-
7	C.O.D	12.0	20.0	12.0	8.0	16.0	12.0	24.0	12.0	8.0	8.0	12.0	24.0
8	Sulphate	22.0	56.0	96.0	210.0	72.0	14.0	48.0	7.0	34.0	8.0	98.0	7.0
9	T.D.S	264.0	180.0	424.0	1191.0	540.0	176.0	626.0	188.0	393.0	269.0	260.0	180.0
NSFWQI Index Value		44	40	40	41	42	41	45	40	55	65	59	54
Avg. NSFWQI Index Value		47.16 (But 25-50 is Bad water quality so that this Year water quality is Bad)											

		For Year 2006											
Sr. No.	Date / Parameter	8.01.06	05.02.06	03.03.06	8.0 4.06	3.05.06	09.06.06	1.07.06	08.08.06	07.09.06	03.10.06	05.11.06	09.12.06
1	PH	7.92	8.73	8.12	8.96	7.94	7.50	7.98	8.01	7.72	7.6	7.9	7.60
2	DO	9.22	7.70	7.94	7.21	7.82	7.41	7.78	7.4	6.93	7.48	6.8	6.67
3	B.O.D	3.9	2.01	4.1	2.9	3.8	4.8	5.2	4.4	5.6	3.92	6.2	3.6
4	Nitrate	-	0.05	-	-	-	-	-	0.14	0.180	0.240	0.87	-
5	Turbidity	11.7	8.9	7.4	9.8	7.6	5.7	6.0	5.58	9.67	4.69	1.20	1.61
6	Phosphate	0.17	0.12	0.11	0.18	2.1	0.99	1.1	0.09	0.09	-	-	-
7	Temperature	27	28	28	29	29	31	32	31	30	29	28	27
8	C.O.D	8.0	8.0	12.0	8.0	12.0	8.0	12.0	16.0	16.0	12.0	16.0	16.0
9	Sulphate	34.0	8.0	18.9	17.5	16.8	10.5	9.7	7.0	26.0	29.0	110.0	124.0
10	T.D.S	393.0	269.0	441.0	379.5	321.5	224.5	201.9	180.0	184.0	170.0	340.0	860.0
NSFWQI Index Value		52	58	52	53	51	52	51	61	59	58	54	46
Avg. NSFWQI Index Value		53.91 (But 50-70 water quality is Medium so that this Year water quality is medium)											

For Year 2007

Sr. No.	Date / Parameter	4.01.07	03.02.07	08.03.07	04.04.07	01.05.07	03.06.07	07.07.07	05.08.07	09.09.07	04.10.07	05.11.07	2.12.07
1	PH	7.45	7.88	7.97	8.41	8.50	8.53	8.35	8.26	8.98	8.52	8.39	8.02
2	DO	6.99	-	6.78	7.16	6.98	6.73	6.61	4.03	6.8	6.32	-	6.94
3	B.O.D	6.4	5.0	6.9	7.3	3.1	6.1	10.8	10.1	6.8	6.8	-	-
4	Nitrate	0.32	-	0.21	-	0.7790	0.91	1.13	1.6767	0.5349	0.9835	0.9447	0.531
5	Turbidity	6.55	1.26	3.41	6.71	4.50	-	9.43	-	1.02	2.17	-	1.04
6	Phosphate	0.06	0.98	0.08	-	-	0.16	0.007	-	0.008	0.011	-	0.014
7	Hardness	138.0	196.0	177.5	126.0	160.0	138.0	140.0	200.0	160.0	154.0	118.0	114.0
8	Temperature	27	28	29	30	32	31	30	29	29	28	27	27
9	C.O.D	32.0	12.0	12.0	16.0	16.0	8.0	32.0	24.0	16.0	16.0	16.0	8.0
10	Sulphate	32.0	40.0	205.4	46.0	42.3	42.5	154.4	186.7	15.0	23.0	318.0	77.0
11	T.D.S	340.0	680.0	457.9	340.4	320.1	292.7	640.3	687.1	560.0	340.0	860.0	440.0
NSFWQI Index Value		53	51	51	42	53	51	50	40	46	52	42	58
Avg. NSFWQI Index Value		49.08 (But 25-50 water quality is Bad so That This Year water quality is Bad)											

For Year 2008

Sr. No.	Date / Parameter	02.01.08	01.02.08	08.03.08	01.04.08	07.05.08	03.06.08	09.07.08	07.08.08	04.09.08	02.10.08	05.11.08	06.12.08
1	PH	8.22	8.21	8.34	7.46	8.54	7.2	8.21	6.5	8.35	8.85	7.42	7.24
2	DO	6.69	6.58	6.68	7.14	7.07	6.10	5.93	6.54	6.42	5.66	7.52	6.71
3	B.O.D	5.38	5.80	6.0	3.8	22.9	16.20	9.56	6.24	6.86	10.20	16.0	5.80
4	Nitrate	1.192	-	0.400	0.130	-	-	0.1339	0.1382	0.1188	3.11	3.75	4.71
5	Turbidity	-	0.602	0.914	0.816	0.616	-	0.613	0.612	0.615	0.489	0.468	0.402
6	Phosphate	0.04	-	-	-	-	0.825	0.081	0.246	0051	0.841	0.827	-
7	Temperature	28	29	29	31	32	29	31	30	29	29	28	27
8	C.O.D	12.0	4.0	12.0	8.0	56.0	40.0	24.0	16.0	16.0	24.0	40.0	16.0
9	T.D.S	380.0	470.0	1400.0	610.0	840.0	1370.0	1840.0	2100.0	1120.0	800.0	490.0	464.8
NSFWQI Index Value		54	40	49	54	42	33	54	53	54	43	46	49
Avg. NSFWQI Index Value		47.58 (But 25-50 water quality is Bad So that This Year water quality is Bad)											

For Year 2009-2010											
Sr. No.	Date / Parameter	07.01.09	05.02.09	02.03.09	08.04.09	07.05.09	03.06.09	05.07.09	07.08.09	03.09.09	5.02.2010
1	PH	8.71	7.24	8.28	7.14	8.20	8.52	9.16	9.11	8.61	7.34
2	DO	6.10	6.71	7.86	5.96	4.97	7.52	5.32	5.50	4.42	4.87
3	B.O.D	7.20	5.80	3.20	12.0	9.60	2.80	2.60	6.7	2.9	2.89
4	Nitrate	1.57	4.71	0.977	0.264	9.31	0.648	11602	5.7205	7.6613	4.32
5	Turbidity	0.312	0.402	0.298	0.287	0.309	0.326	0.438	1.08	1.86	0.98
6	Phosphate	0.030	-	-	-	0.0648	0.292	-	-	0.1222	0.09
7	Temperature	27	28	30	31	32	31	30	29	29.5	29.3
8	C.O.D	24.0	16.0	8.0	40.0	32.0	8.0	8.0	32.0	16.0	12.0
9	Sulphate	33.0	8.0	36.0	19.0	89.0	74.0	1480	94.0	136.0	52.3
10	T.D.S	472.0	468.0	288.0	362.0	148.9	581.0	506.1	960.7	843.0	548.63
NSFWQI Index Value		53	49	55	51	53	55	41	39	50	56
Avg. NSFWQI Index Value		49.55 (But 25-50 water quality is Bad So that this Year water quality is Bad)									

Table 6.13 : At Shahagarh (P_6)

For Year 2008								
Sr. No.	Date / Parameter	08.03.08	07.05.08	03.06.08	09.07.08	07.08.08	04.09.08	02.10.08
1	PH	7.73	8.16	7.40	7.5	8.0	7.49	7.66
2	DO	6.23	7.11	6.81	7.02	6.36	6.42	6.70
3	B.O.D	3.6	3.48	4.54	4.08	4.20	4.36	5.38
4	Nitrate	0.14	-	-	0.1012	0.2630	0.0864	0.5214
5	Fecal Coliform	6.0	7.0	7.0	7.0	280.0	7.0	6.0
6	Colour & Intensity	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless
7	Adour	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless
8	Temperature	29	30	30	31	29	29	30
9	C.O.D	8.0	8.0	12.0	12.0	8.0	8.0	8.0
NSFWQI Index Value		57	49	50	56	47	56	56
Avg .NSFWQI Index Value		53.0 (But 50-70 is water quality is medium so that this Year water quality is medium)						

For Year 2009

Sr. No.	Date / Parameter	8.01. 09	5.02. 09	6.03. 09	7.04. 09	9.07. 09	7.08. 09	7.09 . 09	2.10. 09	6.11. 09	9.12.09
1	PH	7.18	7.16	7.32	7.44	8.06	8.16	7.96	7.76	7.84	8.3
2	DO	7.2	7.2	6.73	7.62	5.39	4.1	4.60	3.84	3.82	3.91
3	B.O.D	3.0	2.8	3.8	3.8	2.58	2.4	3.4	4.2	3.2	4.8
4	Nitrate	0.7	0.99	0.71	9.96	9.46	0.89	9.78	10.746	0.71	2.38
5	Fecal Coliform	4.0	6.0	7.0	4.0	7.0	7.0	8.0	6.0	7.0	6.0
6	Colour & Intensity	colourless	colourless	colourless	colourless	colourless	colourless	colourless	colourless	colourless	colourless
7	Adour	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless	odourless
8	Temperature	28	29	29	30	29	30	29	28	28	29
9	C.O.D	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
NSFWQI Index Value		59	58	57	52	50	56	49	50	56	53
Avg .NSFWQI Index Value		54.0 (But 50-70 is Medium water quality so this Year water quality is medium)									

For Year 2010

Sr. No.	Date / Parameter	05.02.2010
1	PH	7.81
2	DO	4.29
3	B.O.D	4.17
4	Nitrate	0.78
5	Fecal Coliform	7.00
6	Colour & Intensity	Colourless
7	Adour	odourless
8	Temperature	28
9	C.O.D	12.0
NSFWQI Index Value		56

- dissolved oxygen (DO)
- fecal coliform
- pH
- biochemical oxygen demand (BOD) (5-day)
- temperature change (from 1 mile upstream)
- total phosphate
- nitrate
- turbidity
- total solids

The scientists were then asked to graph the level of water quality ranging from 0 (worst) to 100 (best) from the raw data (e.g. pH values 2-12). The curves drawn were then averaged to obtain a weighting curve for each parameter. Results of the nine parameters are compared to the curves and a numerical value, or "Q-value," is obtained. For example, see the curve for feacal coliform shown on the http://kancm.org/stream/img/FCchart1.jpg. A water quality index provides a single number (like a grade) that expresses overall water quality at a certain location and time based on several water quality parameters. The objective of an index is to turn complex water quality data into information that is understandable and useable by the public. This type of index is similar to the index developed for air quality that shows if it is a red or blue air quality day. The use of an index to "grade" water quality is a controversial issue among water quality scientists. A single number cannot tell the whole story of water quality; there are many other water quality parameters that are not included in the index. The index presented here is not specifically aimed at human health or aquatic life regulations. However, a water index based on some very important parameters can provide a simple indicator of water quality. It gives the public a general idea the possible problems with the water in the region.

6.2.1 General Water Quality Indices

Water has a variety of different uses, viz. public drinking water supply, irrigation, recreational. Water quality requirements vary depending upon the intended use. Some indices, however, are based on the assumption that "water quality" is a general attribute of surface water irrespective of the use to which the water is put. Such indices are termed as general water quality indices which include different WQIs. Some selected WQIs are discussed below.

a. **National Sanitation Foundation water quality index (NSFWQI):** This water quality index is selected for present study because of its versatility and also on line software available on internet for calculating indices.

b. **Horton's Quality Index:** Horton's index was the first formal water quality index which was introduced in 1965. Horton selected eight of the most commonly measured water quality variables for his index and fixed weights ranging from 1 to 4 for each variable (Table 6.1). Among the variables, specific conductance served as an approximate measure of total dissolved solids (TDS) and carbon chloroform extract (CCE) reflected the influence of organic matter. A major drawback of Horton's index was that it did not include the effects of toxic substances.

Horton (1965) proposed first water quality index formulated on the following criterion

- Number of variables should be limited
- Variables should be of significance
- Variables should reflect the availability of data.

c. **McDuffie's River Pollution Index:** McDuffie et al. (1973) presented a WQI, which they called the River Pollution Index (RPI). Although 8 pollutant variables are discussed in their study, either fewer or more than 8 variables can be included depending on the available data.

d. **Prati's Implicit Index of Pollution:** Prati et al. (1971) proposed an index for surface water based on the water quality classification system given as under. They considered 13 pollutant variables.

$$PIIP = \frac{1}{n}\sum_{i=1}^{n} q_i$$

This index was developed by Prati, Pavanello and Pesarin in 1971 on the basis of water quality standards used in a number of countries. The concentration values of all the pollutants were transformed into levels of pollution expressed in new units through mathematical expressions. These mathematical expressions were constructed in such a way that the new units were proportional to the polluting effect relative to other factors. It should be noted that toxic substances were not included in the index as it was felt that in case a toxic substance is present in concentrations above a given limit, the index is automatically classified in the highest category, i.e. heavily polluted.

a. **Dinius' Social Accounting System:** Dinius (1972) proposed a water quality index as a first step towards designing a 'rudimentary social accounting system', which would measure the costs and impact of pollution control efforts. This WQI includes 11 parameters. Like Horton's index and NSF WQI, it has a decreasing scale with values ranging from 0-100.

6.3 DISCHARGE MEASUREMENT

Discharge is also very important in case of water quality because if discharge is high then the water quality is good but if discharge is low then the water quality is bad. For Example: In pre-mansoon Period i.e. from April to June the water quality of the river is bad but in the post-mansoon period the water quality of river is good. So it is very important that if river has any nearby dam/reservoir, then the discharge given at that dam/reservoir affect the water quality of river.

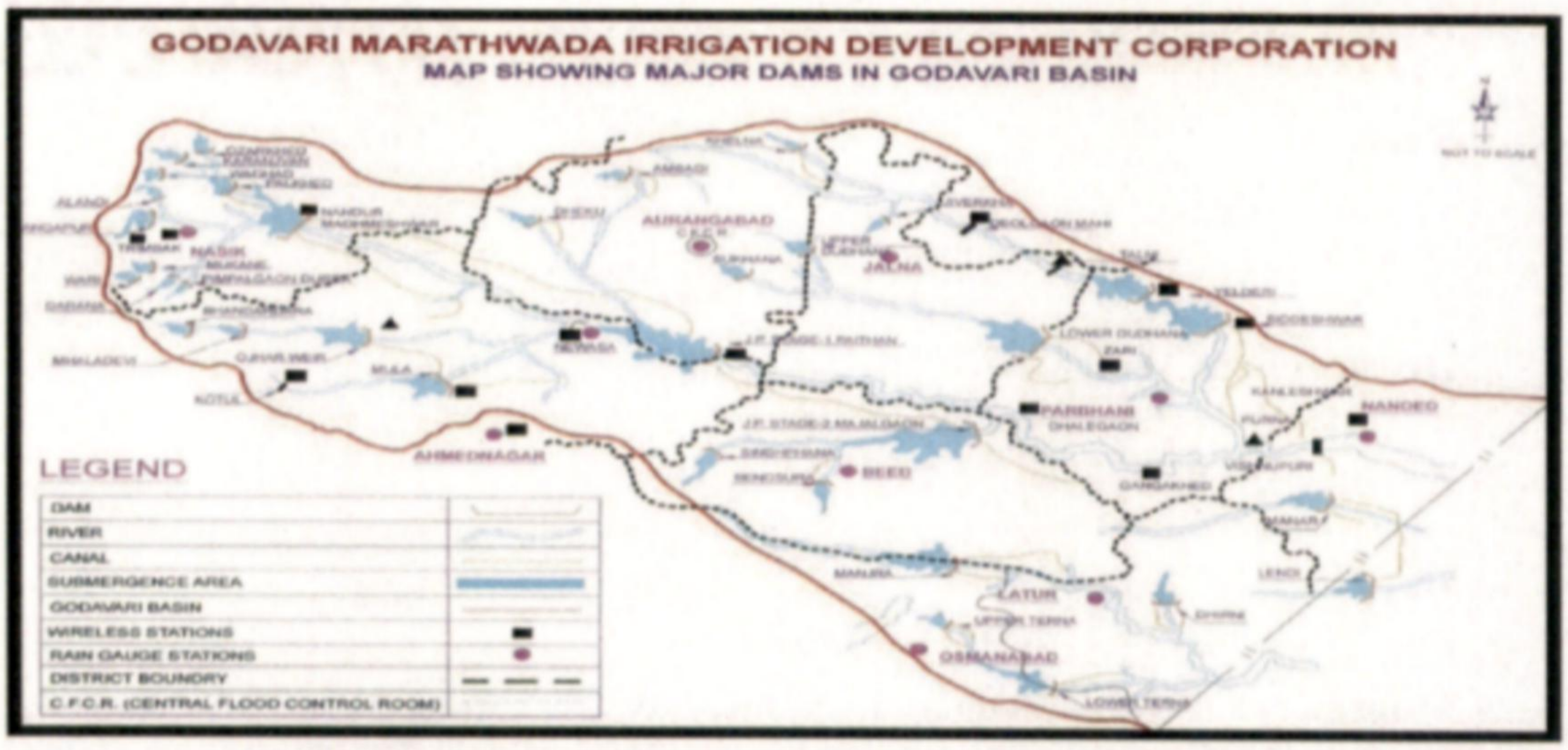

Fig. 6.1: Map showing major Dams in Godavari River.

Three gauge discharge sites data namely Nasik, Kopargaon and Nagamtham were collected for analysis of the water quality change effect. The data collected are shown in Table 6.14, Table 6.15 and 6.16 respectively.

Table 6.14: Gauge discharge data for Nasik

Year	**2004**				
Month	June	July	August	September	October
Discharge (m^3/sec)	-	-	172.4119	40.797	23.081
Average Discharge	78.76				
Year	**2005**				
Month	June	July	August	September	October
Discharge (m^3/sec)		83.470	83.98	117.72	16.6065
Average Discharge	75.44				
Year	**2006**				
Month	June	July	August	September	October
Discharge (m^3/sec)	-	87.769	257.6449	14.241	13.150
Average Discharge	93.20				
Year	**2007**				
Month	June	July	August	September	October
Discharge (m^3/sec)	7.9089	25.6032	30.020	17.642	6.1352
Average Discharge	17.46				
Year	**2008**				
Month	June	July	August	September	October
Discharge (m^3/sec)	0.067001	0.069312	28.94051	83.7923	0.1211
Average Discharge	22.59				

The curve for average discharge for Nasik is shown in Fig 6.1.

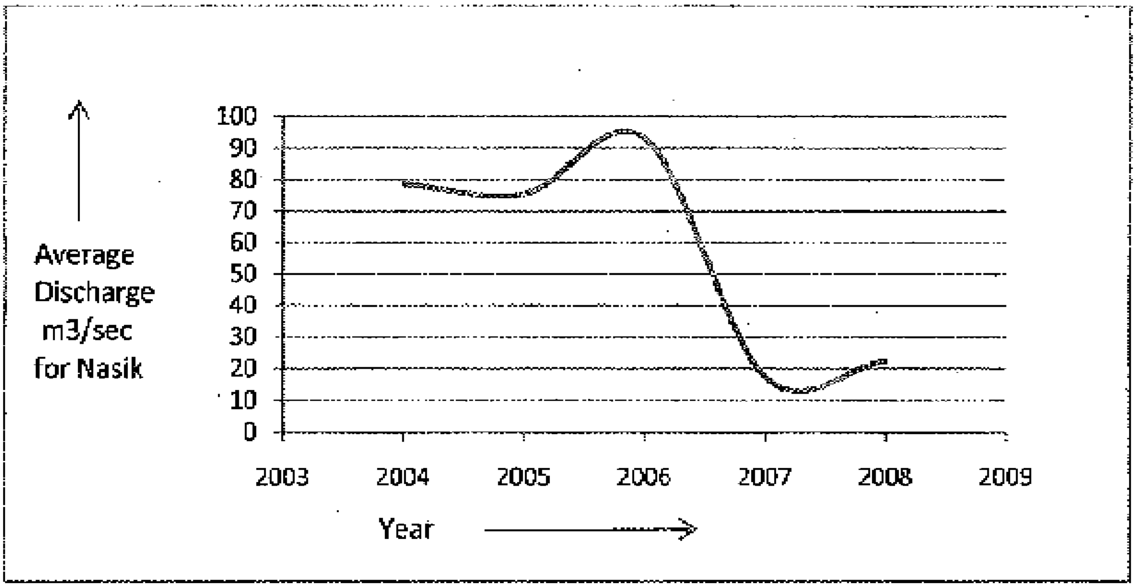

Fig 6.2: Average Discharge for Nasik

From above discharge data we can see that the discharge is varies yearly. In year 2004, 2005, 2006 the discharge data is in between 70-100 m^3/sec. but in year 2007 and 2008 the discharge is very low i.e. in between 15- 25 m^3/sec. The variation in discharge very much affects the water quality of Godavari River at Nasik.

Table 6.15: Gauge discharge data for Kopargaon

Year	**2004**				
Month	June	July	August	September	October
Discharge (m^3/sec)	586.41	108.095	195.39	-	-
Average Discharge	296.63				
Year	**2006**				
Month	June	July	August	September	October
Discharge (m^3/sec)	12.679	229.66	1306.61	132.93	55.71
Average Discharge	347.51				
Year	**2008**				
Month	June	July	August	September	October

Discharge (m^3/sec)	-	31.389	261.52	588.061	52.069
Average Discharge	233.25				

From above discharge data we can see that the discharge is varies yearly. In year 2004, 2006 the discharge data is in between 230-350 m^3/sec. The variation in discharge very much affects the water quality of Godavari River at Kopargaon. Curve for average discharge at Kopargaon is shown in Fig 6.2.

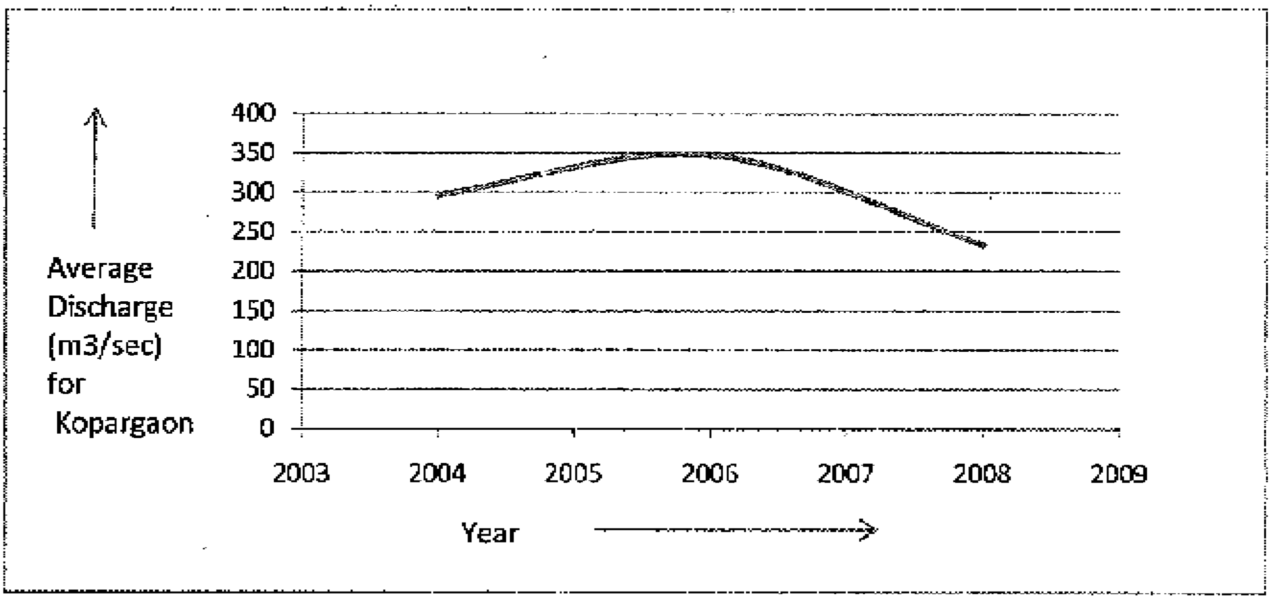

Fig 6.3: Average Discharge for Kopargaon

Table 6.16: Gauge discharge data for Nagamthan (Aurangabad)

Year	**2004**				
Month	June	July	August	September	October
Discharge (m^3/sec)	-	-	714.373	190.99	449.41
Average Discharge	451.591				
Year	**2005**				
Month	June	July	August	September	October

Discharge (m^3/sec)		487.616	489.478	469.14	-
Average Discharge	482.078				
Year	**2006**				
Month	June	July	August	September	October
Discharge (m^3/sec)	77.855	264.287	857.16	302.39	161.5984
Average Discharge	332.65				
Year	**2007**				
Month	June	July	August	September	October
Discharge (m^3/sec)	-	237.123	265.599	344.3961	340.3017
Average Discharge	296.85				
Year	**2008**				
Month	June	July	August	September	October
Discharge (m^3/sec)	-	-	435.64	767.8381	168.121
Average Discharge	457.199				

From above discharge data we can see that the discharge is varies yearly. In year 2004, 2005, 2006 the discharge data is in between 330-460 m^3/sec. but in year 2007 and 2008 the discharge is very low i.e. in between 250-460 m^3/sec. The variation in discharge very much affects the water quality of Godavari River at Nagamthan (Aurangabad).

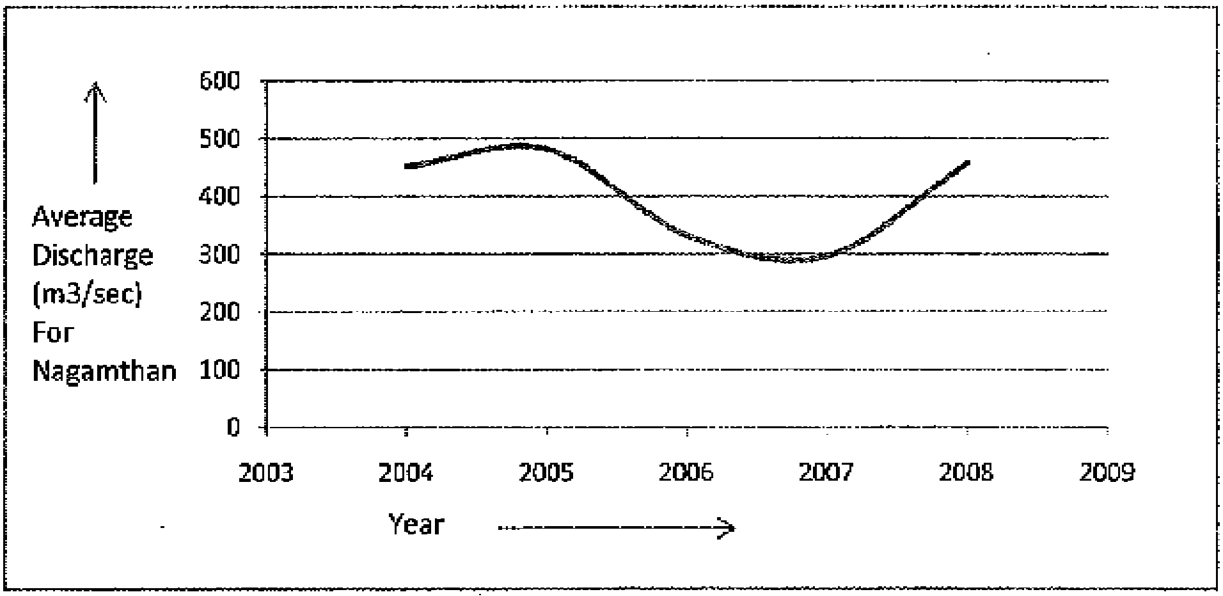

Fig 6.4: Average Discharge for Nagamthan

A commonly applied methodology for measuring, and estimating the discharge value of a river is based on a simplified form of the continuity equation. The equation implies that for any incompressible fluid, such as liquid water, the discharge (Q) is equal to the product of the stream's cross-sectional area (A) and its mean velocity ($\bar{u}$), and is written as:

$$Q = A\bar{u}$$

Where,

- Q is the discharge in m^3/s.
- A is the cross-sectional area of the portion of the channel occupied by the flow in m^2.
- $\bar{u}$ is the average flow velocity in m/s.

6.4 NATIONAL WATER QUALITY MONITORING PROGRAMME (NWMP)

CPCB in collaboration with concerned SPCBs/PCCs established a nationwide network of water quality monitoring comprising 1019 stations in 27 states and 6 Union Territories. The monitoring is done on monthly or quarterly basis in surface waters and on half yearly basis in case of ground water. The monitoring network covers 200 rivers, 60 lakes, 5 tanks, 3 ponds, 3 creeks, 13 canals, 17 drains and 321 wells. Among the 1019 stations, 592 are on rivers, 65 on lakes, 17 on drains, 13 on canals, 5 on tanks, 3 on creeks, 3 on ponds and 321 are groundwater stations. Presently the inland water quality-monitoring network is being operated under a three-tier programme i.e. Global Environment Monitoring System (GEMS), Monitoring of Indian National Aquatic Resources System (MINARS) and Yamuna Action Plan (YAP). Water samples are being analyzed for 28 parameters consisting of 9 core parameters, 19 other physico-chemical and bacteriological parameters apart from the field observations. Besides this, 9 trace metals and 22 pesticides are also analyzed in selected samples. Bio-monitoring is also carried out on specific locations. In view of limited resources, limited numbers of organic pollution related parameters are monitored i.e. micro pollutants (Toxic Metals & POPs) are analyzed once in a year to assess the water quality. The water quality data are reported in Water Quality Status Year Book. [10]

CHAPTER NO.7

PUBLIC PARTICIPATION AND PUBLIC AWARENESS

7.1 PUBLIC PARTICIPATION

In any conservation project, the role played by the public is important. There are many stakeholders involved with the watershed of river Godavari. Various Government Departments, such as Department of Urban Affairs, the Nasik Municipal Corporation, the Maharashtra State Electricity Board, the Maharashtra State Pollution Control Board, the Agriculture Department, the Tourism Department, etc, have a direct role to play with regards to the river. The main stakeholders are, of course, the public. A clean River Godavari means better living environment, clean water to use and even recreation. The only source of pollution in the river is from anthropogenic activities. Stopping these activities will be the only solution to restore the river to its pristine state. The attitude of the people should change completely. They should manage their wastes in a proper manner instead of directly discharging or dumping them into the river. The Government departments can create awareness among the public about the river and its conservation. It is finally only up to the people to see that the river is clean. Several NGOs and Self Help Groups are doing a lot of work in spreading awareness and in trying to clean up the river Godavari. These groups should be encouraged to carry on with their work by the government authorities and people.

The Government with its experts and man-power should start an extensive awareness campaign about cleaning the river Godavari. The high-level meetings and committees should now start their work in the field and ensure that the people are made aware about the danger of our losing a natural resource and how we can join hands together to restore it back to an acceptable level, if not to its original pristine condition.

7.2 GUIDELINES FOR PUBLIC AWARENESS AND PUBLIC PARTICIPATION IN NATIONAL RIVER ACTION PLAN SCHEMES OF THE MINISTRY OF ENVIRONMENT AND FORESTS [27]

It appears to be a turning point in the philosophy and programmes of NRCD to think loudly in terms of the importance and need of community awareness and community action for ensuring the desired success to the non-care and schemes of National River Conservation Programme through people's participation. Unfortunately, even after a huge expenditure of thousands of millions of rupees, the outcome of most of the activities undertaken to implement the ambitious projects like Ganga and Yamuna Action Plans and now National River Conservation Programme has been far below the expectation of the nation. There may be different opinions of the casual factors responsible for such alarming situation. The fact however, remains that much of the disappointing experience or poor performance of the projects like these can be attributed to the fact that from the very beginning there has not been any sincere or systematic effort to involve community at any stage of the execution of the programme. The obvious result is that the general public for whom the whole exercise was planned so ambitiously always remained to be an indifferent on-looker. At times, the target beneficiaries contributed to the problem of river pollution because of number of 'human factors'. Although, they did not do it deliberately, yet the fact remains that it was done because of the lack of proper awareness about the casual factors of river pollution and also the dangers of the hazards of polluted river water, which is gradually turning into a slow poison. Hardly any meaningful effort has even been made to motivate the process to contribute their share to the efforts of keeping rivers of pollution. For example, number of hardware provisions were made to check the "human casual factors'' of river pollution but there was rarely any systematic effort to educate the masses on the recommended practices for the proper use and maintenance of such facilities of toilet complexes, bathing Ghats, crematoria, river bank structures, sewage systems, etc. It is shocking to note that not even ten percent of the total budgetary provision of NRCP has ever been made on software aspects. The outcome has been the same as could be expected under such conditions. It is heartening to note that NRCD has now realized the importance of community awareness/peoples participation in general and software components of the programme in particular. It may be pertinent to point out that the working of NRCP cannot be improved unless at least twenty five percent of budget provision is made for software programme. [27]

7.3. IMPORTANT WAYS OF PUBLIC AWARENESS AND PARTICIPATION [27]

The important action points as regarding to community awareness are described as below:

1. Local influential/Community leaders,
2. Local NGOs,
3. School teachers and students,
4. Elite groups and organizations like Rotary Club, Lions club, Associations and forums of writers and artists, etc.,
5. Religious leaders and priests,
6. Representatives of Industry and Commerce,
7. Leaders of trade unions and organizations like safai karamchari sanghs,
8. Leaders of teachers and students associations,
9. Representatives of political parties including the elected office bearers and members of local bodies,
10. Members of legislative assemblies, legislative councils and parliament representative the legal constituencies,
11. Representatives of media viz. Editors/correspondents of local press and key functionaries of local radio and TV stations,
12. Grass root level functionaries of Municipalities and state government departments like public health, forestry, Jal Nigam, PWD, etc.

7.4 ACTION POINTS FOR COMMUNITY AWARENESS

1. Holding of locality wise meetings and group discussions with local influential, whereby the extent of river pollution, the related physical and humane factors, the consequent health hazards and the possible remedial measures are highlighted through the talks and technical presentations by the experts and social workers.

2. Motivating local influential to play a leading role in promoting environmental sanitation and community health, particularly prevention of river pollution.

3. Motivating and advising local NGOs to participate in outlining execution and follow up efforts of community action plans for ensuring a clean and healthy community life in general and protection of river water quality in particular.

4. Promoting schools as models of clean living and healthy environments and training school teachers and students as motivators and informal change agents for involving families and communities in clean river programmes in general and maintenance of toilets/bathing Ghats/crematoria in particular.

5. Motivating school management programmes/events administrative and teaching faculty to organize special for checking river pollution and plantation of trees on the river banks. 6. Motivate the local influential i.e. leading businessmen, industrialists, office bearers of elite clubs like Rotary, Lions, Junior chamber of Commerce, local chapters of FICC/CII, to undertake or sponsor such activities as solid and liquid waste management services through an effective strategy of public-private partnership for improving sanitation conditions of the towns located at river banks and also for joint efforts for controlling river pollution from industrial effluents. They can be fruitfully motivated to sponsor the plantations on river banks and adopting a certain planted area for protection and preservation.

7. Awaken, educate, organize and motivate religious leaders and priests to participate actively in river pollution control through such efforts as educating the masses, checking the dumping of temple waste on the river bank and throwing of half burnt or unburnt dead bodies into the river.

8. Motivate the office bearers of trade unions and other professional organizations like the teachers and students associations to win public support for their cause by rendering some fruitful service to the society. While doing so they may give highest priority to community health promotional measures like river pollution control and conservation of the quality of river water.

9. Motivate local MLAs and MPs and leaders or political parties to participate actively in the promotional efforts of community involvement for protecting river against the hazards of pollution- an effort, which shall pay them abundantly through the

building of positive public opinions. They should also be motivated to form local level all party organizations/ forums to promote the measures of river pollution control. In addition, they should be motivated to take keen interest in the proper utilization of the funds provided for river pollution. In addition, they should be persuaded to play effective liaison between the government and the people to ensure the timely completion of different programmes and activities undertaken by the Directorate of National River Conservation Programme.

10. Motivate leading persons representing local press and electronic media. Infact, they need to be properly educated and encouraged to be conscious of their social commitment and social obligations. They should also be convinced that socially conscious media shall always be aptly recognized and enormously rewarded through the creation of a sound base of enlightened clientele group which in the long run will help them through the image building process. Accordingly, the editors and correspondents of local press, the officers and key functionaries of radio and TV may be personally contacted and convinced to give maximum coverage to the aspect of river pollution control measures through the active involvement of the people.

11. Awaken, educate and encourage the grass root level functionaries belonging to such departments of state govt. as local bodies like, public health, sewerage forestry, water supply, public works, electricity, industry, tourism etc. to take special interest in the activities which are directly related to the aspect of river pollution control. They should be particularly motivated to be more conscious of their commitment and obligation to ensure the purity of river water so that the future of the present and coming generations of the society and so also the members of their own community is safe-guarded against the health hazards. [27]

7.5 ACTION PLAN FOR GODAVARI RIVER CONSERVATION

For conservation of Godavari river following measures are suggested;

1. Nalas are the major casual factors of river pollution because of factors such as lack of adequate sewerage network, implanted growth of cities, slum settlements, non-

existence of civic sense etc., there is a need to Estimate awareness deficits and fill them up through awareness campaigns.

2. Facilitate settling up of ward wise sanitation committees as 'sanitation watch and ward societies'/action groups.
3. Launch a mass campaign for educating and motivating local community and families about the need to have, on site sanitation facility like community toilet complexes at the public places and household toilets at the family level.
4. Ensure the active participation of the business and industrial establishments of the area through their contribution to the area of liquid and waste management, including the steps to check the industrial waste effluents being allowed to mix with river water,
5. Facilitate promotion of urban farming and social forestry by persuading the local business and industrial establishments to undertake or sponsor these activities. These efforts should be supported by technological innovations and intervention for the fruitful adoption of the use of sewage water in urban farming and social forestry so as to have the double advantage of maximizing the yield of farm and forestry produce and also to check the rivers pollution form sewage water, NRCD should sponsor pilot projects for promoting forestry on community waste land lying unused in the vicinity of river banks. The success models developed through such projects will attract private entrepreneurs to take up this activity as an income generating pre-position.
6. Facilitate and motivate the community to cooperate and segregate the waste at source. This being highly specialized job has to be entrusted to a known NGO having a good track record of contribution to this area. The NGO has to share information on available technologies for recycling of waste with the local traders/manufactures associations educating and convincing them of the economic viability. For this, the success models have to be identified for fruitful replication. Such efforts need to be specially supported by NRCD through adequate funding. (Action: Known NGO, NRCD, and Industrial/business houses). With a view to chock the regular flow of industrial effluents waste in to the river generally through the nalas, there is need to create community pressure on the pollutant units, as well a civic authorities to play their positive role. There is however, need to support those efforts by organizing experience/information sharing professional meets on the available technologies of

industrial effluents/waste management. While adopting this line of action, it has to be well understood that the basic principle of waste management is to add 'value to the waste' and this principle is applicable at all levels, be it be individual household or big industrial houses. The success model of recycling of hotel waste (Banglore) needs to be widely replicated. Similar success models working in the areas of civic sanitation and hospital waste management need to be properly identified and promoted for wider replication.

7. Core schemes have to be re-organized in order to ensure people's participation in making the available facilities and services really meaningful. This has to be done through the provision and placement of community awareness and action at a higher order of priority.
8. It has to be well understood that even the core scheme activities, which are mostly of hardware type, need software support to involve community sincerely and systematically. The fact remains that the people shall remain indifferent and apathetic towards the effective functioning of these services so long their participation in carrying on these public assets is not ensured in words and spirit.
9. It has to be realized that there has to be a proper strategy and support system for a meaningful involvement of the community. This can only be done by highly specialized agency which has to be assigned the software aspect of awakening, educating and motivating people to consider every asset or facility created under core schemes as their own and hence to offer their voluntary support and involvement for the success of the programme.

CHAPTER NO.:8

CONSERVATION MEASURES

8.1 CONSERVATION MEASURES FOR THE GODAVARI RIVER WHICH WILL PLAY IMPORTANT ROLE IN CONTROLLING THE WATER POLLUTION IS AS FOLLOWS

A. Short Term Measures

This Includes following:

a. Immediate closure of all the unauthorized activities which discharge industrial effluents, sludge, oil and chemicals.

b. Provide proper garbage collection system to prevent citizens from dumping the same into the river.

B. Long Term Measures

Long Term measures to minimize pollution in the Godavari river includes the following

a. Plan for sewers on the both banks of Godavari river and provide sewage treatment plants at various locations. Such plants can be provided wherever a proper drainage line exists today.

b. Dredge the entire length of Godavari river bed to improve its carrying capacity.

c. Provide proper garbage collection stations for the benefits of hutment dwellers.

8.1.1 Pollution Control at Source

1. The water polluting industries which had not so far installed ETPs should be asked to furnish a time bound programme to the Ministry of Environment and Forests for treatment of their effluents.
2. Those who have given commitment under Corporate Responsibility on Environment Protection (CREP) should adhere to it.
3. Such programmes should clearly indicate the existing and proposed arrangements with detailed time schedules. The programme should be backed up by a commitment from the Administrative Ministry concerned or the respective State Government, as

the case may be, to provide the funds as necessary and ensure compliance by the industries.

4. If the undertakings and the administrative Ministry/State Government failed to respond, action under the Environment (Protection) Act need to be taken forthwith thereafter.
5. SPCBs should monitor the progress and report on the outcome. The SPCBs should examine the prevailing arrangements in charging water supply for industry and formulate proposals in consultation with the concerned departments on how the system can be rationalized to conserve water and recycle it for use.
6. Emerging technologies such as aerobic composting, vermiculture, ferti-irrigation, etc. as secondary treatment should be adopted for the organic wastes by the industries. Recently, the root-zone technology is also being advocated is yet another alternative for energy saving for treatment of industrial wastewaters.
7. Incentives have to be made more attractive to make the industries undertake pollution control measures. It is important to assess the effectiveness of this measure and work out other measures which would serve as effective incentives for pollution control.

8.1.2 Reuse/recycling of Treated Industrial Waste and Resource Recovery:

1. The reuse and recycling of wastes for agricultural purpose would not only help to reduce the pollution and requirement of fresh water for such use but also would supplement the much needed nutrients and organic manure to the plants.
2. The segregation of waste water streams may help in reducing waste water volume and waste strength and may help recycling and reuse of majority of waste streams. The quantity of the effluent generated in sugar industry can be reduced from 300 litres to 50 litres per tonne of cane crushed, if recycling techniques are meticulously followed. The wastewater quantity generated in continuous fermentation distilleries is 7 liters per liter of alcohol produced, as compared to 14-15 liters per liter of alcohol produced in batch fermentation process distilleries. The reduction in wastewater quantity is mainly achieved by recycling wash and adopting re-boiler system. In pulp and paper industries, the paper mill wastewater is completely recycled into pulp mill

by adopting fiber recovery system. It has helped to reduce the wastewater from 200 cum to 50 cum per tonne of paper produced.

8.1.3 Waste Minimization and Clean Technologies:

1. It may be noted that by recycling techniques the waste concentrations may increase, however the total load remain the same. The concentration of waste strength would help the economical conversion of spent wash to bio-fertilizer. Waste strength reduction can be achieved by adopting in plant control measures such as reduction of spillages of wastes, elimination of process failures, use of proper equipment for handling and dry cleaning techniques etc. This is often termed as clean technologies; it does not add to the cost of production, in fact industry gains from it.
2. Innovation in pollution prevention/waste minimization efforts on the part of the industries needs to be sternly promoted. Pollution prevention/ waste minimization, in our country at least, is done only for product quality improvement, energy saving or other economic reasons and any reduction in pollution is only incidental.
3. All organic wastes are best source of energy. A number of anaerobic technologies are now available for treatment of organic industrial effluents. Spent wash, black liquor (pulp mill), dairy effluents, sugar factory effluents and press mud etc. are some of the organic wastes tried for energy recovery. The energy recovery will incidentally solve the air pollution problem, as biogas is a cleaner fuel compared to baggasse, rice husk or coal. It is essential to introduce energy audit in all the industries so that cost-benefit ratio can be established in each case.
4. Bio-fertilizers are now prepared from organic rich wastes by admixing filler materials. Spent wash is converted to manure by addition of press mud, bagasse cillo, agricultural residues etc. In this technology the entire liquor effluent is converted into solid mass and it can be termed as "Zero-discharge" technology.

8.1.4 Waste Water Discharge Standards and charges on Residual Pollution

1. The limits need to be fixed on water use and wastewater generation per unit production for each industry. In order to achieve this goal, guidelines are to be evolved and the industry should be forced to adopt recycling and reuse through legislation and vigilance monitoring.

2. New measures such as imposing charges on residual pollution once the prescribed limits are complied will have to be introduced to encourage recycle and reuse of effluents and adoption of the zero-discharge concept.

8.1.5 Mixing Sewage with Industrial Waste wherever Advantageous

1. Wherever it is possible, industrial wastes should be combined with domestic wastes for treatment if no toxicity.
2. Economy of scale, better treatability of industrial waste water and better arrangements for disposal of treated effluents are some of the advantage of the joint treatment of industrial and domestic effluents.
3. Contribution from industries to capital expenditure of laying sewers and construction of treatment plant would render finance to sewerage and treatment schemes.
4. Joint treatment is attractive for cities and towns and industrial areas surrounded by residential areas.
5. Baroda and Ahmadabad cities have such joint treatment schemes under a notified charging formula.
6. It is considered that for small-scale industries located in cities, such joint collection and treatment is a win-win option. For medium and large industries wherever possible such joint collection and treatment would improve, besides other technical advantages, the financial viability of the city sewerage and treatment system.

8.2 Pollution from non-point sources

1. It is also extremely important to focus attention upon the problem of non-point pollution from unsewered sanitation, uncollected wastes dumped haphazardly in urban and industrial areas and application of chemicals in agriculture such as pesticides, insecticides and chemical fertilizers.
2. Presences of unacceptably high levels of the persistent pollutants in the groundwater and run-off water these are likely to increase with greater application of these commodities in the future.
3. In this regard it is essential that an integrated pest management policy should be evolved and standards made to regulate the use of toxic pesticides and to develop substitutes which are ecologically more acceptable.

8.3 Some Important Options for Restoration of Water Quality in a Water Body

A. Reuse/recycling of treated domestic sewage:

1. Cities/towns discharging wastewater should treat the wastewater suitably for land application and dispose of such water on land to the maximum extent possible. In cases where waste water is to be discharged into a water body, the degree of treatment will have to be higher, keeping in view the low quantity of available water for dilution and abstraction points downstream, etc.
2. If the city does not have adequate land for irrigation due to increased urbanization, the neighboring states may be approached. The fresh water so saved from irrigation could be utilized for meeting the drinking water requirements or for ensuring minimum flow in river.
3. It is felt that the dilution of effluents is not a practical and economically viable solution to the problem that domestic and industrial effluents be adequately treated for re-use, for irrigation, industries, etc.
4. Where irrigation from treated sewage is not feasible, the possibility of recharging ground water aquifer by sewage, treated to a certain desirable level, may be explored by taking up some experimental studies.

Table 8.1: Criteria for Sitting of industries with reference to classification of river zones

Sr. No.	Classification	Criteria	Type of Industry
1	Fresh water A-II	A) 3 kms.on the either side of river B) From 3 kms. To 8 kms. From river (H.F.L.) on either side. C) Beyond 8 kms. From river (H.F.L.) on either side	• No development zone for the any type of industries. Only specific Non-Industrial activities are allowed • Classified Green and Orange category of industries irrespective of investment, with requisite pollution control devices. • Any type of industry with requisite pollution control devices.

2	A-II	a) 1 km. on either side of river (H.F.L.) b) 1 km. to 2 km. on either side. c) Beyond 2 kms.	• Development zone. Only Specified Non-Industrial listed activities are allowed. • Classified Green and Orange category of Industries irrespective of investment, with requisite pollution control devices. • Any type of industry with requisite pollution control devices.
3	A-III A-IV	a) Up to ½ km. on either side b) ½ km. to 1 km. on either side c) Beyond 1 km.	No development zone for any type of industries. Only specified Non-Industrial listed activities are allowed. Classified Green and Orange category of Industries irrespective of investment, with requisite pollution control devices. Any type of industry with requisite pollution control devices.

Note:

1) Distances mentioned in the note above are shortest distances measured as the crow files.
2) High Flood Levels (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 boundary, restrictions apply up to the ridge line.
4) Arrangement for pollution control shall be foolproof irrespective of the pollution
5) In No development zone, the permissible activities and Non permissible activities are separately prescribed.

6) Categorization 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 arrangement. Expansion, diversification, modernization, sub situation 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 mts. 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 Forest's notification (CRZ Notification) dated 19.02.1991.

8.4 Wastewater as a Resource

Since, there is no dilution available in the receiving water bodies, it is important that no wastewater is discharges into them even after treatment. The efforts should be to use entire wastewater after proper treatment. There are many cases where the sewage or industrial wastewater is treated and used for various inferior uses. Many companies are coming in this business. Focus should be to promote such business. This will benefit the water quality in many ways:

1. Reduce pollution
2. Save water
3. Save nutrients
4. Reduce over-exploitation of water resources

8.5 Wastewater Use in Agriculture

The incorporation of wastewater use planning into national water resource and agricultural planning is important, especially where dilution water in the receiving water bodies shortages exist. This is not only to protect sources of high quality waters but also to minimize wastewater treatment costs, safeguard public health and to obtain the maximum agricultural and aquacultural benefit from the nutrients that wastewater contains. Since in most of the urban centres, treatment plants either do not exist or not adequate. Wastewater use may well help reduce costs, especially if it is envisaged before new treatment works are built, because the standards of effluents required for various types of use may result in costs lower than those for normal environmental protection. The use of wastewater has been practiced in many parts of the country for centuries. Unfortunately, this form of unplanned and, in many instances unconscious, reuse is performed without any consideration of adequate health safeguards, environmentally sound practices or basic agronomic and on-farm principles. Authorities, particularly the Ministries of Health and Agriculture, should investigate current wastewater reuse practices and take gradual steps for upgrading health and agronomic practices. The implementation of an intersectoral institutional framework is the next step that should be taken. This entity should be able to deal with technological, health and environmental, economic and financial, and socio-cultural issues. It should also assign responsibilities and should create capacity for operation and maintenance of treatment, distribution and irrigation systems, as well as for monitoring, surveillance and the enforcement of effluent standards and codes of practice. In places with little or no experience on planned reuse, it is advisable to implement and to operate a pilot project.

8.6 Prevent Pollution rather than Control.

Past experience has shown that remedial actions to clean up polluted water bodies are generally much more expensive than applying measures to prevent pollution from occurring. Although wastewater treatment facilities have been installed and improved over the years in many parts of the country, water pollution remains a problem. In some situations, the introduction of improved wastewater treatment has only led to increased pollution from other media, such as wastewater sludge. The most logical approach is to prevent the production of wastes that require treatment. Thus, approaches to water pollution controls that focus on wastewater minimization, in-plant refinement of raw materials and production processes, recycling of waste products, etc., should be given priority over traditional end-of-pipe treatments. For water pollution originates from diffuse sources, such as agricultural use of fertilizers, which cannot be controlled by the approach mentioned above. Instead, the principle of "best environmental practice" should be applied to minimize non-point source pollution.

8.6.1 Apply the Polluter-Pays-Principle:

The polluter-pays-principle, where the costs of pollution prevention, control and reduction measures are borne by the polluter, is not a new concept but has not yet been fully implemented, despite the fact that it is widely recognized that the perception of water as a free commodity can no longer be maintained. The principle is an economic instrument that is aimed at affecting behavior, i.e. by encouraging and inducing behavior that puts less strain on the environment. Examples of attempts to apply this principle include financial charges on sewage generated by urban population; industrial waste-water discharges and special taxes on pesticides. The difficulty or reluctance encountered in implementing the polluter-pays principle is probably due to its social and economic implications. Full application of the principle would upset existing subsidized programmes (implemented for social reasons) for supply of water and removal of wastewater in India. Nevertheless, even if the full implementation of the polluter-pays-principle is not feasible at present, it should be maintained as the ultimate goal.

8.6.2 Balance Economic and Regulatory Instruments:

Until now, regulatory instruments have been heavily relied upon. Economic instruments, typically in the form of wastewater discharge fees and fines, have been introduced to a lesser extent. Compared with economic instruments, the advantages of the regulatory approach to water pollution control is that it offers a reasonable degree of predictability about the reduction of pollution, i.e. it offers control to authorities over what environmental goals can be achieved and when they can be achieved. A major disadvantage of the regulatory approach is its economic inefficiency. Economic instruments have the advantages of providing incentives to polluters to modify their behavior in support of pollution control and of providing revenue to finance pollution control activities. In addition, they are much better suited to combating nonpoint sources of pollution. The setting of prices and charges are crucial to the success of economic instruments. If charges are too low, polluters may opt to pollute and to pay, whereas if charges are too high they may inhibit economic development. Against this background it seems appropriate, therefore, to apply a mixture of regulatory and economic instruments for controlling water pollution. In our country financial resources and institutional capacity are very limited, the most important criteria for balancing economic and regulatory instruments should be cost-effectiveness and administrative feasibility.

8.6.3 Establish Mechanisms for Cross-Sectoral Integration:

Since water quality management is related to many sectors, their involvement is very crucial in implementing various policies and regulations. The most important ones are: Ministry of Water Resources, Central Water Commission, Central Ground Water Board, State ground Water departments, State Irrigation/Water Resources Departments, Rajiv Gandhi Drinking Water Mission, State Public Health Departments, Water Supply Authorities, Ministry of Industries, Ministry of Power, and Ministry of Urban Development, Ministry of Agriculture. In order to ensure the co-ordination of water pollution control efforts within water-related sectors, a formal mechanisms and means of co-operation and information exchange need to be established. Such mechanisms should:

a. Allow decision makers from different sectors to influence water pollution policy.
b. Urge them to put forward ideas and plans from their own sector with impacts on water quality.
c. Allow them to comment on ideas and plans put forward by other sectors. For example, a permanent committee with representatives from the involved sectors could be established. The functions and responsibilities of the cross-sectoral body would typically include at least the following:
d. Co-ordination of policy formulation on water pollution control.
e. Setting of national water quality criteria and standards, and their supporting regulations.
f. Review and co-ordination of development plans that affect water quality.
g. Resolution of conflicts between different states and government bodies regarding water pollution issues that cannot be resolved at a lower level.

8.6.4 Encourage Participatory approach with involvement of all relevant Stakeholders:

The participatory approach involves raising awareness of the importance of water pollution control among policy-makers and the general public. Decisions should be taken with full public consultation and with the involvement of groups affected by the planning and implementation of water pollution control activities. This means, for example, that the public should be kept continuously informed, be given opportunities to express their views, knowledge and priorities, and it should be apparent that their views have been taken into account. Various methods exist to implement public participation, such as interviews, public information sessions and hearings, expert panel hearings and site visits. The most appropriate method for each situation should take account of local social, political, historical, cultural and other factors. Public participation may take time but it increases public support for the final decision or result and, ideally, contributes to the convergence of the views of the public, governmental authorities and industry on environmental priorities and on water pollution control measures.

8.6.5 Open access to Information on Water Pollution:

This principle is directly related to the principle of involvement of the general public in .the monitoring, decision-making process, because a precondition for participation is free access to information held by public authorities. Open access to information helps to stimulate understanding, discussions and suggestions for solutions of water quality problems.

8.6.6 Promote Interstate co-operation on Water Pollution Control:

Trans-boundary water pollution, typically encountered in large rivers, requires interstate co-operation and co-ordination of efforts in order to be effective. Lack of recognition of this fact may lead to wasteful investments in pollution load reductions in one state if, due to lack of cooperation, measures are introduced upstream (Delhi-Haryana case) that have counteractive effects. Permanent interstate bodies with representatives from riparian states can be established, with the objective of strengthening interstate co-operation on the pollution control of the shared water resources.

8.6.7 Economic Instrument for Pollution Control:

Besides the 'command and control' regulatory mechanism the government has also introduced major economic incentives for pollution abatement in India, not as alternative to regulation but only as a supplementary measure. The Water Cess Act was introduced in 1977, empowering the state pollution control boards to levy a Cess on local authorities supplying water to consumers and on consumption of water for certain specified activities. The Act also provides for a rebate on the Cess payable if the person or local authority concerned installs a plant to treat sewage or trade effluent. Besides the Water Cess Act, efforts have to be made to introduce and implement the Zero discharge concepts, which would enhance recycle and reuse of effluent discharge.

8.7 WASTE MINIMIZATION AND CLEAN TECHNOLOGIES

It may be noted that by recycling techniques the waste concentrations may increase, however the total load remain the same. The concentration of waste strength would help the economical conversion of spent wash to bio-fertilizer. Waste strength reduction can be achieved by adopting in plant control measures such as reduction of spillages of wastes, elimination of process failures, use of proper equipment for handling and dry cleaning techniques etc. This is often termed as clean technologies; it does not add to the cost of production, in fact industry gains from it. Innovation in pollution prevention/waste minimization efforts on the part of the industries needs to be sternly promoted. Pollution prevention/ waste minimization, in our country at least, is done only for product quality improvement, energy saving or other economic reasons and any reduction in pollution is only incidental. All organic wastes are best source of energy. A number of anaerobic technologies are now available for treatment of organic industrial effluents. Spent wash, black liquor (pulp mill), dairy effluents, sugar factory effluents and press mud etc. are some of the organic wastes tried for energy recovery. The energy recovery will incidentally solve the air pollution problem, as biogas is a cleaner fuel compared to baggasse, rice husk or coal. It is essential to introduce energy audit in all the industries so that cost-benefit ratio can be established in each case. Bio-fertilizers are now prepared from organic rich wastes by admixing filler materials. Spent wash is converted to manure by addition of press mud, bagasse cillo, agricultural residues etc. In this technology the entire liquor effluent is converted into solid mass and it can be termed as "Zero-discharge" technology.

CHAPTER NO.9

RESULT AND DISCUSSION

In the present study, 7 sampling locations from Nasik and 6 sampling locations were selected along the Godavari river at Aurangabad for water quality analysis as shown in Table-9.1, Table-9.2 and Fig.-9.1, .Fig 9.2.The water quality data from 2005-2009 were collected from the records of the Maharashtra Pollution Control Board (MPCB), Nasik and Aurangabad Head office and some from the MPCB websites. Table-9.3 shows the rating scale for NSFWQI (National Sanitation Federation Water Quality Index) used for water quality assessment [www.water-research.net, 2010].

Table 9.1: Sampling Locations at Nasik **[20]**

Sampling station	Sampling station code and Name	Latitude	Longitude	Description of station
1.	K_1 -Gangapur Dam	20^0 02.400'	$73^0$40.751'	Dam is sources of drinking water
2.	K_2 -Chikhali Nala	$20^0$01.022'	$73^0$44.116'	Heavy industrial waste is coming through it
3.	K_3-Someshwar	$20^0$01.391'	$73^0$43.740'	Bathing,washing activites and puja material thrown
4.	K_4-Ramkund	$20^0$00.482'	$73^0$47.542	Mass bathing activities
5.	K_5-D/s of nasik	$20^0$00.310'	$73^0$41.120'	Treated waste water from sewage treatment plant
6.	K_6-Goda- kapila sangam	$20^0$00.012'	73^0 48.914'	Kapila river meets, sewage water is added
7.	K_7-Saikheda Village	20^0 00.859'	$74^0$00.350'	Remains/ashes of human dead bodies sewage waste water ,Hospital waste and over flow from septic tanks is discharged to the river

Table 9.2: Sampling Locations at Aurangabad [**20**]

Sampling station	Sampling station code and Name	Latitude	Longitude	Description of station
I	P_1-Kaigaon Toka	19^0 37.463'	$75^0$01.490'	U/s of Nat sager Reservoir

2	P_2-Jaikwadi Dam	$19^{0}29.263'$	$75^{0}22.272'$	Pollution Through Agricultural Runoff ,Fertilizers & Pesticides
3	P_3-U/s of Paithan Town	$19^{0}30.887'$	$75^{0}22.457'$	At Paithan Intake Pump House
4	P_4-D/s of Paithan Town	$19^{0}28.835'$	$75^{0}23.835$	Pollution Due to Domestic sewage & Human Activities At Pathegaon Bridge
5	P_5-Wadwali Village	$19^{0}25.675'$	$75^{0}36.475'$	Domestic Pollution
6	P_6-Shahaghad	$19^{0}21.392'$	75^{0} 42.870	Industrial & Domestic Pollution At Jalna Intake Water House

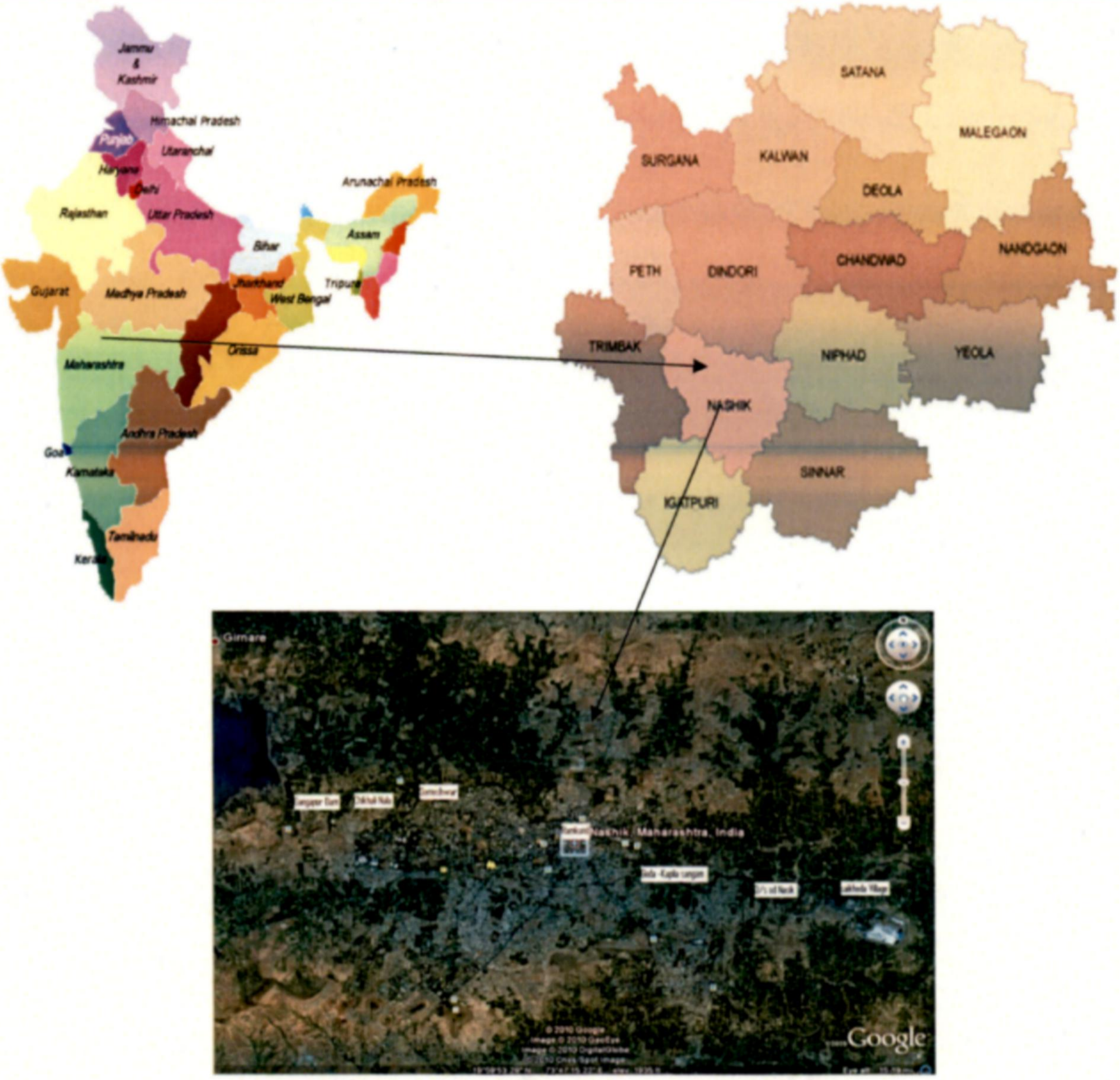

Fig 9.1: Location of study area on the Godavari River at Nasik **[35]**

Table 9.3: Rating scale for NSFWQI **(National Sanitation Federation Water Quality Index) [25]**

Index Value	**Rating**	**Indicating Colour**
0 and <=25	Very Bad	Red
>25 and <=50	Bad	Orange
>50 and <=70	Medium	Yellow
>70 and <=90	Good	Green
>90and <=100	Excellent	Blue

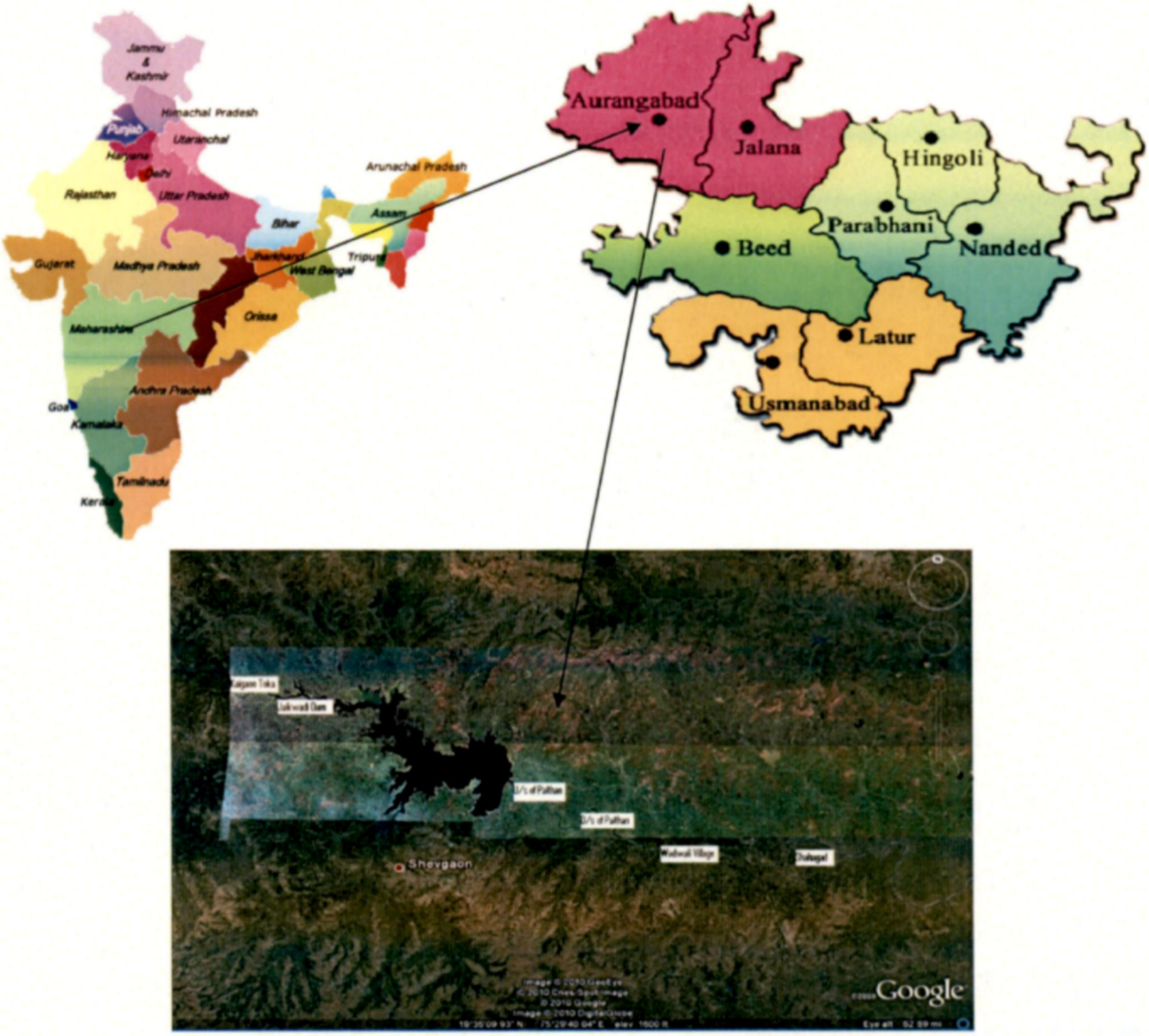

Fig 9.2: Location of study area on the Godavari River at Aurangabad **[35]**

Fig 9.2: Location of study area on the Godavari River at Aurangabad **[35]**

During Sept.2009 and Feb.2010 period analysis of the water quality parameters was carried out in order to detect pollution of the river. Samples were collected from the drainage outfall point, river water as well as from the sediments of the river. Average water quality parameters for (post mansoon) September 2009 has been shown in Table-9.4 and average water quality parameters for the (Pre-mansoon) February 2010 is shown in Table-9.5 for Nasik reason.

Physical parameters PH, Temperature (^{0}C),Turbidity (NTU), TSS (mg/l), TDS (mg/l),Color, taste & odour, Electrical conductivity, etc. Chemical parameters like BOD, COD, DO (mg/l), Ca, Mg as CaCO3, Oil & grease (mg/l), Sulphates were converted to NSFWQI scores which give an idea about the status of the water quality at the given location at the specified time and help the policy and decision makers at the government and public sector levels to plan for conservation of the river. The Numerical Scores with water quality descriptions are given in the Table.-9.3.The Comparison of NSFWQI at the five locations for the years 2005-2009 is given on Table.-9.9 based on data collected from the MPCB.

Table 9.4: Average Water Quality Parameters **(Post-monsoon 2009 in September for Nasik) [20]**

Sampling Location	Temp. (^{0}C)	Temp. Variation (^{0}C)	PH	Conductivity (µ mho/cm)	DO (mg/l)	BOD (mg/l)	COD (mg/l)	TDS (mg/l)	Turbidi-ty NTU	Nitrate (mg/l)	Phosphate (mg/l)	Sulphate (mg/l)	Magnesium (mg/l)
K_1	31	0.2	7.48	251.3	5.:	5.0	12.0	-	1.0	0.73	0.48	-	-
K_2	31.8	0.8	8.2	1072.0	4.7	7.0	12.0	-	1.0	1.47	0.65	-	-
K_3	30.0	1.8	7.48	-	5.1	5.0	12.0	-	-	0.73	-	-	-
K_4	29	1.0	8.21	468.1	4.9	7.5	16.0	-	1.0	0.34	-	-	-
K_5	31	2.0	7.48	500.6	3.9	16.0	44.0	-	6.0	0.89	0.43	-	-
K_6	29.1	1.9	8.17	489.7	4.5	7.9	12.0	-	1.0	0.22	-	-	-
K_7	32.6	2.5	7.36	459.1	5.40	7.0	20.0	-	2.0	0.34	0.28	-	-

Table 9.5: Average Water Quality Parameters **(Pre-monsoon 2010 in February for Nasik) [20]**

Sampling Location	Temp. (^{0}C)	Temp. Variation (^{0}C)	PH	Conductivity (µ mho/cm)	DO (mg/l)	BOD (mg/l)	COD (mg/l)	TDS (mg/l)	Turbidity NTU	Nitrate (mg/l)	Phosphate (mg/l)	Sulphate (mg/l)	Magnesium (mg/l)
K_1	25	0.3	8.09	141.6	6.9	4.0	12.0	-	1.0	0.19	-	-	-
K_2	25.9	0.9	7.99	892.6	5.2	12.0	12.0	-	1.0	3.32	-	-	-
K_3	26.8	09	7.61	673.0	5.7	8.0	12.0	-	1.0	0.97	-	-	-
K_4	27.1	0.3	8.31	451.5	4.9	16.0	12.0	-	1.0	3.01	-	-	-
K_5	26.5	0.6	8.03	752.5	5.9	8.0	16.0	-	11.0	3.41	-	-	-
K_6	25.0	1.5	8.40	483.8	5.8	12.0	12.0	-	1.0	2.9	-	-	-
K_7	25.8	0.8	8.37	284.3	6.6	6.0	12.0	-	1.9	1.42	0.142	-	-

Using same methodology average water quality parameters for (post mansoon) September 2009 is shown in Table-9.6 and Average water quality parameters for the (Pre-mansoon) February is shown in Table-9.7 for Aurangabad region.

Physical parameters PH, Temperature (^{0}C),Turbidity (NTU), TSS (mg/l), TDS (mg/l),Color, taste & odour, Electrical conductivity, etc. Chemical parameters like BOD, COD, DO (mg/l), Ca, Mg as $CaCO_3$, Oil & grease (mg/l), Sulphates were converted to NSFWQI scores which give an idea about the status of the water quality at the given location at the specified time and help the policy and decision makers at the government and public sector levels to plan for conservation of the river. The Comparison of NSFWQI at the five locations for the years 2005-2009 is given on Table.-9.10 which has been analyzed based on data collected from the MPCB.

Table 9.6: Average Water Quality Parameters **(Post-monsoon 2009 in September for Aurangabad)** [20]

Sampling Location	Temp. (^{0}C)	Temp. Variation (^{0}C)	PH	Conductivity (μ mho/cm)	DO (mg/l)	BOD (mg/l)	COD (mg/l)	TDS (mg/l)	Turbidity NTU	Nitrate (mg/l)	Phosphate (mg/l)	Sulphate (mg/l)	Magnesium (mg/l)
P_1	28	0.1	8.45	1091.0	4.48	2.09	16.0	1200.6	0.240	1.279	-	462.56	87.0
P_2	28.4	0.4	7.82	-	4.22	5.0	12.0	-	-	0.76	-		-
P_3	30.0	2.0	8.41	311.4	4.45	2.2	16.0	310.0	0.770	0.8283	-	42.0	120.0
P_4	29.0	1.0	8.21	410.3	5.03	3.92	12.0	258.3	0.915	0.983	0.035	24.9	88.4
P_5	29.5	0.5	8.61	890.79	4.42	2.9	16.0	843.0	1.86	7.6613	0.1222	136.0	197.2
P_6	29.3	0.2	7.96	-	4.60	3.4	8.0	-	-	9.78	-	-	-

Table 9.7: Average Water Quality Parameters **(Pre-monsoon 2010 in February for Aurangabad)** [20]

Sampling Location	Temp. (^{0}C)	Temp. Variation (^{0}C)	PH	Conductivity (μ mho/cm)	DO (mg/l)	BOD (mg/l)	COD (mg/l)	TDS (mg/l)	Turbidity NTU	Nitrate (mg/l)	Phosphate (mg/l)	Sulphate (mg/l)	Magnesium (mg/l)
P_1	28	0.1	7.72	412.7	4.03	2.59	8.0	415.9	0.894	1.047		24.1	105.4
P_2	28	0.0	7.51		3.37	2.1	12.0			0.70			
P_3	27	1.0	7.39	398.59	4.52	5.09	16.0	307.5	0.497	0.427		17.8	101.3
P_4	29	2.0	7.52	311.9	4.02	3.5	12.0	207.5	0.0981	0.4921	0.1209	27.4	89.8
P_5	29.8	0.8	7.34	541.3	4.87	2.89	12.0	548.3	0.98	4.32	0.09	52.3	151.6
P_6	28	1.8	7.81		4.29	4.17	12.0			0.78			

9.1 RESULTS AND DISCUSSIONS FOR NASIK

The results of Table-9.8 as shown in Fig.9.4 indicate that in September 2009 and February 2010 the water quality at the chalikhali Nala (k_2) Ramkund (k_4) and Goda-kapila sangam (k_5) is bad while the water quality at other locations was medium, thereby indicating that there is not much change in the river water quality at all the locations during this period. The result shows that the pollution is not high at the k_1, k_3, k_6 and k_7 but at K_2, k_4 and k_5 the pollution load is increasing due to the industrial and domestic load. Due to the Gangapur Dam the water quality at the k_1 is medium.

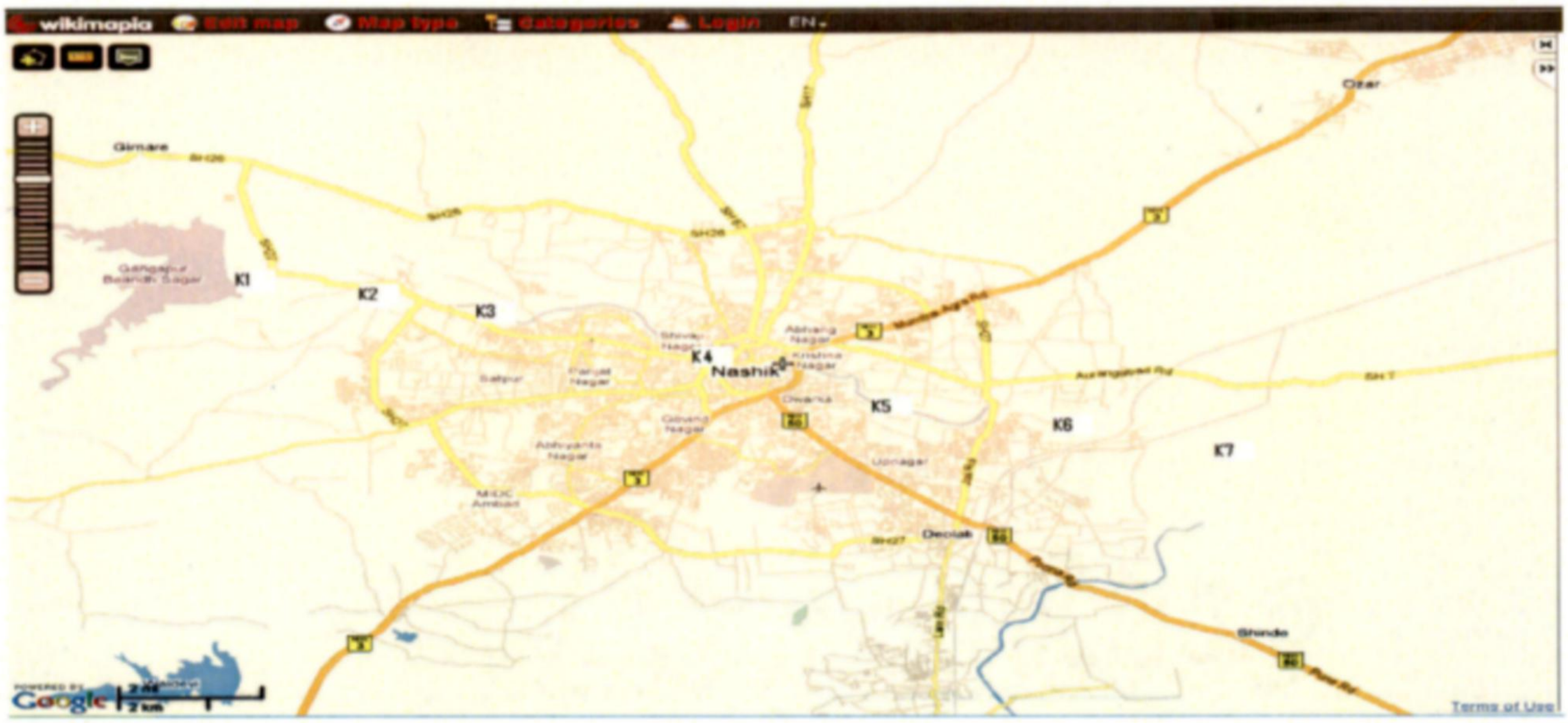

Fig.9.3: Location of study area on the Godavari River at Nasik City [39]

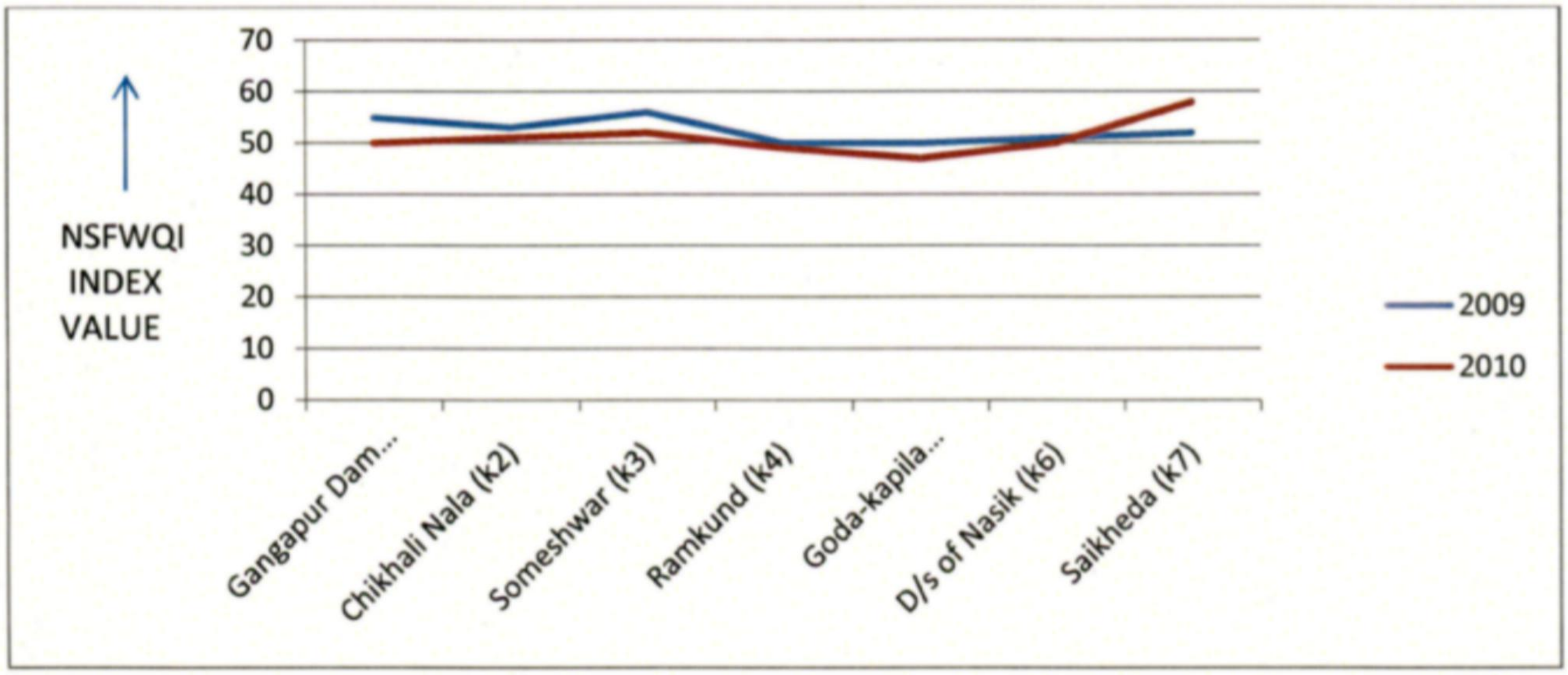

Fig 9.4: NAFWQI value of Godavari River at Nasik

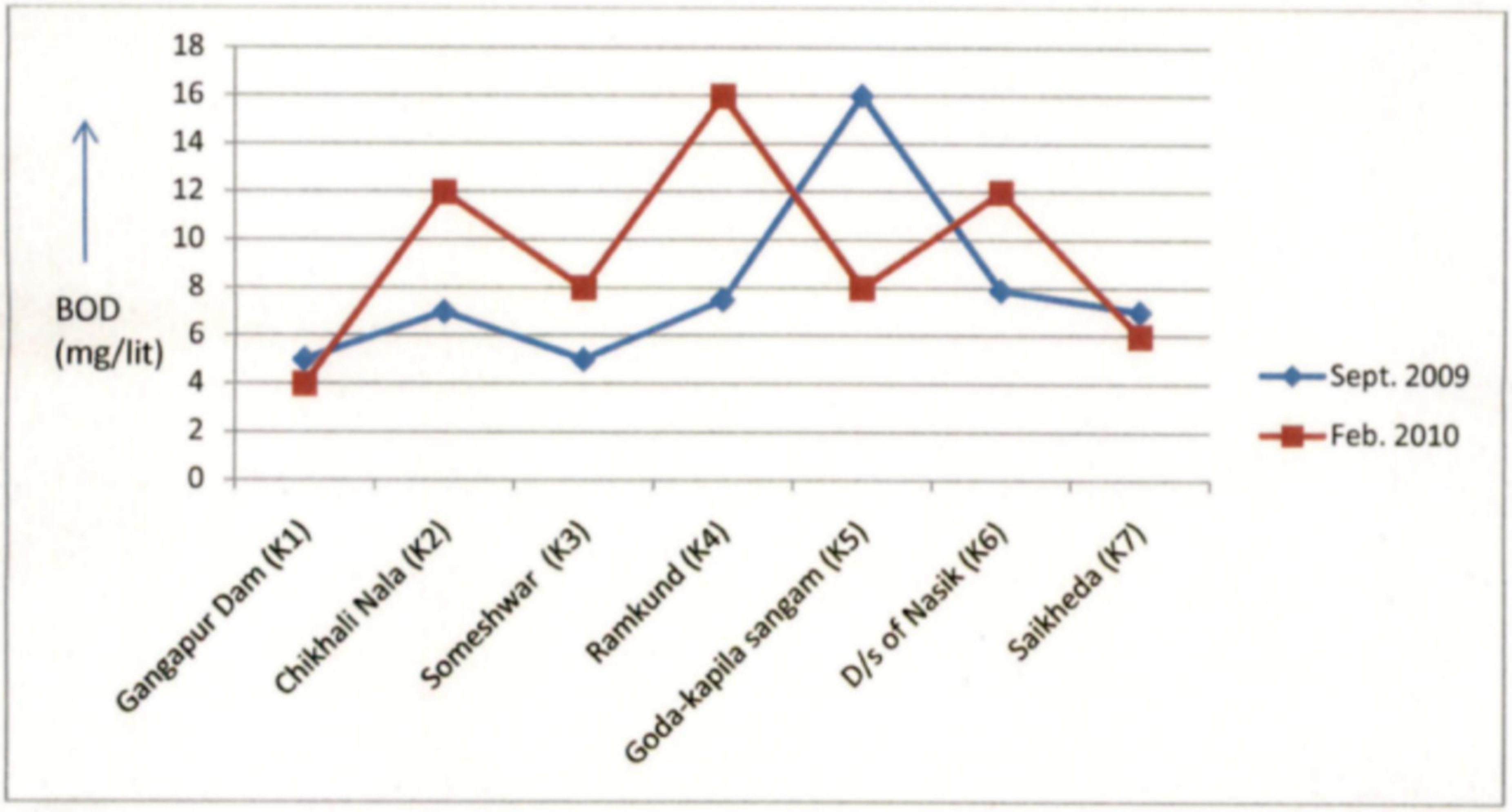

Fig.9.5: BOD Status of Godavari River at Nasik City

Table 9.8: **NSFWQI** Sub-Index value **(Base on Year 2009 Post-monsoon and 2010 Pre-monsoon) (Water Quality Index) for Nasik City.**

Post-Monsoon 2009	**September 2009**						
Parameters	**K_1**	**K_2**	**K_3**	**K_4**	**K_5**	**K_6**	**K_7**
Temp.	31	31.4	30.0	29	31.0	29.1	32.6
PH	7.48	8.2	7.48	8.21	7.48	8.17	7.36
Conductivity (µ mho/cm)	251.3	1072.0	-	468.1	500.6	489.7	459.1
DO (mg/l)	5.1	4.7	5.1	4.90	3.9	4.5	5.40
BOD (mg/l)	5.0	7.0	5.0	7.50	16.0	7.9	7.0
COD (mg/l)	12.0	12.0	12.0	16.0	44.0	12.0	20.0
TDS (mg/l)	-	-	-	-	-	-	-
Turbidity(NTU)	1.0	12.0	-	1.0	6.0	1.0	2.0
Nitrate (mg/l)	0.73	1.47	0.73	0.34	0.89	0.22	0.34
Phosphate (mg/l)	0.48	0.65	-	-	0.43	-	0.28
Sulphate (mg/l)	-	-	-	-	-	-	-
Mangesium (mg/l)	-	-	-	-	-	-	-
NSFWQI Value	**55**	**53**	**56**	**50**	**50**	**51**	**52**

Pre-Mansoon 2010	February 2010						
Parameters	**K_1**	**K_2**	**K_3**	**K_4**	**K_5**	**K_6**	**K_7**
Temp.	25.0	25.9	26.8	27.1	26.5	25.0	25.8
PH	8.09	7.99	7.61	8.31	8.03	8.40	8.37
Conductivity (μ mho/cm)	141.6	892.6	673.0	451.5	752.5	483.8	284.3
DO (mg/l)	6.9	5.2	5.7	4.9	5.9	5.8	6.6
BOD (mg/l)	4.0	12.0	8.0	16.0	8.0	12.0	6.0
COD (mg/l)	12.0	12.0	12.0	12.0	16.0	12.0	12.0
TDS (mg/l)	-	-	-	-	-	-	-
Turbidity (NTU)	1.0	1.0	1.0	1.0	11.0	1.0	1.9
Nitrate (mg/l)	0.19	3.32	0.97	3.01	3.41	2.9	1.42
Phosphate (mg/l)	-	-	-	-	-	-	0.142
Sulphate (mg/l)	-	-	-	-	-	-	-
Mangesium (mg/l)	-	-	-	-	-	-	-
NSFWQI Value	**50**	**51**	**52**	**49**	**47**	**50**	**58**

Table 9.9: Comparison of NSFWQI in different Years at seven sampling locations at Nasik

Sampling stations	NSFWQI Value				
	2005	**2006**	**2007**	**2008**	**2009**
Gangapur Dam (k_1)	36.58-Bad	54.66-Medium	52.58-Medium	56.3-Medium	54.41-Medium
Chikhali Nala (k_2)	-	-	-	41.14-Bad	45.66-Bad
Someshwar (k_3)	-	52.58-Medium	49.72-Bad	52.71-Medium	53.25-Medium
Ramkund (k_4)	38.59-Bad	50.25-Madium	49.09-Bad	52.00-Medium	50.67-Medium
Goda-kapila sangam (k_5)	-	-	-	48.14-Bad	45.53-Bad
D/s of Nasik (k_6)	34.5-Bad	48.91-Bad	48.54-Bad	48.00-Bad	50.66-Medium
Saikheda (k_6)	-	-	-	54.42-Medium	47.91-Bad

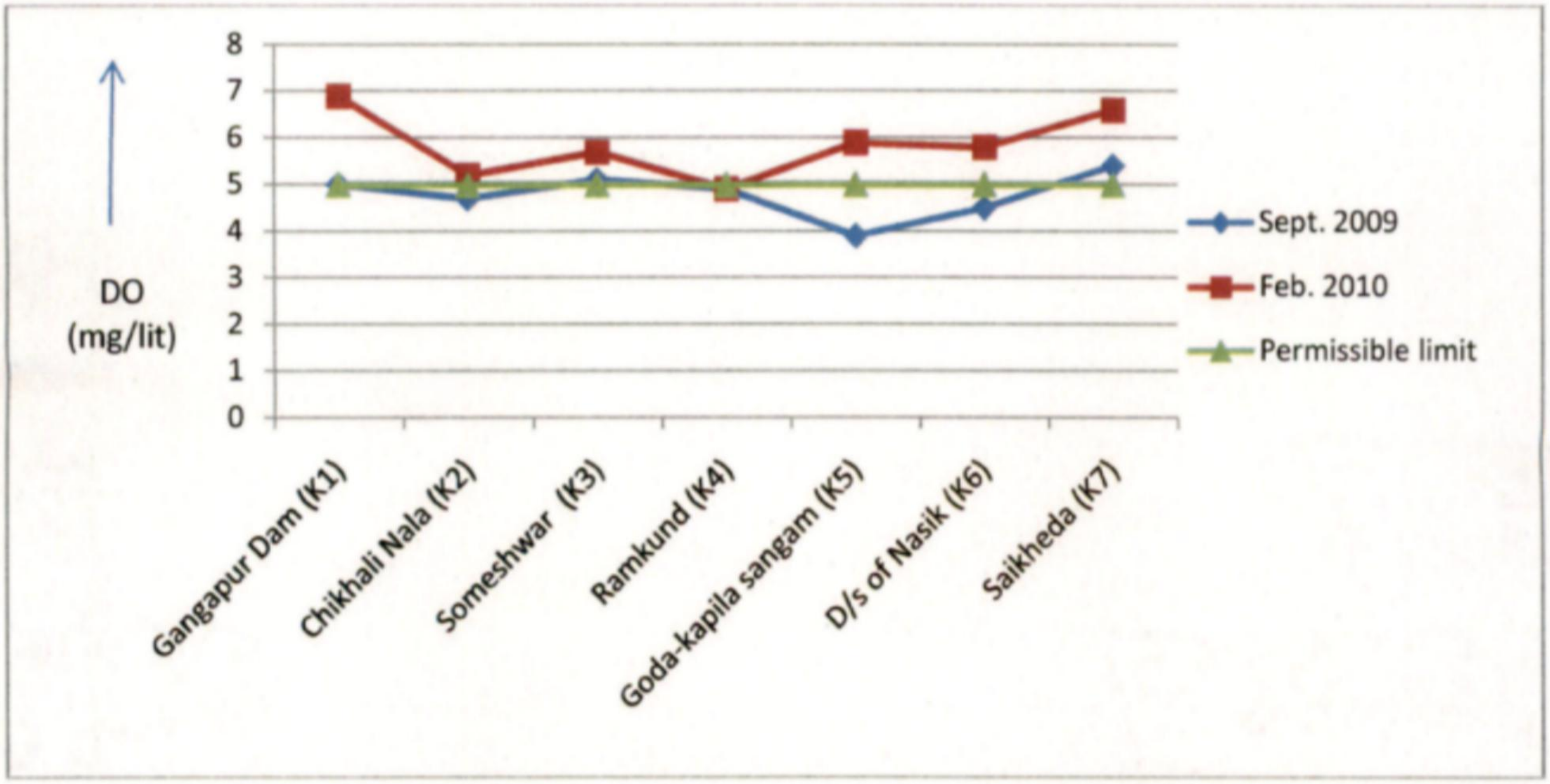

Fig. 9.6: DO Status of Godavari River at Nasik City

9.2 RESULT AND DISCUSSION FOR AURANGABAD

The results of Table-9.10 as shown in Fig. 9.8 Indicate that in September 2009 and February 2010 the water Quality at the Shahagad (P_6) is bad while the water quality at other locations was medium, thereby indicating that there is not much change in the river water quality at all the locations during this period. The result shows that the pollution is not high at the P_1, P_2, and P3 but at P_4 the pollution load is increasing due to the domestic load. Due to the Nath Sager dam (Jaikwadi dam) the water quality at the P_4 (U/s of the Paithan town) is medium. The actual locations are shown in Fig.9.7.

Fig.9.7: Location of study area on the Godavari River at Aurangabad [39]

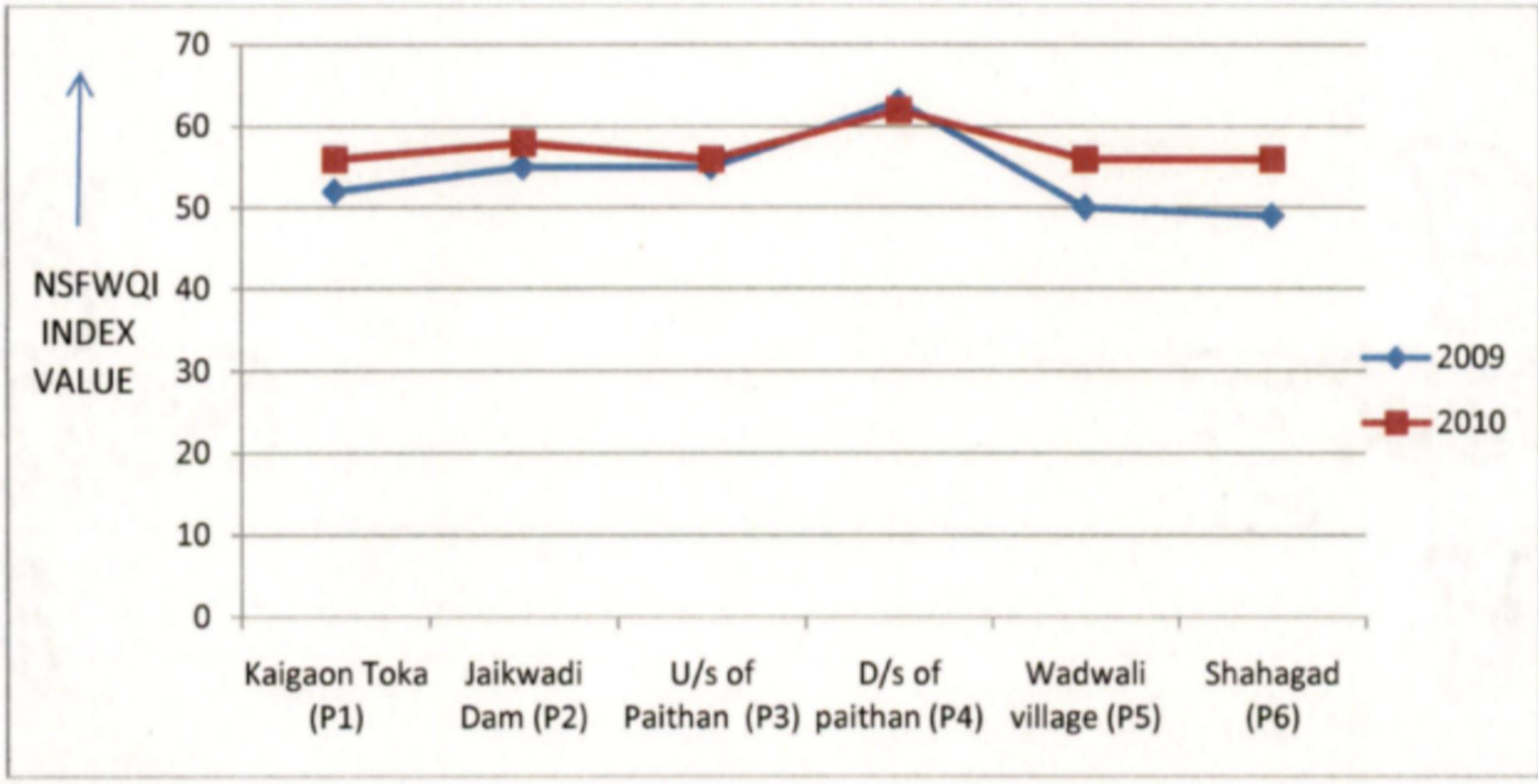

Fig. 9.8 : NAFWQI value of Godavari River at Aurangabad city

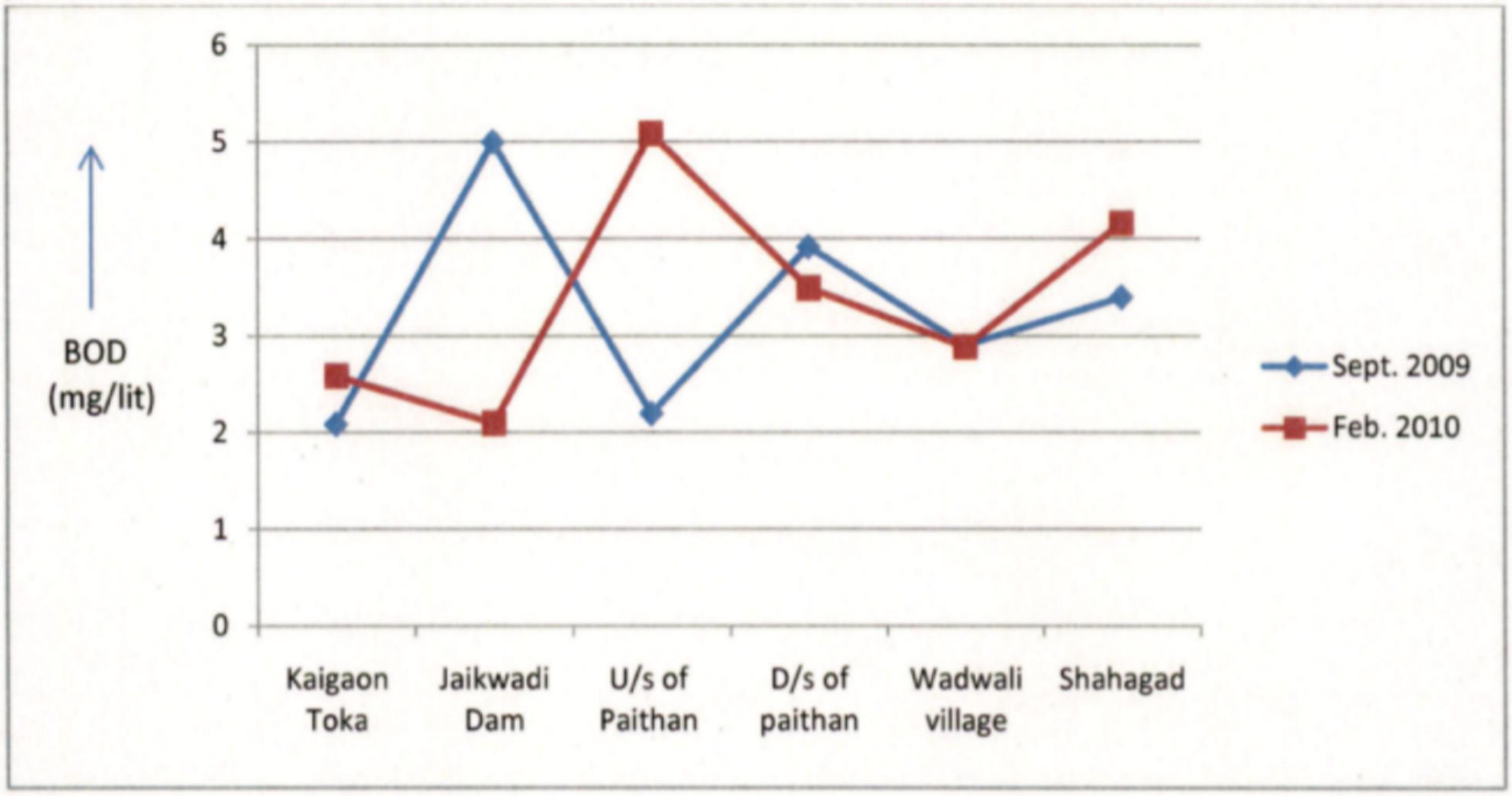

Fig.9.9 : BOD Status of Godavari River at Aurangabad city

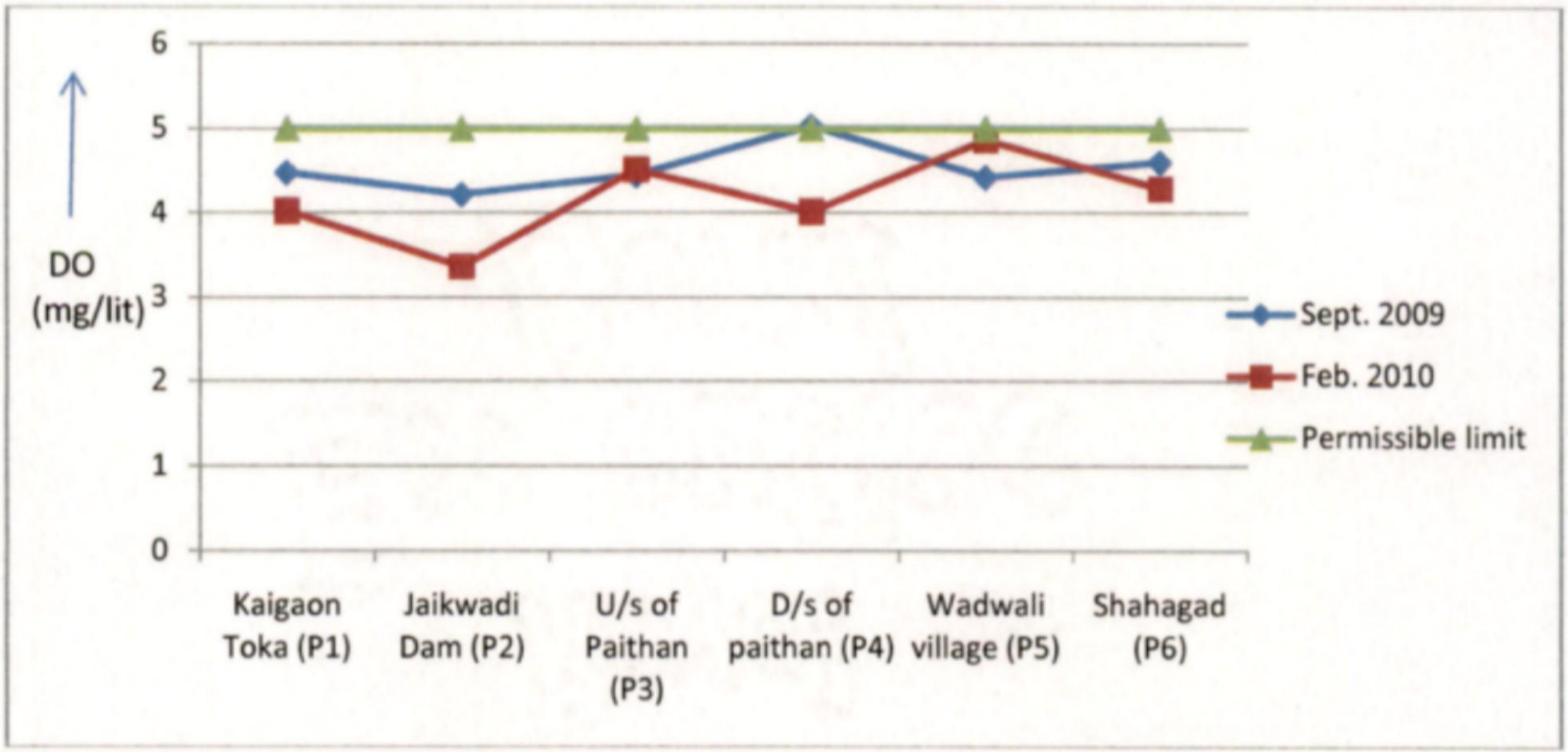

Fig. 9.10: DO Status of Godavari River at Aurangabad city

Table 9.10: **NSFWQI** Sub-Index value **(Base on Year 2009 Post-monsoon and 2010 Pre-monsoon) (Water Quality Index) for Nasik City.**

Post-Monsoon 2009	**September 2009**					
Parameters	**P_1**	**P_2**	**P_3**	**P_4**	**P_5**	**P_6**
Temp.	28	28.4	30.0	29	29.5	29.3
PH	8.75	7.82	8.41	8.21	8.61	7.96
Conductivity (µ mho/cm)	1091.0	-	311.4	410.3	890.7	-
DO (mg/l)	4.48	4.22	4.45	5.03	4.42	4.60
BOD (mg/l)	2.09	5.0	2.2	3.92	2.9	3.4
COD (mg/l)	16	12	16	12.0	16.0	8.0
TDS (mg/l)	1200.6	-	310.0	258.3	843.0	-
Turbidity(NTU)	0.240	-	0.770	0.915	1.86	-
Nitrate (mg/l)	1.2791	0.76	0.828	0.983	7.661	9.78
Phosphate (mg/l)	-	-		0.035	0.122	-
Sulphate (mg/l)	462.56	-	42.0	24.9	136.0	-
Mangesium (mg/l)	87	-	120	88.4	197.2	-
NSFWQI Value	**52**	**55**	**55**	**63**	**50**	**49**

Pre-Mansoon 2010	February 2010					
Parameters	**P_1**	**P_2**	**P_3**	**P_4**	**P_5**	**P_6**
Temp.	28	28	27	29	29.8	28
PH	7.72	7.51	7.39	7.52	7.34	7.81
Conductivity (μ mho/cm)	412.7	-	398.59	311.9	541.3	-
DO (mg/l)	4.03	3.37	4.52	4.02	4.87	4.29
BOD (mg/l)	2.59	2.1	5.09	3.5	2.89	4.17
COD (mg/l)	8.0	12.0	16.0	12.0	12.0	12.0
TDS (mg/l)	415.9	-	307.5	207.5	548.3	-
Turbidity (NTU)	0.894	-	0.497	0.0981	0.98	-
Nitrate (mg/l)	10.47	0.70	0.427	0.492	4.32	0.78
Phosphate (mg/l)	-	-	-	0.120	0.09	-
Sulphate (mg/l)	24.1	-	17.8	27.4	52.3	-
Mangesium (mg/l)	105.4	-	101.3	89.8	151.6	-
NSFWQI Value	**56**	**58**	**56**	**62**	**56**	**56**

Table 9.11: Comparison of NSFWQI in different Years at five sampling locations

Sampling stations	NSFWQI Value				
	2005	**2006**	**2007**	**2008**	**2009**
Kaigaon Toka(P_1)	45.90-BAD	50.08-MEDIUM	45.9-BAD	48.9-BAD	50.66-MEDIUM
Jaikwadi Dam (P_2)	55.16-MEDIUM	54.55-MEDIUM	54.7-MEDIUM	53.88-MEDIUM	56.88-MEDIUM
U/s of Paithan Town (P_3)	43.09-BAD	47.72-BAD	46.67-BAD	49.16-BAD	53.37-MEDIUM
D/s of Paithan Town (P_4)	47.16-BAD	45.08-BAD	50.58-MEDIUM	47.09-BAD	56.12-MEDIUM
Wadwali Village (P_5)	47.16-BAD	53.91-MEDIUM	49.08-BAD	47.58-BAD	49.55-BAD

Conservation Measures

Process of conservation is synonymous of preservation against loss or waste. Technically, conservation of water implies the same meaning in a much wider perspective. Briefly stated it means putting the water resources of the country for the best beneficial use with all the technologies at our command. Water conservation basically aims at matching demand and supply. The strategies for water conservation are demand oriented or supply oriented and/or management oriented. The strategies can vary depending upon the field of water use domestic, irrigation or industrial. Public Participation and Institutional Development, Solid waste management, Watershed management & development, Sewerage and sanitation.

CONCLUSIONS

CONCLUSION:

- The water quality assessment of 213 km long stretch of Godavari river from Nasik to Aurangabad district in Maharashtra state indicates that the river is heavily polluted due to the large and medium scale industrial units. The water quality at P_1 location i.e. Kaigaon Toka is foundto be medium. The results show that the pollution is not high at the P_1, P_2, and P_3 location but at P_4 location the pollution load is increasing due to the domestic load.

- Due to the Nath sager Dam (Jaikwadi Dam), the water quality at the location P_4 (U/s of the Paithan town) is found to be medium. The water Quality at the chikhali Nala (k_2) Ramkund (k_4) and Goda-kapila sangam (k_5) is bad while the water quality at other locations was medium, thereby indicating that there is not much change in the river water quality at all the locations during September 2009 to February 2010. The result shows that the pollution is not high at the k_1, k_3, k_6 and k_7 but at K_2, k_4 and k_5 the pollution load is increasing due to the industrial and domestic load. Due to the Gangapur Dam the water quality at the k_1 is medium.

- The National Sanitation Federation Water quality Index (NSFWQI), computed from the data of September 2009 and February 2010 as well as from 2005-09 indicates that the study stretch at Aurangabad has medium water quality at the starting of the Nath-Sager reservoir (Jaikwadi dam).The water quality is medium but at the D/s of the Paithan town the water quality is degraded. The water quality has not improved beyond medium range up to 2009, due to either to the fact that current facilities have become inadequate or are not properly functioning.

- At Nasik the water quality at Gangapur Dam is medium but the water quality at Ramkund ,Goda-kapila sangam and Chikhali Nala is degraded due to the domestic and industrial pollution. At Someshwar, Saikheda and D/s of Nasik the waste quality is Medium. It is therefore suggested that in the light of present development in the study stretch, there is need to reassess the required facilities and to take effective steps to put them into full operation to achieve the targets.

FUTURE WORK FOR CONSERVATION OF GODAVARI RIVER:

- Interception and diversion works to capture the raw sewage flowing into the water through open drains and divert them for treatment.
- Sewage Treatment Plants should be established for treating the diverted sewage.
- Low cost sanitation works to prevent open defecation of the riverbank.
- Reuse/recycling of Treated Industrial Waste and Resource Recovery
- Apply the Polluter-Pays-Principle; it will be very effective tool for conservation of Godavari river.

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