"A STUDY OF AN ECOLOGICAL PATHOLOGICAL AND BIO-CHEMICAL IMPACT OF URBANISATION AND INDUSTRIALISATION ON WATER POLLUTION OF BHIMA RIVER AND ITS TRIBUTARIES PUNE DISTRICTS, MAHARASHTRA, INDIA"

BY

Dr. PRATAPRAO RAMGHANDRA DIGHAVKAR, I. P. S.

THESIS SUBMITTED FOR THE DEGREE OF VIDYAVACHASPATI (DOCTOR OF PHILOSOPHY)

FACULTY FOR MORAL AND SOCIAL SCIENCES
DEPARTMENT OF SOCIOLOGY

TILAK MAHARASHTRA VIDHYAPEETH
PUNE

JUNE 2016

CERTIFICATE

This is to certify that the entire work embodied in this thesis entitled A STUDY OFECOLOGICAL PATHOLOGICAL AND BIOCHEMICAL IMPACT OF URBANISATION AND INDUSTRILISATION ON WATER POLLUTION OF BHIMA RIVER AND Its TRIBUTARIES .PUNE DISTRICT FOR A PERIOD 2013-2015 has been carried out by the candidate DR.PRATAPRAO RAMCHANDRA DIGHAVKAR. I. P. S. under my supervision/guidance in Tilak Maharashtra Vidyapeeth, Pune.

Such materials as has been obtained by other sources and has been duly acknowledged in the thesis have not been submitted to any degree or diploma of any University or Institution previously.

Date: / / 2016

Place: Pune. Dr.Prataprao Ramchatra Dighavkar, I.P.S.

DECLARATION

I hereby declare that this dissertation entitled A STUDY OF AN ECOLOGICAL PATHOLOGICAL AND BIO-CHEMICAL IMPACT OF URBANISNTION AND INDUSTRIALISATION ON WATER POLLUTION OF BHIMA RIVER AND Its TRIBUTARIES ,PUNE DISTRICT FOR A PERIOD 2013—2015 is written and submitted by me at the Tilak Maharashtra Vidyapeeth, Pune for the degree of Doctor of Philosophy The present research work is of original nature and the conclusions are base on the data collected by me. To the best of my knowledge this piece of work has not been submitted for the award of any degree or diploma in any University or Institution.

I further declare that the material obtained from other sources has been duly acknowledged in thesis.

Date: / /2016

Place: Pune.

Dr.Prataprao Ramchatra Dighavkar, I.P.S.
(Research Student)

ACKNOWLEDGEMENTS

I thanks to shri K. P. Bakshi, I.P.S. Additional Chief Secretary (Home), Shri. Vivek Phansalkar, I.P.S., Addl. D.G., A.T.S. Maharashtra, Dr. Shri. Bhushankumar Uppadhya,I.P.S. Additonal Director General of Police (Prisons), Pune, Prin Dr. Kishore Pawar, Dr. Jaiprakash Jadhav, Subhash Chaudhary, Jt. Director, Industrial Health and Safety Mumbai, and my Mother Mrs.Kamlabai Ramchadra Dighavkar, of being so patient with me the last two years.

Nobody has been more important to me in pursuit of this work than the members of my family. I wish to thanks my loving and supportive wife Dr. Asmita for assisting me in every possible way and my daughter Dr. Sharyu, son Himanshuaii of them ensured that I get conductive atmosphere to complete my work with zeal and great contribution and always contributed these thoughts to streamline this my end ever and my thesis work.

I am also grateful to PC Sandash B. More, Greater Mumbai Police for collection of data and synghronizing the information.

Maharashtra Pollution Control Pune Regional office and these staff also co-operated for provide the data and also provide valuable guidance and submitted assistance.

This work is an outcome of sincere help and co-operation from other people. I express my deep sense of gratitude and sincere feeling to all and lot to owe to all of them.

This work is being dedicated to common people and police Jawans who work under scorching sun, freezing cold and thundering storms.

Dr. Prataprao Ramchandra Dighavkar. I. P. S.

INDEX

LIST OF FIGURE

LIST OF TABLE

CHAPTER-I

INTRODUCTION

1.1 Introduction

Bhima river is an important tributary of river Krishna. Krishna is one of the most important rivers of south peninsula of Indian continent. The origin of Bhima river is Bhima-Shankar Mountain of Western ghat near Karjat, Raigad district. The origin of Bhima river is 945 meters above sea level. The catchment area of Bhima river is around 6 Million hectres and mainly found in hilly regions. The direction of river flow is from west to east in Maharashtra and Karnataka state and confluence with Bhima river in state of Karnataka. Krishna river makes its own course in Andhra Pradesh and confluence with Bay of Bengal in Andhra Pradesh east-coast. Surrounding area of Bhima river and bank of Bhima river is a highly fertile and organic land, which is main attraction for human civilization, so the density of population in the vicinity of Bhima river Bank is absolutely dense, due to the good agricultural belt and agro-based industries where employment is generated. Bhima river is also vulnerable of monsoon floods as at the origin of this river heavy rainfall occurs. Due to development of habitat and human civilization the potential threats of pollution of Bhima river has increased by many fords.

Not only the main river is prone to water pollution but its tributaries have also become highly polluted. The increasing water pollution has very high impact on the ecological balance, flora and fauna. The polluted water affects agriculture, animals and increase in severity of water borne deceases. The ecological, pathological and biochemical impact of the polluted water of Bhima river and its tributaries which are polluted due to industrialization and urbanization have not been studied preciously. Hence the present study is focused on such aspects considering the case of Pune district in Maharashtra (Fig. 1).

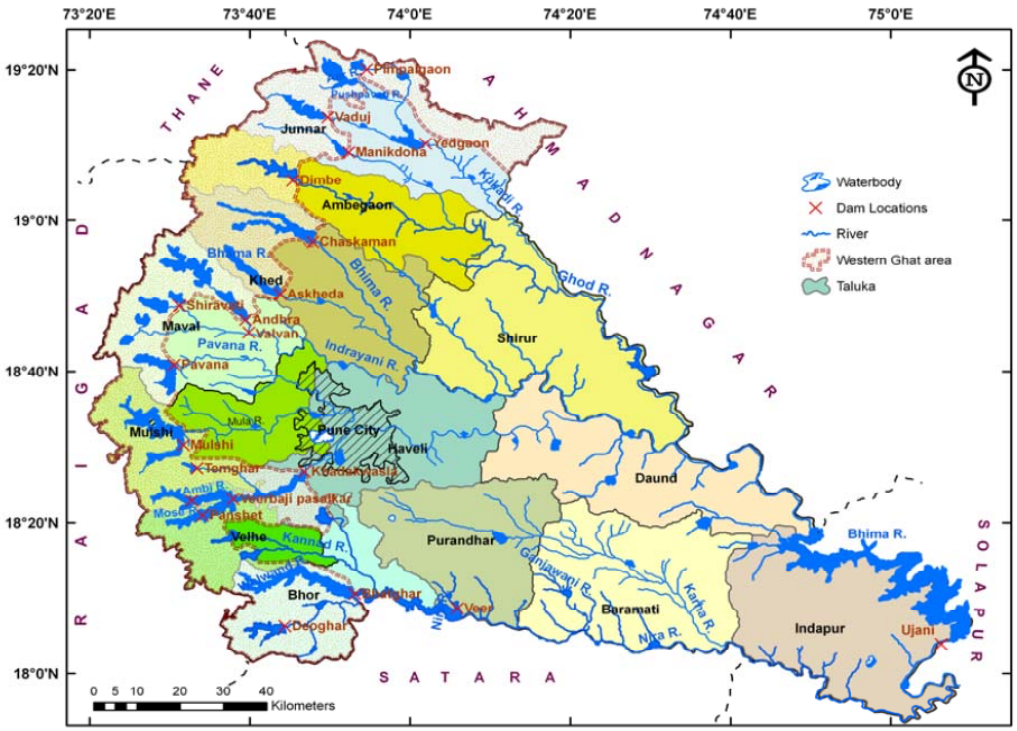


Fig. 1.1 : Map of Maharashtra state showing major rivers.

1.2 Tributaries of Bhima river:

The western Ghat of Sahyadri ranges is origin of many rivers that have made their ways towards east and confluence with Bhima river at various places. Following are tributaries of Bhima river;

- Kukdi
- Ghod
- Bhama
- Indrayani
- Mula
- Mutha
- Pauna

The river Indrayani, Mula, Mutha and Pauna flows in the vicinity of Pune, Pimri-Chinchwad area which is major Industrial belt and urbanized area of Pune district.

Table 1.1 : Detail information of tributaries of Bhima river

Name of river	Starting Point	Confluence Point	river which Confluence	Length of river (Mtrs)	Name after Confluence
Kukadi	Yedgaon Dam	Mhase	Ghod	95	Ghod river
Ghod	Dhimbe Dam	Mhase	Kukadi	67	
Indrayani	Valvan Dam	Lonikand	Bhima	85	Bhima
Bhama	Pardyachiwadi	Shel Pimpalgaon	Bhima	56	Bhima
Mula	Mulshi Dam	Dapodi, Pune	Pawna	50	Mula
Pauna	Pawna Dam	Dapodi, Pune	Mula	48	Mula-Mutha
Mutha	Khadakwasla Dam	Sangam Bridge, Pune	Mula	70	Bhima
Mula-Mutha	Sangam Bridge,Pune	Rahu	Bhima	66	Bhima
Bhima	Bhima-hankar Mountain	Daund	Dhod	--	Bhima
		Lonikand	Indrayani	--	
		Rahu	Mula-Mutha	--	
		Shel Pimpalgaon	Bhama		

Source: Study Report of Maharashtra Pollution Control Board, Pune Regional Office.

Table 2 : Sources of water pollution of Bhima and its tributaries - Classification of Tributaries of Bhima basin

Sr. No.	Name of river	Classification			
		A-1	A-2	A-3	A-4
1.	Bhima river	Origin to Chasakman Dam	Chasakman Dam to Confluence of Mula-Mutha river, Pargaon	---	---
2.	Mina river	Origin to Wadaj Dam	Wadaj Dam to Confluence of Ghod river	---	---
3.	Ghod river	Origin to Dimbe Dam	Dimbe Dam to Confluence of Bhima river	---	---
4.	Wale river	Origin to Confluence of Bhima river	---	---	---
5.	Bhama river	Origin to	Aaskheda Dam to	---	---

Sr. No.	Name of river	Classification			
		A-1	**A-2**	**A-3**	**A-4**
		Aashkheda Dam	Confluence of Bhima river		
6.	Andhra river	Origin to Wadiwale Dam	Wadiwale Dam to Confluence of Indrayani river	---	---
7.	Kundali river	Origin to Shiravti Dam	Shiravti Dam to Confluence of Indrayani river	---	---
8.	Indrayani river	Origin to Lonavala Dam	Lonavala Dam to Confluence of Bhima river	---	---
9.	Pawana river	Origin to Pawana Dam	Pawana Dam to Ravet Bandhara	---	Ravet Bhandara to Confluence of Mula river
10.	Mula river	Origin to Mulshi Dam	Mulshi Dam to Wakad Bhandara	---	Wakad Bhandara to Confluence of Mutha river
11.	Mutha river	Origin to Khadakvasla Dam	Khadakvasla Dam to Vitthalwadi Bhandara	---	Vitthalwadi Bhandara to Confluence of Bhima river
12.	Bhima river	---	Pargaon (Confluence of Mula-Mutha) to Ujani	---	---

Source: Study Report of Maharashtra Pollution Control Board, Pune Regional Office.

The major source of Bhima river water pollution is sewage of Pune Municipal Corporation, Pimpri-Chinchwad municipal corporation, Dehu, Pune & Khadki cantonment boards. The systems of sewage disposal of municipal corporation and cantonment boards are still in rudimentary and dormant stage. It is high time gear-up sewage treatment process to promote protect and reserve ecological balance, flora & fauna of Bhima river. This has become serious threat for the bio- diversity. The 20th century has witnessed a geometric and exponential increase in human population, which is supposed to be concentrated in urban area causing bio-diversity loss for the greatest extend. There are lot of questions about this.

a) Can we sustain under the pressure of pollution ?

b) Will the eco-system survive and flourish they use to do once ?

c) It this magnificent system dumb to misery ?

d) Shall we be the silent spectator for this type of pollution ?

Fig. 1.2 : Threats of water pollution (Source - www.google.com)

1.3 Quick facts of Water Pollution:-

1) According to UNICEF, more than 3000 children die everyday due to consumption of contaminated water.

2) The U.S. EPA estimate that about 1.2 trillion gallons of untreated sewage, Industrial wastes and large amounts of surface water due to heavy rain are dumped into the lakes every single year.

3) According to the World Health Organization and UNICEF, around 2.5 billion people do not have access to improved sanitation.

4) The WHO reports that in developing nations, almost 3.2 million children under the age of five die each year from diarrhea-related diseases, as a result of unsafe drinking water and poor sanitation.

5) According to a reported by the World watch Institute on nuclear waste, Lake Karachay in Russia is regarded as the most polluted spot on earth due to decades of dumping of nuclear waste. Spending an hour there can probably kill a person.

6) A survey by Food & Water watch noted that by 2025, two-thirds of the world's Population will face scarcity of water and five times as much land is likely to be under drought.

7) Food and Water watch survey also mentioned that the water quality in 40% of rivers and streams and 46% of lakes in the U.S. are too dangerous for fishing, swimming or drinking, because of toxic waste produced from the massive use of Industrial weed killers, farm and livestock operations.

1.4 What is Water Pollution?

In the wake of current situation worldwide where water scarcity is increasingly becoming a major issue, pollution of the available water only makes it worst. The following account gives you an idea of water pollution and the factors leading to it.

1.5 Cardinal Point for Concern:-

According to the data provided by the United Nations (UN), since 1990, more than 1.7 billion people have gained easy availability to potable drinking water, whereas 884 million people still lack access to safe drinking water.

Water pollution is an undesirable change in the state of water, contaminated with harmful substances. Any change in the physical, chemical, and biological properties of water that has a harmful effect on living things is called water pollution. It affects all the major water bodies of the world, such as lakes, rivers, oceans and groundwater.

Water-pollution has been increasing at a worrying rate. If consumed in a contaminated state, it may prove fatal to both – human being and the environment. Let's find out how this pollution affects the ecological balance and poses a threat to our lives.

1.6 Sources of Water Pollution:

1.6.1 Point Sources: When pollution is generated from a single source, then the sources are called Point Sources. For example sewage water discharged from Industries.

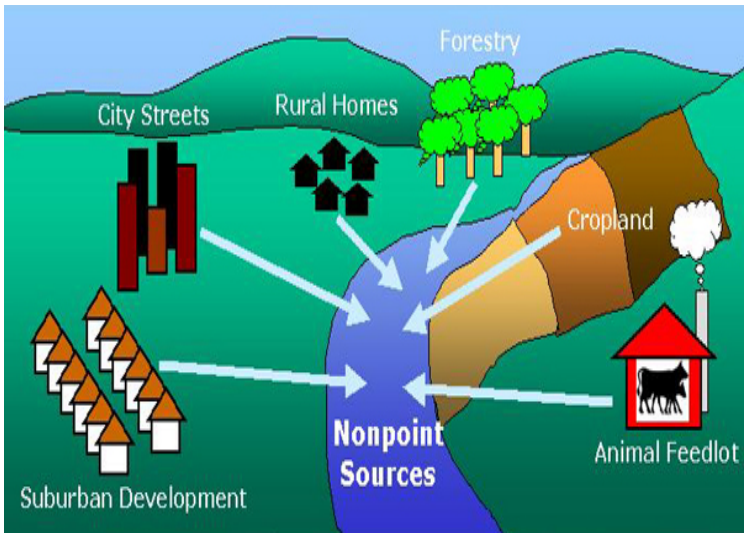


Fig. 1.3 : Sources of water pollution

1.6.2 Non-Point Sources: Pollution generated by more than one source is called Non-Point sources e.g. pesticides, fertilizers, domestic waste and other day-to-day activities carried out by humans – such as riding a bike, driving a car, smoke emitted from chimney, fertilizing your garden, etc.

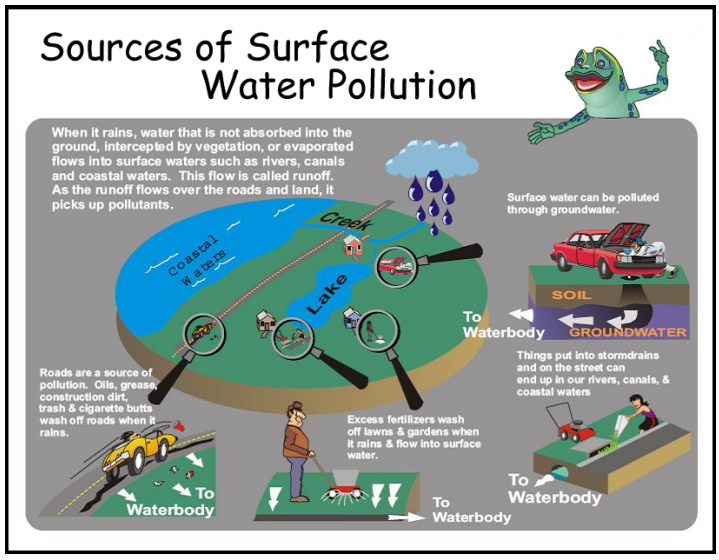


Fig. 1.4 : Different Sources of water pollution

1.7 Source and causes of Water Pollution of river Bhima and its Tributaries:

1.7.1 Domestic Waste from Urban Settlement: It originates from household activities including waste water from kitchen, bathroom and utility goods including sewage water too. Detergents and soaps that we use to wash clothes or other purposes and domestic sewage are carried through the drains and gutters and ditches into nearby streams and rivers. Due to fast urbanization of Pune wastage water is directly released into the rivers, without any physical or chemical treatment, process which is disturbing total flora and fauna of Bhima river.

Fig. 1.5 : Different pollutant sources of water pollution

1.7.2 Chemical and Industrial waste: Industrial waste are also a significant source of water pollution often giving rise to contamination with heavy metals like lead, mercury, arsenic, cadmium and also many organic compound.

Fig. 1.6 : Industrial pollution

In Pune district there are nine Industrial Complexes and major Industries are situated near river banks. Industrial waste many times without processing is discharged into the river and create serious water pollution.

1.7.3 Solid Waste:

Pune is one of the fastest growing cities and become a hub for Automobile Industries, I.T. Industries and in various Educational Institutes. Solid waste which is collected by Municipal Corporation, Municipal Council and Gram Panchayat is stored in the dumping ground without any process, when there is rainfall the waste is percolated from the solid waste alongwith rain water into the river and create serious problem of water pollution.

Fig. 1.7 : Solid waste causing river pollution

1.7.4 Agricultural Run-offs:

On the banks of Bhima river and its tributories there is fertile land which is used for cultivation of sugarcane, pady and other crops. There is excess use of inorganic fertilizers and pesticides, insecticides and fungicides to increase the yield of crops, this is finally enters into therivers alongwith runs-off water during rainy season and cause severe pollution in river. Pesticides and fertilizers are rich in nutrients like Nitrogen, Phosphorous; Potassium that stimulates enrichment of the water bodies this process is called as Eutrophication or Hypertrophication, which leads to gloming of water plants, alge and phytoplanktons, which secret toxic substances which are harmful and fatal for human as well as animals.

Fig. 1.8 : Waste from mining activities is leached by rain water and cause pollution

1.7.5 Mining Activities:

Mining sites expose heavy metals, sulfur compounds and other metals. The waste that is generated as a result of mining activities is leached by rain water and ultimately ends up in polluting soil, ground water and surface water. This can create very high pollution of arsenic, sulfuric acid, mercury, cyanide and heavy metals like lead or cadmium in the water sources. Due to excess activities of mining many lower portion of the river bed created by dressing activities and due to this there is lot of water logging and the natural river flow become stagnant. Due to water logging percentage of minerals, salts increases and it disturb the PH level of the water.

Fig. 1.9 : Mining activities

1.7.6 Growth of Phytoplanktons, alge and Water Plants:

Due to stagnation of the flow and run-offs from the agriculture land the water become rich in potassium, nitrogen, phosphorus and sulphure which accelerate the growth of algae Phytoplankton and other types of water plants, which create lot of water pollution.

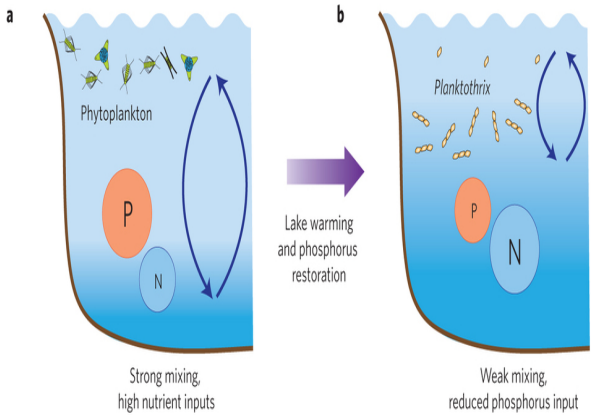


Fig. 1.10 : Mining activities and growth of phytoplancton

Water plants also get decomposed and create lot of gases like methane and carbon-dioxide.

1.7.7 Landfills:

The areas where cities garbage is buried are called as Landfills. An ideal landfill should be well-protected at the base to prevent seepage. However, if it has even a slight crack in the bottom layer, the pollutants seep through it and mix with the ground water present below. This makes the water unfit for consumption in any form.

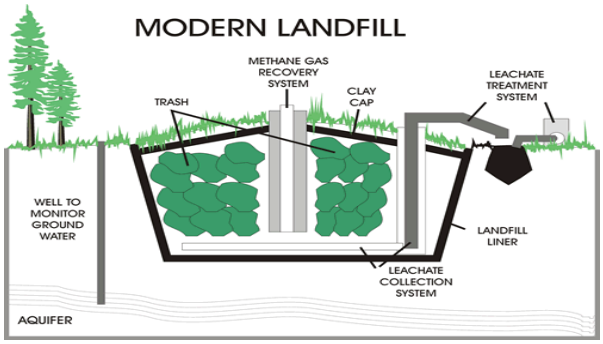


Fig. 1.11 : Landfill activites

1.7.8 Oil Spills:

The causes of oil spills can be both natural and anthropogenic. More often than not, they result from human activities, be it accidentally, or deliberately. Oil products stored in special containers often leak over a long period, the same can happen during handling of the containers or improper transport. Sometimes, oil and its products are intentionally discharged down the drain after their use, proving harmful in the long run.

1.7.9 Dumping of Plastic and Polythene:

Due to fast urbanization of Pune district, use of plastic and polythene is at high end Plastic is an inevitable material which is used and produced on a large scale. Plastic waste requires around 400 years to degrades and kill many fresh water fishes. The water gets contaminated with plastic due to dumping in or it is thrown on the road which gets washed away by the rain eventually in the rivers.

Fig. 1.12 : Pollution of water due to plastic material

1.7.10 Other Reason:

Pilgrimage places like Dehu, Alandi, Pandarpur are situated on river banks and at the time of religious festivals celebrations many people as a tradition have holy bath in the rivers. In a given time millions of people are taking bath and use to wash their cloths into the river creating water pollution.

Fig 1.13 : Rivers at holy places are getting polluted by bath and washing clothes

1.8 Types of Pollutants

1.8.1 Surface water may have the following types of Pollutions:

a) **Suspended solids:** The inorganic suspended solids blankets the streams bed affecting benthos (flora and fauna at bottom of water) organisms, while the organic solids create sludge banks and decompose, causing odours and pathogens.

b) **Floating solids including oils, greases:** Floating materials obstruct passage of light and aeration, which are fatal for flora and fauna and self-purification of water.

c) **Organic Matter:** Biological decomposition of waste organic matter in stream deplates dissolved oxygen content of water which may stifle the fish and aquatic life due to lack of oxygen. Unpleasant odour, flavor and taste, result due to lack of dissolved oxygen. Untreated sewage is the biggest pollutant and a cause of pathogens in water.

d) **Inorganic dissolved salts:** High total dissolved solids (TDS) may interfere with the use of water in industries, municipal supplies and for irrigation purpose. Phosphorus and Nitrogen are plant nutrients which induce algae growth and sometimes create 'Atrophic' condition, these excessive growth of plants and algae kill fishes and water animals.

e) **Acid, alkalis, toxic chemicals and heavy metals:** These cause adverse affect on human and animal life and plants.

f) **Radioactive materials:** Adverse affects on all biological beings.

g) **Foam and color** are indicators of contaminations.

h) **Micro-Organisms:** Pathogenic bacteria, viruses, etc are health hazards.

CHAPTER-II

METHODOLOGY

2.1 Introduction

To study the impact on ecological, pathological and biochemical aspects of water pollution of Bhima river and its tributaries due to industrialization and urbanization.

The information was collected from various departments of Maharashtra and this information data was taken into consideration to interpret and conclude.

Following departments of Government of Maharashtra had provided very vital and relevant information for the study. Preliminary, Secondary & Tertiary data were collected with the spirit to assertain impact of pollution of Bhima river and its tributaries on various ecological, pathological and biochemical aspects.

a. Water Resources Dept
b. Zilla Parishad
c. Water Supply Dept
d. Health Department
e. Maharashtra Jivan Pradikaran
f. Pune Municipal Corporation
g. Pimpri-Chincwads Municipal Corporation
h. Dehu Cantonment Board
i. Pune Cantonment Board
j. Municipal Council In basin of Bhima
k. Maharashtra Industrial Development Corporation
l. Panchayat Samiti in Bhima basin
m. Collector Office
n. SDM Office
o. Maharashtra Pollution Control Board Pune

p. Directorate of Industrial Safety and Health

q. Agricultural Department of Pune district.

r. Sasson Hospital, Pune

s. Primary Health Centre in basin of Bhima and its tributaries

t. Tahsildar offices in Bhima basin

For this study relevant data and information was also collected about the water supply and sewage water of the different villages and towns on the bank of Bhima and its tributaries. This study also includes positively the short term and long term remedies and solutions for the protection of ecological flora and fauna of Bhima river.

The basin of Bhima river from origin to Ujani Dam includes two municipal corporations, 10 municipal councils, 3 cantonments and 196 villages. Similarly in its basin and tributaries there are 10 industrial hubs, which are designed maintained and promoted by Maharashtra Industrial Development Corporation which are as follows;

- MIDC, Talegaon
- MIDC, Bhosri
- MIDC, Pimri-Chinchwad
- MIDC, Hinjawadi
- MIDC, Talawade
- MIDC, Chakan
- MIDC, Ranjangaon
- MIDC, Jejuri
- MIDC, Kurkum
- MIDC, Baramati

(Source: Information director Industry safety and health. Year)

In addition to above mentioned MIDCs industrial hubs there are 9 industrial co-operative units working on principle of co-operation. There are also mseveralajor Industrial units working in the basin of Bhima river and its tributaries. This study also extended to what will be the expenditure to reduce the pollution of the Bhima river in two categories

1. Short term remedies,

2. Long term remedies.

2.2 Hypothesis and Limitations

a) In every municipal corporation of India the water supply is about 100-135 ltrs/day/person while in Municipal council area water supply is 60-80 ltrs/day/person. In rural areas water supply is 40-50 lts/day/person. These parameters are not based on any logical reference, but this water supply is hypothetical presumption for the research work.

b) Sewage water created is around 60-80 ltrs/person/day. If water supply is 100 ltrs the sewage water gebnerated will be around 60-80 ltrs. This information is collected from Maharashtra Pollution control board, Pune for the following Villages:

a. Haveli, Tahsil

Bhivri, Bhaurapur, Hingangaon, Khamgaontek, Nirgudi, Bhavdi, Tulapur, Phulgaon, Waduk-Khurd, Dongargaon, Gurkhedao, Sangvi-Sandas and Nhavi-Sandas.

b. Indapupur, Tahsil

Bhavdi, Chandgaon, Khalton No.1, Agoti No1, Kalthon No.2 Ganga walan, Hingangaon, Taradgaon, Kandalgaon, Ajyoti, Pimpri-Kurd, Padast, Takralwadi, Kumbargaon,Dalas no1, Dalas No2, Dalas no 3, Diksal, Kalewadi No1.

c. Shirud, Thahsil

Vitthalwadi, Aligaon, Baga, Nangargaon, Mandav-Pharata, Tandli, Darekarwadi.

d. Mhawal, Tahsil

Kale, yedse, Mahagaon, Kadde, Chikalse, Ahirwadi, Baurud, Ade, Ozarde, Warul, Koturne, Chichwad, Shivli, Bhadawli, Thugaon, Malwandi, Dhore, Chandanwadi, Dhone, Dhamane, Gudumbre, Salunkbre, Dalunbre, Sangaonwade, Takwe, Taje, Pimproli, Patergaon, Naigaon, Sai, Nanoni, Parud, Ghonshet, Katwi, Rajpuri, Ambi, Mangrud, Mundware, Ambre, Warangwadi.

e. Khed, Tahsil

Wadgaon, Vatole, Chanduli, Manjrewadi, Nimgaon, Daundkarwadi, Saddegava, Chandus, Rohkal, Shelgaon, Sangurdi, Yelwadi, Khalubre, Dhanubre, Goregaon.

2.3 Classification of Bhima river by the Environment department

Government of Maharashtra Department of Environment had conducted various experiments and classified Bhima river and its tributaries as A1, A2, A3, & A4. The basic objective of classification of Bhima river water was guided by the following Principles.

1. The quality of river water for human consumption

2. Versantain pollution index

3. Guidline for location of Industrial units at the bank of Bhima river and its tributaries

4. Protection, promotion and preservation of environment in rural and urban area.

Table 2.1 : Categorization of Bhima river

Categorization of water	Probable use of water
A1	This type of river water after purification and disinfection can be used as a drinking water
A2	In this category the water can be made portable after performing processes like rapid filtrations followed by disinfection or full fledge water treatment plant

Categorization of water	Probable use of water
A3	This category of water is not fit for human consumption as well as fisheries, cattles and wild animals
A4	This type of water is not fit for human consumption but fit for fisheries, agriculture and cattles.

(Source: Report of Maharashtra Pollution Control Board, Pune Regional office.)

Table 2.2 : Water quality standards for Best Designated Usages

Category of Fresh Water	A1	A2	A3	A4
Best usage	Unfiltered public water supply after approved disinfection	Public water supply with approved treatment equal to coagulation sedimtation & dis infection	Not fit for human consumption Fish & wildlife Propagation	Fit for agriculture Industrial cooling & Process water
Chemical Qualitites : Maximum allowable concentration				
1.Toxic Substances				
Arsenic (As)	0.3mg/l	0.3 mg/l	1.0 mg/l	0.1 mg/l
Cadmium (Cd)	0.01 mg/l	0.01 mg/l	-	-
Chromium (Cr +6)	0.05 mg/l	0.05 mg/l	0.05 mg/l	0.2 mg/l
Cyanide (CN)	0.05 mg/l	0.1 mg/l	0.05 mg/l	0.2 mg/l
Lead (Pb)	0.1 mg/l	0.1 mg/l	-	0.1 mg/l
Boron (B)	-	-	-	2.0 mg/l
Mercury (Hg)	0.001 mg/l	0.001 mg/l	0.001 mg/l	-
Gross alpha activity	3 PCI/L	10-9 uc/ml	3 PCI/l	3PCI/l
Gross Beta activity	30 PCI/l	10-8uc/m	30PCI/I	3 PCI/I
2. Substances affecting health				
Fluroide (F)	1.5mg/l	1.5mg/l	-	1.0mg/l
Nitrate (NO3)	45mg/l	45mg/l	-	-
3. Substances affecting the potability of water				
pH	6.5 to 8.5	6.5 to 8.5	6.5 to 9.0	6.5 to 9.0
TDS	-	TDS	TD	-
Total Solids	1500 mg/l	1500 mg/l	-	-
Total Suspended Solids	25 mg/l	-	-	-
Total Hardness (CaCO3)	50 mg/l	-	-	-
Total Residual Chlorine	-	-	-	-
Electrical conduct at 25.C	-	-	1000x10-6 mhos	3000x10-6mhos
Free carbon Di Oxide	-	-	1.2 mg/l	-
Free Amonical Nitrogen	-	-	1.2 mg/l	-

Category of Fresh Water	A1	A2	A3	A4
Best usage	Unfiltered public water supply after approved disinfection	Public water supply with approved treatment equal to coagulation sedimtation & dis infection	Not fit for human consumption Fish & wildlife Propagation	Fit for agriculture Industrial cooling & Process water
Oil & Grease	-	-	0.1 mg/l	-
Pesticides	-	-	0.02 mg/l	-
Biotic Index	-	-	6.0 mg/l	-
Total Ammonical Nitrogen	1.5 mg/l	1.5 mg/l	-	50 mg/l
Chlorides (Cl)	600 mg/l	600 mg/l	-	mg/l
Sulphates	400 mg/l	400 mg/l	-	1000 mg/l
Copper (Cu)	1.5 mg/l	1.5 mg/l	-	-
Manganese (Mn)	0.5 mg/l	3.0 mg/l	-	-
Iron (Fe)	1.0 mg/l	5.0 mg/l	-	-
Sodium	-	-	-	-
Zinc (Zn)	15.0 mg/l	1.5 mg/l	5.0 mg/l	5.0 mg/l
Phenolic Compounda	0.002 mg/l	0.002 mg/l	0.05 mg/l	-
Alkyl Benzene sulphates	1.0 mg/l	1.0 mg/l	-	-
Mineral oil	0.3 mg/l	0.3 mg/l	-	-
Ammonia	1.5 mg/l	1.5 mg/l	-	-
BOD (5days 20.C)	2.0 mg/l (monthly average of atleast 10 samples)	5.0 mg/l (monthly average of atleast 10 samples))	10 mg/l	30mg/l
COD	-	-	-	150 mg/l
DO	Not less than 5 (mg/l average of atleast 100 samples)	4.0mg/l	Not less than 3 mg/l	Not less than 2 mg/l
Bacteriological standards: (MPN/100)	Coliform Bact. 250	Not greater than 5000	-	-

Source: Report of Maharashtra Pollution Control Board, Pune Regional office.

Table 2.3 : Classification of Bhima rivers and its Tributaries in context with utility of water for human consumption:

Sr. No.	Name of river	Classification			
		A-1	A-2	A-3	A-4
1.	Bhima river	Origin to Chasakman Dam	Chasakman Dam to Confluence of Mula-Mutha river, Pargaon	---	---
2.	Mina river	Origin to Wadaj Dam	Wadaj Dam to Confluence of Ghod river	---	---
3.	Ghod river	Origin to Dimbe Dam	Dimbe Dam to Confluence of Bhima river	---	---
4.	Wale river	Origin to Confluence of Bhima river	---	---	---
5.	Bhama river	Origin to Aashkheda Dam	Aaskheda Dam to Confluence of Bhima river	---	---
6.	Andhra river	Origin to Wadiwale Dam	Wadiwale Dam to Confluence of Indrayani river	---	---
7.	Kundali river	Origin to Shiravti Dam	Shiravti Dam to Confluence of Indrayani river	---	---
8.	Indrayani river	Origin to Lonavala Dam	Lonavala Dam to Confluence of Bhima river	---	---
9.	Pawana river	Origin to Pawana Dam	Pawana Dam to Ravet Bandhara	---	Ravet Bhandara to Confluence of Mula river
10.	Mula river	Origin to Mulshi Dam	Mulshi Dam to Wakad Bhandara	---	Wakad Bhandara to Confluence of Mutha river
11.	Mutha river	Origin to Khadakvasla Dam	Khadakvasla Dam to Vitthalwadi Bhandara	---	Vitthalwadi Bhandara to Confluence of Bhima river
12.	Bhima river	---	Pargaon (Confluence of Mula-Mutha) to Ujani	---	---

Source: Irrigation department, Government of Maharashtra

The modern settlements (Pimpri-Chinchwad Municipal Corporation & Pune Municipal Corporation in upper Bhima basin comes under category A-2, which is indication of the drinking water sources in adjoining rive banks, which can be used after due process like coagulation, rapid and filtration, followed by dis-infection or full fledge water treatment plant.

2.4 Filled Methodology:

The Spatial aspect of water pollution of Bhima river and its tributaries in Pune district is studied. These necessities the pattern of water pollution of Bhima river and its tributaries revealed through various graphs, charts and quantitative analysis of data. The data collected through primary and secondary sources were processed and represented by statistical and cartographic techniques. The various methods and techniques used are explained the work of systematic analysis has been accomplished mainly through the causes of water pollution and effect model of analysis availing the relevant section in the texts.

The special analysis based on this Methodology is covering a period of April 2009 to March 2010. The Maharashtra pollution control board and various departments of the state government have collected the samples of 22 different places every month and the river water tested once in 3 months for percentage of dissolve oxygen (DO), bio-chemical oxygen demand (BOD), nitrate total and fecal chloroform etc. for each river which are mentioned in detail in concerned chapters.

2.5 Sources of Data:

The river Bhima basin to Ujani Dam is covering area of two Municipal Corporation, ten Municipal Councils, Three Cantonment Boards and 196 Villages. The Bhima basin is having Industrial belt at Talegaon, Bhosri, Pimpri-Chichwad, Hinjawdi, Talaware, Charkan, Ranjangaon, Jejuri, Kurkum, and Baramati. This Industrial belt is established by Maharashtra Industrial Development Corporation is a premier body of Government of Maharashtra, which is dedicated for Industrial development infrastructure development and various issues related to Industrial development of the state. This basin is also having nine Industrial estates which are run on co-operative basis. The Bhima basin is having good soil and perinial water

supply, hence sugarcane crop is a natural choice of the farmers in the crop pattern. Co-operative sugar mills are also operating on large scale in these areas.

2.6 Secondary Sources:

It includes published and unpublished reports and abstract such as reports of Maharashtra Pollution Control Board, District Statistical Abstract, and Census hand book, Gazetteers. Agriculture bulletin published by Department of Agriculture Maharashtra State, Report of Maharashtra Industrial Development Corporation, Published and unpublished Documents of Irrigation Department. This document provides a rich back ground material in the form of quantitative and qualitative amount of information, which is both compressive and iterated. The offices of Tahsildars and Collector provided the data information regarding the distribution of crop irrigation methods, population distribution and settlement of civilization along the bank of Bhima and its tributaries. The data was also collected from Zilla Parishad offices, Panchayat Samiti offices of Pune and Pimpri-Chinchwad Municipal Corporation and Cantonment Boards in Pune District.

2.7 Other Sources:

- Pune District Gazetteer.
- Map of Pune district published by government of Maharashtra.
- Topographical Map of the survey of India.

2.8 Information collected from following sources:

a) Pune Municipal Corporation

b) Pimpri-Chinchwad Municipal Corporation

c) Talegaon Municipal Council

d) Lonawala Municipal Council

e) Daund Municipal Council

f) Baramati Municipal Council

g) Jejuri Municipal Council

h) Bhor Municipal Council

i) Saswad Municipal Council

j) Indapur Municipal Council

Cantonment Board:

1. Pune Cantonment Board

2. Dehu Cantonment Board

Sources of data

a) Collector of Pune office

b) Irrigation Department

c) Zilla Parishad, Water supply and health department of Zilla Parishad

d) Maharashtra Jeevan Pradhikaran

e) Maharashtra Pollution Control Board, Pune

f) Maharashtra Industrial Development Corporations

g) Panchayat Samiti's of Lonawala, Mulshid, Bhor, Haveli, Daund, Baramati, Indapur

h) District Health Officer

Possulate:

Table 2.4 : The water supply policy of state defines per capita water supply

Name of the Body	Per Capita of Water Supply per day
a) Pune and Pimpri-Chinchwad Municipal Corporation per capita water supply	100 – 135 Ltrs.
b) Municipal Council Area	60-80 Ltrs.
c) Village Panchayat Area	40-50 trs.

a) The water sewage is approximately 60-80% of supplied water, which is not properly cycled and treated ending in water sewage.

b) The expenditure for long term and short planning for prevention of water pollutiuon of Bhima and its tributaries is inference with the projection of information supplied by the target villages.

c) Sample survey of villages and collection of data of villages.

d) Data collection of population of villages and cities with their water supply.

e) Graphs, Charts and their Interpretation.

Objective:

To estimate and understand **"**an ecological, pathological, and bio-chemical impact of urbanisation and industrialisation on water pollution of Bhima river and it's tributeries, Pune district, Maharashtra, India**".**

Hypothesis:

Industrialization and Urbanization plays important role in water pollution of rivers.

The Bhima river is also called *Punya Dayini Bhima.* In South India, people give regards to Bhima river inthe same way as they do to Ganga. The Bhima river originates from the Sahyadri hills. According to the legends, when Lord Shankar came neat Bhima Shankar Mountain after killing the demon Tripurasur, he found that the Ayodhya's saintly king Bhimak was under penance at that place. King Bhimak begged for the blessings of Lord Shankar so that a pious river might originate from the sweat of Lord Shankar. Lord Shankar gave the desired blessings and accordingly, a river originated from his sweat. On the name of King Bhimak, this river was called as Bhima river. The river joins Krishna at Kurugadi in district Raipur, which is 25 km away from Gulbarg. A *Jyotirling* (glorifies symbol of Lord Shiva) namely, Bhima Shankar, and a religious place, namely Pandarpur, are located on the banks of this river.

Table 2.5 : The acreage under different crops in the various Talukas of Pune district (1942-43)

1	Maval	Mulshi	Junnar	Ambegaon	Khed	Haveli
	2	3	4	5	6	7
Rice	31,726	13,708	19,151	8,144	19,499	5,977
Wheat	8,804	1,619	15,365	1,490	10,900	2,525
Javari	13,592	14,732	46,951	5,090	46,596	83,996
Bajri	2,351	4,882	1,13,629	37,817	88,679	61,330
Ragi	5,146	2,617	3,566	5,468	8,003	1,583
Varai-Sawa	2,928	1,364	…	4,133	3,995	122
Gram	2,048	936	10,885	2,299	10,460	3,797
Tur	809	477	1,924	573	2,299	3,395
Math	4	86	5,129	982	2,332	1,398
Kulthi	126	259	5,937	1,542	3,827	1,769
Groundnut	612	48	2,241	1,876	9,658	950
Safflower	104	119	778	…	271	1,883
Nigerseed	…	775	…	3,310	6,459	1,322
Sugarcane	16	…	676	32	147	1,722
Potatoes	45	…	1,134	1,609	5,594	365
Green Vegetables	83	173	243	117	378	1,730
Mosambi	16	22	679	264	366	280
Other Fruit	49	92	1,522	333	700	1,736

Source: Office of the Superitendent of Agriculture, District Pune.

CHAPTER-III
BOUNDRIES AND SUBDIVISIONS OF PUNE DISTRICT PHYSICAL FEATURES AND NATURAL RESOURCES

Physical Features

Situation:

Pune (previously Pune) is lying between, 17' 54' and 19' 24' north latitude and 73' 19' and 75' 10' east longitude, has an area of about 6,027.5 square miles, and, according to the census of 1951, a population of 19,50,976 or 323.7 to the square mile. The district has the shape of a triangle with its base in the Sahyadri mountains on the west, and its apex in the extreme south-east corner near the point of confluence of the Bhima and Nira rivers.

Boundaries:

In the West, along the Sahyadris, Pune has a breadth of nearly eighty miles. from this it stretches about 130 miles south-east, sloping gradually from about 2,000 to 1,000 feet above the mean sea level, and narrowing in an irregular wedge-shape to about 20 miles in the east. It is bounded on the north by the talukas of Akola, Sangamner and Parner in Ahmednagar District; on the east by Parner, Shrigonda and Karjat, also in Ahmednagar District, and Karmala in Sholapur District; on the south by Malshiras in Sholapur District, and Phaltan and Wai in North Satara District ; and on the West by Roha, Pen and Karjat in Kolaba District, and Murbad in Thana District.

Sub-Divisions:

For administrative purposes, the district is divided into four prants, viz., Pune City, Haveli, Junnar, and Bhimthadi. The Pune city Prant comprises only one taluka, called the Pune City Taluka. This taluka consists of the areas of the Pune City Municipal Corporation (but excluding certain village areas falling within the revenue

jurisdiction of the Haveli taluka, viz., the entire village of Hingane Budruk and parts of the villages of Dhanori, Lohogaon, Vadgaon Sheri, Hadapsar, Kondhave Khurd Dhankawadi, Kothrud and Pashan), the Cantonments of Khadki (Kirkee) and Pune, and such parts of the villages of Ghorpadi, Mundhave and Wanawadi as are not included in the area of the Pune City Municipal Corporation.

The other three prants are made up of twelve talukas and one mahal Excluding Pune City Taluka, a taluka has on an average 114 villages, 1,04,376 population, and 458 sq. miles of area. The administrative divisions, with their area, number of villages and towns. and population according to the Census of 1951, are given below:-

Table 3.1 : Administrative divisions of Pune district (with area, number of villages and towns, and population according to census of 1951)

Prant	Name of taluka	Area in sq.miles.	No. of Villages	No. of Towns	Population
Pune City	Pune City --- Composed of –				
	Pune City Municipal	50.0	…	1	4,80,982
	Corporation *	5.4	…	1	59,011
	Pune Cantonment …	5.1	…	1	48,552
	Khadki Cantonment …				
	Parts of villages of Ghorpadi, Mundhave and Wanawadi not included in the Pune City Municipal Corporation area …	7.3	3	…	5,538
		67.8	3	3	5,94,083
Haveli	Haveli	514.9	117	6	1,80,653
	Mulshi	353.3	132	…	68,884
	Bhor	324.8	181	1	73,711
	Mawal	413.8	168	2	98,386
	Velhi (Mahal)	196.2	124	…	27,391
Junnar	Junnar	532.7	131	6	1,40,287
	Ambegaon	401.5	101	3	98,880
	Khed	539.4	155	2	1,26,457
	Sirur	610.5	77	2	1,03,108
Bhimthadi	Baramati	539.7	60	3	1,34,271
	Indapur	585.8	80	5	1,12,304
	Dhond	516.1	64	1	89,162
	Purandar	426.5	82	2	1,03,399
	Total	6,023.0 ×	1,475	36	19,50,976

Source: Pune district Gazatteer

(* The Pune City Municipal Corporation includes certain villages or parts of villages falling within the revenue divisions of Pune City Taluka and Haveli Taluka. The areas falling within the revenue division of Pune City Taluka are —(1) the entire villages of Bopodi and Yerawada (excluding the area forming part of the Khadki Cantonment), Kasabe Pune (excluding the area forming part of Pune Cantonment), parvati, Erandavana, Shivaji Nagar and Aundh, and (2) parts of the villages of Ghorpadi, Mundhawa and Wanawadi. Those falling within the revenue division of Haveli Taluka are:- (1) the entire village of Hingane Budruk, and (2) parts of the villages of Dhanori, Lohogaon, Vadgaon Sheri, Hadapsar, Kondhave Khurd, Dhankawadi, Kothrud and Pashan. Figures of area and population for portions of villages which lie outside the limits of Pune City Municipal Corporation are included in the figures given for the talukas in whose limits they lie.)

(= Some villages of the Mulshi taluka are still unsurveyed, and so the area of 353.3 sq. miles covers only the villages surveyed.)

(× The area figure of the district of Pune supplied to the Census authorities by the Surveyor General of India was 6,027.5 sq. miles. The area figures given by the Census authorities, which are reproduced in this table in column 3, were obtained by the Census authorities from the District Inspector of Land Records or from local records.)

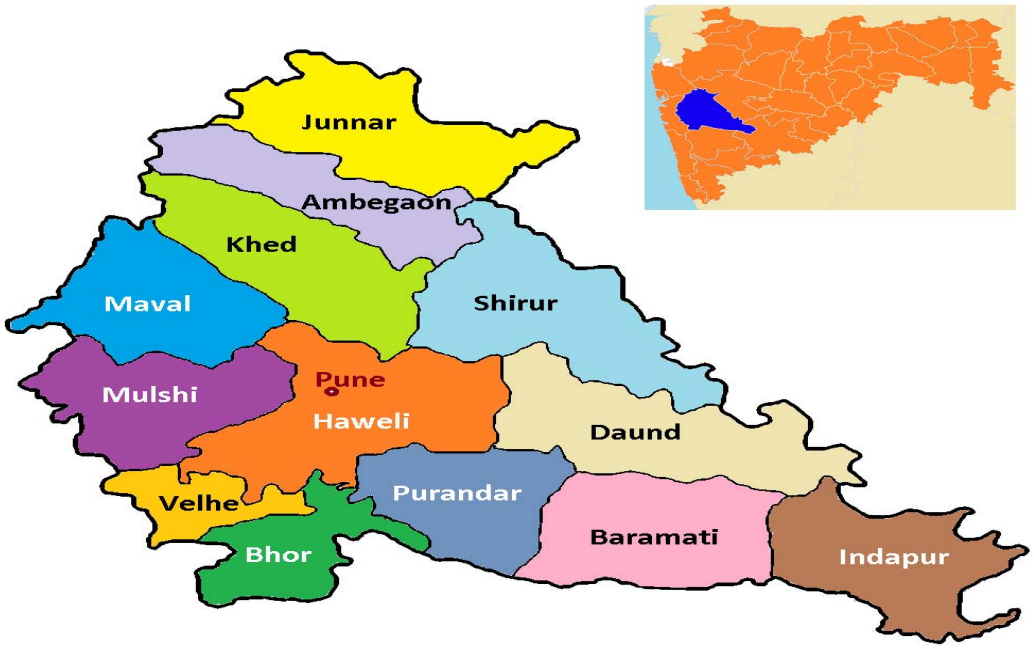


Fig. 3.1 : Different talukas of Pune district

Sub-divisions of Pune District:-

- District Subdivisions
- Baramati
- Baramati taluka
- Daund taluka
- Indapur taluka
- Bhor taluka
- Purandar taluka
- Velhe taluka
- Bhor taluka
- Pune[edit]
- Haveli taluka
- Pune City taluka
- Pimpri-Chinchwad City taluka
- Khed[edit]
- Khed taluka
- Ambegaon taluka
- Junnar taluka
- Shirur taluka
- Maval
- Maval taluka
- Mulshi taluka

List of talukas in Pune district by area

The table below list all 14 talukas of Pune district (except Pimpri-Chinchwad City taluka) in the Indian state of Maharashtra, along with district subdivision and location map in the district information.

Name of Taluka	District Subdivision	Location on District Map
Ambegaon	Khed	
Baramati	Baramati	
Bhor	Bhor	
Daund	Baramati	

Name of Taluka	District Subdivision	Location on District Map
Haveli	Haveli	
Indapur	Baramati	
Junnar	Junnar	
Khed	Khed	

Name of Taluka	District Subdivision	Location on District Map
Maval	Maval	
Mulshi	Maval	
Pune City	Haveli	
Purandar	Bhor	

Name of Taluka	District Subdivision	Location on District Map
Shirur	Khed	
Velhe	Bhor	

Aspects:

In the gradual change from the rough hilly west to the bare open east, the 130 miles of the Pune district from three belts. In the west are two or more less hilly belts ten to twenty miles broad (west-east) and seventy to eighty miles long (north-south). Beyond the second belt, whose eastern limit is roughly marked by a line passing through Pune north to Pabal and south to Purandar, the plain narrows to fifty and then to about twenty miles, and stretches east for about ninety miles. These three belts may be called as the Western, Central and Eastern Belts.

Western belt:

The western belt, stretching ten to twenty miles east of the Sahyadris, is locally known as Mawal or the sunset land. It is extremely rugged, a series of steppes or tablelands cut on every side by deep winding valleys and divided and crossed by mountains and hills. From the valleys of the numerous streams whose waters feed the

Ghod, the Bhima and the Mula-Mutha, hills of various heights and forms rise terrace above terrace, with steep sides often strewn with black basalt boulders. During the greater part of the year most of the deep ravines and rugged mountain sides which have been stripped bare for wood-ash manure have no vegetation but stunted underwood and dried grass. Where the trees have been spared they clothe the hill sides with a dense growth seldom more than twenty feet high, mixed with almost impassable brushwood, chiefly composed of the rough russet-leaved karvi (Strobilanthes Grahamianus), the bright green karvand (Carissa Carandas), and the dark-leaved anjani or ironwood (Memecylon edule). Here and there are patches of ancient evergreen forest whose holiness or whose remoteness has saved them from destruction.

Central Belt:

The central belt stretches ten to twenty miles east of the westen belt across a tract whose eastern boundary is roughly marked by a line drawn from pabal, about twelve miles east of Khed, south through Pune to Purandar. In this central belt, as the smaller chains of hills sink into the plain, the valleys* (*These valleys are locally known as ners, nawals, and khores, and are called either after the stream or after some leading village. In Junnar all the valleys are ners, Madh-ner, Kokad-ner, Bhim-ner, and Min-ner, called after the country-town of Madh and the Kukdi, Bhima, and Mina rivers. In Khed there is Bham-ner, the valley of the Bhima. The Mawal taluka consists of Andhar-mawal, Nane-mawal, and Paun-mawal, called after the river Andhra, the country-town of Nana, and the river Pavna. Further south there is Paud-khore, the valley of the country-town of Paud, and Musa-khore, the valley of the Musa, a tributary of the Mutha.) become straighter and wider and the larger spurs spread into plateaus in places broader than the valleys. With a moderate, certain, and seasonable rainfall, a rich soil, and a fair supply of water both from wells and from river beds, the valleys yield luxuriant crops. Except towards the west where in places is an extensive and valuable growth of small teak, the plateaus and hill-slopes are bare and treeless. But the lowlands, studded with mango, banian, and tamarind groves, enriched with patches of garden tillage and relieved by small picturesque

hills, make this central belt one of the most pleasing parts of the Deccan. Near Pune the country has been enriched by the Mutha canal, along which, the Mutha valley, from Khadakvasale to about twenty miles east of Pune, is green with crops of vegetables and cereals.

Eastern Belt:

East of the city of Pune the district gradually narrows from about fifty to twenty miles and stretches nearly ninety miles east, changing gradually from valleys and broken uplands to a bare open plain. During these ninety miles the land falls steadily about 800 feet. The hills sink slowly into the plain, the tablelands become lower and more broken, often little more than rolling uplands, and the broader and more level valleys are stripped of most of their beauty by the dryness of the air. The bare soilless plateaus, yellow with stunted spear-grass and black with boulders and sheets of basalt, except in the rainy months, have an air of utter barrenness. The lower lands, though somewhat less bleak, are also bare. Only in favoured spots are mango, tamarind, banian, and other shade trees, and except on river banks the babhul is too stunted and scattered to relieve the general dreariness.

Though it is very gradual the change from the west to the east is most complete. Rugged wooded hills and deep valleys give place to a flat bare plain; months of mist and rain to scanty uncertain showers; rice and nagli to millet and pulse; and thatched hamlets to walled flat-roofed villages. From Diksal, if a semi-circle is drawn with Daund (Dhond) as centre we get an area which comes within the 20" isohyet. This area records the lowest annual rainfall in the district.

Hills

Sahyadris:

The hills of the district belong to two distinct systems. One running, on the whole, north and south, forms the main range of the Sahyadris, about seventy-three miles in a straight line and about includes the narrow broken crested ridges and the

bluff flat-topped masses that stretch eastwards and gradually sink into the plain. The crest of the Sahyadris falls in places to about 2,000 feet, the level of the western limit of the Deccan plateau. In other places it rises in rounded bluffs and clear-cut ridges 3000 or 4000 feet high. The leading peaks are: In the extreme north, Hariscandragada whose mighty scarps, nearly 4670 feet high, support a plateau crowned by two low conical peaks. About ten miles to the south-west, at the head of the Kukdi valley and commanding the Nane pass, the massive rock of Jivdhan, its fortifications surmounted by a rounded grass covered top, rises about 1000 feet above the Deccan Plateau. About three miles south of Jivdhan, the next very prominent hill is Dhak. From the east Dhak shows only as a square flat tableland, but from battlements of the Sahyadris. Ten miles south-west of Dhak, where south, is the Sahyadris changes from about the Deccan plateau in gentle slopes, but falls west into the Konkan, a sheer cliff between 3000 and 4000 feet high.

From here several spurs branch off forming valleys in which the rivers Pushpavati, Mina, Khukdi, Ghod and several of their minor tributaries have their source. Eight miles south of Ahupe, and, like it, a gentle slope to the east and a precipice to the west, stands Bhimashankar, the sacred source of the river Bhima. About fourteen miles south comes a second Dhak, high, massive, and with clear-cut picturesque outline. Though its base is in Thana it forms a noticeable feature among the peaks of the Pune Sahyadris. Five miles further south, at the end of an outlying plateau, almost cut off from the Deccan, rises the famous double-peaked fort of Rajmachi. Ten miles south, a steep slope ends westwards in a sheer cliff known to the local people as Nag-phani (Cobra's hood) and to Europeans as the Duke's Nose. About six miles south of Nag-ppani and a mile inland from the line of the Sahyadris, rises the lofty picturesque range known as the Jambulni hills. Further south the isolated rocks of Koiri and Majgaon command the Ambavni and Amboli passes. Six miles further is the prominenet bluff of Salter (3530 ft.), and fifteen miles beyond is Tamhini (3151 ft.), the south-west corner of Pune.

The Tamhini range goes to the east for about 25 miles separating the Mula and the Mutha valleys. On this spur there are several peaks above 3400 feet. Koludat

is 3587 feet. About four miles from the Koludat peak is the Mahadeo peak (3949 feet).

About a mile and half to the east of Mahadeo is Guruduhi peak (3561 ft.) The Tamhini spur slopes towards the northern edge of the Khadakvasle lake. About four miles north of Tamhini is the Pondi peak (3183 feet). From Saltar three miles to the south-west is the flat topped Sudhagad fort. Three miles to the south of Pondi is another peak Dipat (3294 feet).

Minor Ranges:

From the main line of the Sahyadris four belts of hills run east wards. Of these, beginning from the north, the first and third consist of parallel ridges that fall eastwards till their line is marked only by isolated rocky hills. The second and fourth belts are full of deep narrow ravines and gorges cut through confused masses of hills with terraced sides and broad flat tops.

The north belt, which is about sixteen miles broad, corresponds closely with the Junnar taluka. It has three well-marked narrow ridges, the crests occasionally broken into fantastic peaks, and the sides sheer rock or steep slopes, bare of trees, partly under tillage and partly under grass. The north most ridge stretches from Harishchandragad along the Pune boundary and on to Ahmadnagar. South of this ridge two short rnages of about twenty miles fall into the plain near Junnar. The chief peaks in the northern spur are: Hatakeshvar, about five miles north of Junnar and more than 2000 feet above the Junnar plain, a lofty flat-topped hill which east in a series of jagged pinnacles. It forms the eastern end of the spur that divides the Madhner and Kokadner valleys. About half-way between Hatakeshvar and the Sahyadris, on a half-detached ridge at right angles to the main spur, is Hadsar, a great fortified mass, which with rounded top rises about 1200 feet from the plain, and ends westwards in a rocky fortified point cut off by a chasm from the body of the hill. About four miles to the south-west, guarding the right bank of the Kukdi, Chavand rises about 700 feet from the plain. It is a steep slope crested with a scarp sixty to a hundred feet high, whose fortifications enclose a rounded grassy head. Fourteen miles

further east, Shivner, part of the broken ridge which separates the Kukdi and the Mina, rises from a three-cornered base about 800 feet from the plain and commands the town of Junnar. Its long waving ridge is marked for miles round by a flying arch, which stands out against the sky between the minarets of a mosque. Sixteen miles south-east, isolated, but like chavand and Shivner marking the line of water parting between the Kukdi and the Mina, is the ruined hill-fort of Narayangad. It has a clear-cut double-peaked outline, the western and higher peak being crowned by a shrine. South of these, a spur, thirty-five miles long, forms the south wall of the Mina valley.

South of the crest of this spur, for about fifteen miles, the second belt of eastern hills stretches a confused mass of uplands separated by abrupt gorges, their steep slopes covered in the west with evergreen woods, and in the east with valuable teak. The slopes are broken by terraces with good soil which are cultivated in places, and their tops stretch in broad tilled plateaus which often contain the lands of entire villages. In this belt of hill land several peaks rise from the centre of a large plateau, such as Nayphad (3389 feet), south of Dhumalwadi (3767 feet). Through this upland region the Ghod having its source near Ahupe, and the Bhima having its source near bhimashankar flow through narrow valleys. At the southern limit of this hill region, on the north of the Bhama valley, are two conical hills Shinga (4243 feet) and Kundeshwar (4086 feet).

The third belt like the first belt includes several spurs or ridges. Of these the five chief spurs are:

(i) The Tasubai ridge (3766 feet) between the Bhama and the Andra ending a few miles west of Chakan. This ridge ends with the hill of Bhamchander (2177 feet). The great saint Tukaram lived on this hill.

(ii) Shridepathar about twelve miles long dividing the valleys of the Andra and the Kundali.

(iii) The Vihirgaon spur about ten miles long separating the Kundali and the Indrayani valleys.

(iv) The Sakhupathar plateau from which an offshoot with the four peaks of Lohgagad (3412 feet), Visapur (3567 feet), Bhatrasi (3621 feet) and Kudwa separates the valleys of the Indrayani and the Pavna.

(v) Further south within Bhor limits in the Pavna valley is the fifth spur from which rise the peaks of Tung (3521 feet), Tikona (3480 feet) and Mandvi (4121 feet). This spur divides the Pavna and the Mula valleys.

The fourth belt of east-stretching hills is further to the south, in the Mulshi taluka, where the Mula and its seven tributaries cut the country into a mass of hills and gorges. This is almost as confused as the second belt of hills, but has fewer trees and more tillage, the hill-sides being less terraced and the hill tops narrower. South of Mulshi, a belt of about twenty miles broad cuts off Pune from the main line of the Sahyadris. Though separated from the main line of the Sahyadris the south-west of the district is not without hills. Starting 2000 feet from the plain in the scarped flat-topped fort of Sinhgad, a range of hills stretches east for seven miles, and near the Katraj pass, divides in two, one branch, with well-marked waving outline stretches about fifteen miles to the fortified peak of Malhargad. From Malhargad it passes nine miles to Dhavleshvar, and from Dhavleshvar about six miles to the famous temple of Bholeshvar. Beyond Bholeshvar, for about fifty miles to near Indapur, the line is still marked by low hills, rolling downs, and barren uplands. The second branch, after leaving the main range close to the Katraj pass, turns south-east for twelve miles, and, with several bold spurs, centres in the fortified mass of Purandar. Out of the same mountain mass rises, from the level of the lower Purandar fort, the fortified peak of Vajragad which commands the lower and main fort of Purandar. Beyond Purandar the range forms the water-parting between the Karha and the Nira rivers, and, after stretching ten miles further east, is prolonged in low bare hills and stony ridges to near Baramati. About fourteen miles east of Purandar, above the village of Jehuri, at

the end of the last ridges, of any noticeable height, is the small plateau of Kharepathar which is occupied by an ancient much venerated temple of Khandoba.

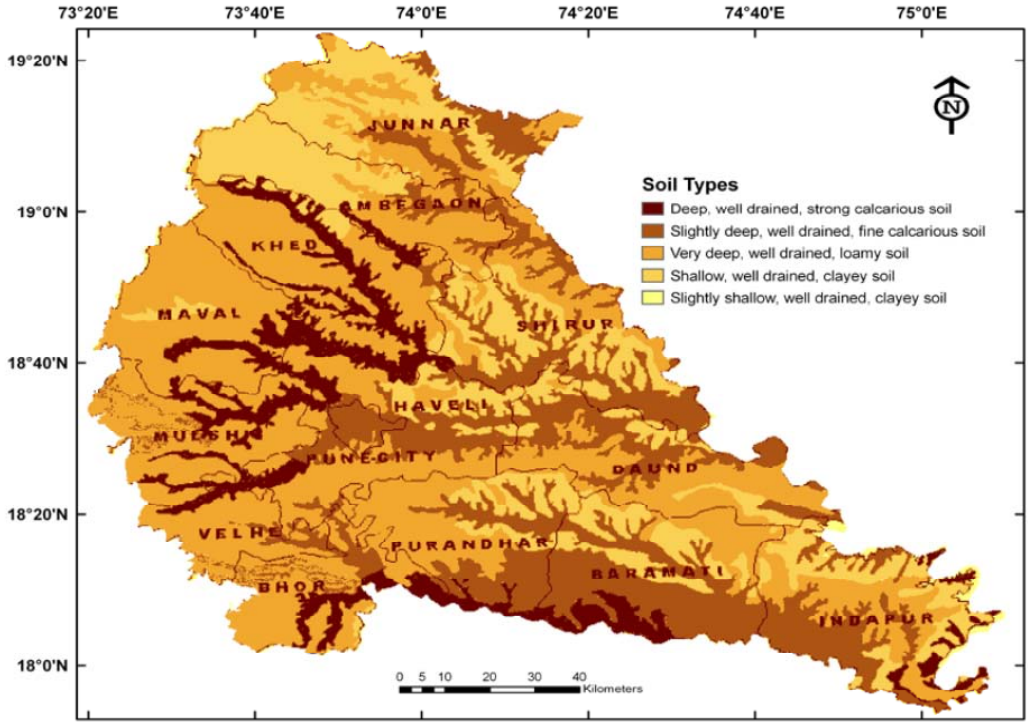


Fig 3.2 : Geographical features of Pune District

River systems:

Pune is crossed by many rivers and streams, which take their rise in and near the Sahyadris, and, bounded by the east-stretching spurs, flow east and south across the district. The chief river is the Bhima, which crosses part of the district and for more than a hundred miles forms its eastern boundary. The main tributaries of the Bhima are the Vel and the Ghod on the left, and the Bhama, the Indrayani, the Mula or Mula-Mutha, and the Nira on the right. Besides the Bhima and its feeders there are seven river: the Kukdi and the Mina, tributaries of the Ghod; the Andra, a tributary of the Indrayani; and the Shivganga and the Karha, tributaries of the Nira. The Pushpavati with its feeder the Mandvi is a minor stream which flows into the Kukdi, and the Pavna is a feeder of the Mula. During the rainy season all of these rivers flow

with a magnificent volume of water and during the hot season shrink to a narrow thread in broad stretches of gravel. At intervals barries of rock cross the beds damming the stream into long pools.

Bhima:

The famous temple of Bhimashankar on the crest of the Sahyadris, twenty-five miles north of Khandala, marks the source of the Bhima. From a height of about 3000 feet above the sea, the river falls over terraces of rock osme 600 feet in the first five miles. Further east, with a general course to the south-east, it flows thirty-six miles through the very narrow and rugged valley of Bhimner. On its way it passes the large villages of Vade, Chas, and Khed, and near the village of Pimpalgaon from the right receives the water of the Bhama, and at Tulapur the waters of the Indrayani. From Tulapur it bends to the south, skirting the Haveli taluka, and after receiving from the left the waters of the Vel about five miles below Talegaon-Dhamdhers, it turns again north-east, to Mahalungi, a point sixteen miles east of Tulapur. Then running south for about nine miles, at the village of Ranjangaon it is joined from the right by the Mula-Mutha. This point is 1951 feet above the sea level or 475 feet below the village Vade. From Ranjangaon the Bhima runs south-east with a winding course of about fourteen miles, till, on the eastern border of the district, it receives from the left the waters of the Chod. After meeting the Ghod, the Bhima's course is very winding, the stream at Diksal flowing north-west for some miles. Finally at the extreme south-east corner of the district, after a deep southward bend round the east of Indapur, it is joined from the right by the Nara. The banks of the Bhima are generally low and after its meeting with the Indrayani are entirely alluvial. Here and there, where the winding stream has cut deep in to the soft mould, are steep banks of great height, but in such places the opposite bank is correspondingly low. In places, where a ridge of basalt throws a barrier across the stream, the banks are wild and rocky, and the water, dammed into a long deep pool, forces its way over the rocks in sounding rapids. Except in such places the bed of the Bhima is gravelly and in the fair season has but a slender stream. Here and there muddy deposits yield crops of wheat or vegetables and even the sand is planted with melons.

Vel:

The Vel rises at Dhakale in a spur of the Sahyadris near the centre of Khed. It flows south-east nearly parallel with the Bhima, and, about five miles below Talegaon-Dhamdhere, falls into the Bhima after a course of nearly forty miles.

Ghod:

The Ghod rises near Ahupe on the crest of the Sahyadris, nine miles north of the sources of the Bhima, at a height of about 2700 feet above the sea. A steep winding course, with a fall of about 800 feet, brings it sixteen miles east ot Ambegaon. From Ambegaon it runs east-south- east, and passing the large villages of Ghode and Vadgaon on the north border of Khed, is joined from the left by the Mina. From here for about twenty-five miles till it receives the Kukdi, about six miles above the camp of Sirur, and for about twenty miles further till it falls into the Bhima, the Ghod with a very winding course keeps, on the whole, south-east along the Pune Ahmadnagar boundary. Near the Sahyadris the course of the Ghod is varied and picturesque, the stream dashing over rocky ledges or lying in long still pools between woody banks. At Pargaon, where it is joined by the Mina about forty-five miles from its source, the valley changes into the level plain of Kavthe, about ten miles wide, through which the Ghod flows over a rocky bed between bare banks. The water of the Ghod is famed for its wholesomeness, a character which analysis bears out.

Bhama:

The Bhama rises in the Sahyadris about six miles south of Bhimashankar. It winds between banks 150 feet high down the valley to which it gives the name of Bhammer, and after a south-easterky course of about twenty-four miles, falls from the right into the Bhima near the village of Pimpalgaon. The Bhama valley from its beginning about seven miles east of the Sahyadris, continues level, and gradually widens eastward for fourteen miles. The stream flows 150 feet below the cultivated lands, which are on a higher terrace.

Indrayani:

The Indrayani rises near Kurvande Village at the head of the Kurvande pass on the crest of the Sahyadris about three miles south-west of Lonavale, and flows on the whole east through the Nane maval and past the village of Name till after sixteen miles it is joined on the left by the Andra. It then enters the open country and passes twelve miles east fo Dehu, a place of Pilgrimage sacred to the Vani saint Tukaram. From Dehu it flows twelve miles south-east by the village of Alandi, a place of pilgrimage sacred to Dnyaneshvar, and after keeping south-east for about twenty miles, turns and meets the Bhima near Tulapur after a course of about sixty miles.

Mula-Mutha:

The Mula or Mula-Mutha is formed of seven streams which rise at various points along the crest of the Sahyadris between eight and twenty-two miles south of the Bor pass. The united stream keeps nearly east to Lavla about five miles east of the village of Paud which gives the valley the name of Paud-khore. From Lavla, with many windings, it passes east to Pune, receiving on the way the Pavna on the left, and at Pune the Mutha on the right, and then under the name of Mula-Mutha winds east till at Rangangaon Sandas it reaches the Bhima after a total course of about seventy miles.

Nira:

The Nira has its source in the Bhor taluka in the spur of the Sahyadris which is crowned by the fort of Torna. It flows north-east till it reaches the southern border of Pune where it is jointed from the north by the Shivaganga. From this it turns east and forms the southern boundary of the district, separating it from Satara North and Sholapur. It finally falls into the Bhima at the south-east corner of the district near Narsingpur after a course of about hundered miles.

Kukdi:

The Kukdi rises at Pur, two miles west of Chavand near the Nane pass in the north-east corner of the district, and runs south-east by the town and fort of Junnar twenty-four miles to Pimpalvandi From Pimpalvandi it flows south-east for thirty miles, passes into the Parner taluka of Ahmadnagar, and falls into the Ghod six miles north-west of the Sirur camp on the eastern border of the Sirur taluka. The valley of this river occupies greater part of Junnar.

Mina:

The Mina rises on the eastern slope of Dhak in the west of Junnar and flows east through the rich vale known as Minner. In the rainy season, during the first two miles of its course, the river overflows its banks and causes much damage. In the lands of the Kusur village, about fifteen miles from its source, the river is crossed by a dam known as the Tambnala dam. From this the Mina flows to Narayangaon on the Pune-Nasik road, where there is another useful dam for irrigation. There is also a dam at Vaduj two miles south-east of Kusur. Past Narayangaon, where it is crossed by a bridge, the Mina joins the Ghod at Pargaon, leaving the fort of Narayangad to its left.

Andra:

The Andra rises in the Sahyadris near the Savle pass about 2250 feet above the sea. It source is at the head of a broad valley which runs west to the crest of a scarp whose base is in the Konkan. It flows south-east along a bed 100 to 150 feet below the cultivated land, through one of the openest valleys in the district, for eighteen miles, and joins the Indrayani on its north bank near the village of Raipuri.

Mutha:

The Mutha, which gives its name to Mutha-khore (glen Mutha), rises in a mass of hills on the edge of the Sahyadris nearly 3000 feet above the sea. From the hill-side it enters a gorge or valley so narrow that the bases of the hills stretch to within forty or fifty yards of the river-bank. During the first twenty miles of its course the Mutha flows through the Bhor taluka. Immediately after entering the Pune district

the current of the river is chekced by the great Khadakvasle dam about ten miles further down. This dam has turned the valleys of the Mutha and of its feedrs the two Musas into a lake about fifteen miles long and half a mile to a mile and a half broad. Below the dam the Mutha flows north-east past the Parvati hill by the north-west limit of the city of Pune, till it joins the Mula at a point known as the sangam (meeting).

Karha:

The Karha rises a few miles east of Sinhagad and with a south-easterly course of less than sixty miles through the Purandar and Baramati talukas falls into the Nira near Songaon in the south-eastern corner of the Baramati taluka.

Shivganga:

The Shivganga rises on the south slopes of Sinhagad and flows east for about six miles to Shivapur and south for about ten miles to Nasrapur, where it is joined by the Khanind. From Nasrapur, under the name of Ganjavni, it passes south-east for about six miles and falls into the Nira near Kenjal in Purandar.

Pushpavati:

The Pushpavati rises near the Melsej pass at the north-west corner of the Junnar taluka. It flows down Madhner by the villages of Pimpalgaon-joga and Udapur, nearly parallel to the Mina river, and joind the Kukdi at the Village of Yedgaon, about eight miles east of junnar. Near Udapur the river is known by the name of Ad.

Pauna:

The Pauna rises on the crest of the Sahyadris south of the range of hills which forms the southern border of the Indrayani valley and includes the fortified summits of Lohogad and Visapur. It flows at first nearly east along the winding vale of Pava (Pavna-maval), till, leaving the rugged westlands, it turns south-east, and, after a vety

winding course, joins the Mula from the north near Dapudi. At the village of Ambegaon, about six miles east of its source, the bed of the Pavna is about 1820 feet above the sea.

Lakes:

The district has no natural lakes, but several artificial lakes provide a considerable supply of water for drinking and irrigation and for the generation of electricity. Khadakvasle, Katraj and Pashan are in Haveli Taluka and they supply Pune City and the cantonments of Pune and Khadki with drinking water, and Khadakvasle is an important source of canal irrigation. Out of the five lakes which store water for the Tata-Hydro- Electricity Companies, four, namely Shiravate, Walwhan, Lonavale and Andra, are in Mawal Taluka and the fifth viz., Mulshi Lake is in Mulshi Taluka. In the eastern part of the district are situated the lakes at Kasurdi in Baramati Taluka ; at Bhadalwadi and Shetphal in Indapur Taluka ; at Shirsuphal, Pimpalgaon (Matoba) and Khamgaon in Daund Taluka ; and at Rakh in Purandar Taluka

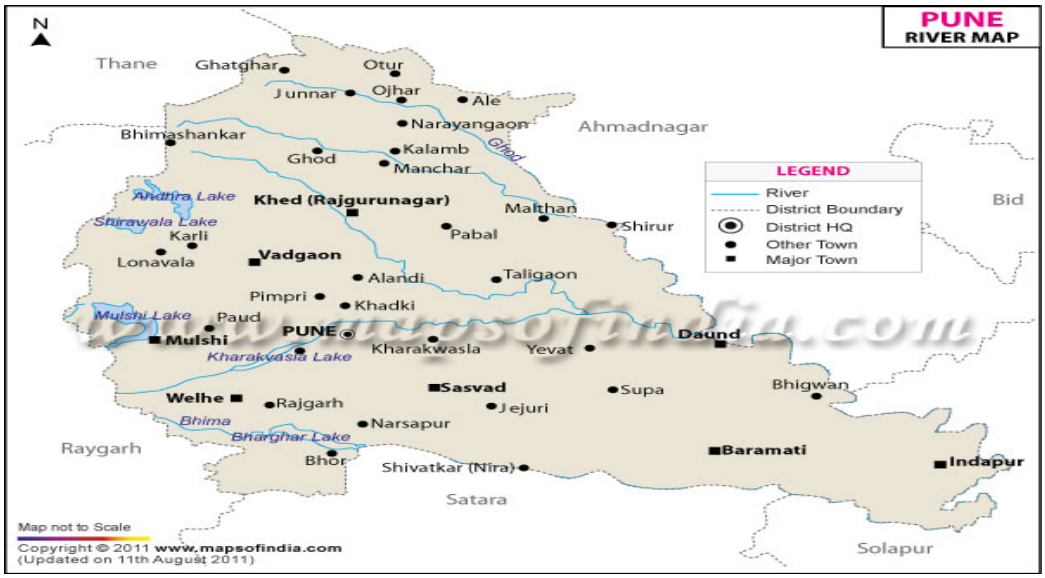


Fig 3.3 : Differenct rivers of Pune district

Besides these more important lakes there are many locally important tanks used mainly for drinking purposes. A number of bunds (bandharas) for catchment of water for irrigational purpose have been recently prepared or reconditioned. Of these the more important ones are at Ane, Basti, Kusur, Narayangaon, Otur, Pimpal-wandi, Pimpari-Pendhar, Savargaon Udapur, Vadaj and Yedgaon in Junnar Taluka ; Avsari and Thugaon in Ambegaon Taluka ; Dondle, Haveli Taluka ; Belsar, Bhivadi, Dhalewadi, Hibare, Kamthadi, Taluka ; Dongargaon, Kolawali, Kondhavale, Lawale, and Valane in Mulshi Taluka; and Kapurvahal in Bhor Taluka.

Geology*

*(*This section is extracted from "A Note on the Geology of Pune District" by Shri Y.S.Sahasrabudhe of the Geological Surveyof India.)*

General:

Almost all the rocks of the Pune district are varieties of Deccan trap-basalts. They were formed by the outpouring of enormous lava flows which spread over vast areas encompassing about 2,00,000 square miles in western and central India. Because of the tendency to form flat-topped plateau-like features and their dominantly basaltic composition, the lavas are called "Plateau basalts." Such flows are called "traps" because of their step-like or terraced appearance. The rock is dark grey to greenish grey in colour. Brownish to purplish tints are also met with. The specific gravity is 2.9 on an average. Generally two types are seen. The non-vesicular types are hard, tough, and compact and medium to fine grained, with conchoidal fracture. The vesicular or amygdular types are comparatively soft and break more easily.

Structural features:

The rocks exhibit a tendency to spheroidal weathering by the exfoliation of roughly concenteric shells and hence rounded weathered masses called "boulders" are very common. These are seen generally scattered along the foot hills of the hilly terrain throughout the whole district. Another structural feature is the prismatic and

columnar jointing. These are generally observed in the step-like series of perpendicular escarpments on the hill sides and slopes of the narrow winding valleys. These are well marked on the low tableland of Karde, Sirur, Khandale, between Talegaon and Lohgad and at Bor-ghat. They are also observed west of Yevat, Kadur, Khed and near Nane-ghat.

Petrology:

The Deccan traps consist mainly of plagioclase (labradorite), enstatite-augite, small amounts of titaniferous iron-ore and glass. A little olivine is also present. Occasionally olivine is represented by iddingsite, etc. In the vesicular variety the vesicles are partly or completely filled with secondary minerals like zeolites, calcite, crystalline and amorphous quartz such as rock crystal, chalcedony, agate, jasper, etc. Palagonite is of common occurrence in the lining of vapour cavities and are well noticed near Harishchandragad, Karle, Junnar, Nane-ghat and other localities. Sometimes the amygdules are filled by stilbite. These are marked in Parvati Hill near Pune and Sirur.

Inter-trappean beds:

During the interval which elapsed between successive eruptions of lava there came into existence some rivers and fresh water lakes in the depressions and in places where there was obstruction to drainage. The fluviatile and lacustrine deposits formed therein are intercalated with the lava flows and are of small horizontal extent, generally 2 to 10 feet thick. They comprise sandstones, limestones, shales, clays and pyroclastic materials. They are known as inter-trappean beds. Limestones of this nature are noticed at Phaltan, Kedgaon and Patas.

Basalt dykes:

The basaltic dykes of the district are all upright and do not seem to have caused disturbance or dislocation in the strata of basalt. Two dykes about 4 feet wide run obliquely across the Indrayani valley, 35 miles north-west of Pune, and intersect

each other. The Bor-ghat road which runs through this valley to Panvel is frequently crossed by ridges which are presumed to be outcrops of dykes. Small dykes are seen near Pune Cantonment and at the southern slopes of the hills near Bosri and Dighi. These dykes are to be regarded as feeders for the trap flows and are expected to be present underneath the main mass of traps. In general they show regularity in direction, thickness and size.

Laterite and soils:

Laterite is a kind of vesicular clayey rock with characteristic red and brown colour and is composed essentially of a mixture of the hydrated oxides of alumina and iron. The iron oxide generally preponderates and gives to the rock its prevailing red colour. It caps the summit of some fo the hills of high altitudes in the district. Low grade bauxites rarely occur in some of the hills. The traps give rise to either a dep brown to rich red soil or "regur" (black cotton soil), as seen in the plains all over the area. The ‘regur’ is rich in the plant nutrients such as lime, magnesia, iron and alkalies. It has the property of swelling greatly and becoming very sticky when wetted by rain. On drying, it contracts again with numerous cracks.

Minerals:

Being dense, hard and durable, the rocks of the district are used extensively as building stones. They are excellent for macadam and tarred roads and are among the best materials obtainable in India. Thery are hard, tough, water-resisting and have good binding properties. They are also excellent for use as aggregates in cement concrete. They are quarried on a large scale near Chinchwad, Yeravade, etc. Compact dark varieties take a high polish and are used in carving work. Weathered traps, moram, along the slopes of the cliff sections are quarried all over the district for flooring. Zeolites and calcites are powdered and used as rangoli for decorating houses. Irregular nodules of Kankar and gypsum occur in the soil at a number of places, especially in the eastern parts of the district. Kankar is locally used for lime burning.

Climate*

(**For this section an article on "The Climate of Pune" by Dr. S.K. Pramanik, M.sc., Ph.D., D.I.C., Indian Meteorological Department, has been largely drawn upon.*)

POSSESSED of a high altitude, a soil free from alluvial deposits and prevalence of westerly breezes, Pune has a climate dry and invigorating.

Seasons:

The year may be divided into three seasons, the cold season from November to February, the hot season from March to May, and the wet season from June to October. In the cold season dry easterly land winds prevail during most part of the day and coll westerly valley winds in the night, and from February onwards, there is sea-breeze in the evening. By about the middle of March, the temperature rises somewhat rapidly and hot breeze of variable direction prevails during day time. The hot season may be said to begin in the middle of March and end by June, though the hot winds and other characteristics of the hot weather are mostly over by the middle of May. In April and May the maximum temperature at Pune and several other places in the district often rises above 100’F and temperature as high as 108-110’F have been recorded.

At the beginning of the hot weather the wind blows from the east in the morning and from the west in the afternoon. The sea breeze that sets in towards evening on most days in the months of February to May brings considerable relief on hot days during evening and the early part of the night. Thunderstorms occasionally alleviate the heat but the precipitation sometimes renders the air sultry.

During the hot season there is haze. April and May, though the hottest, are not the driest months. In the east and centre of the district, sometimes early in May, but as a rule not till towards the close of the month, after three or four oppressive days, in the afternoon clouds gather in the east in great masses, and with a strong blast from

the north-east, drive west with thunder and heavy rain. The thunderstorms are occasionally accompanied by violent winds, and sharp showers, and also hail on rare occasions.

Rainfall:

Over the whole district the chief supply of rain is from the south-west monsoon which begins about the middle of June and lasts till the end of October. The returns show marked variations from year to year at the different rain stations.

Rainfall statistics are available for 16 stations in different parts of the district. The following table gives these statistics:-

Table 3.2 : Rainfall in Pune district

Name of Place	Years	N. Latitude	E. Longitude	Average No. of rainy days	Mean rainfall	Maximum		Minimum	
						Year	Inches	Year	Inches
1	2	3	4	5	6	7	8	9	10
Lonavla	1888-1940	18° 45’	73° 24’	…	170.08	1931	249.98	1899	67.13
Paud	1878-1940	18° 31’	73° 37’	78.3	59.84	1914	88.24	1918	24.93
Vadgav (Mawal)	1878-1940	18° 44’	73° 38’	64.6	41.83	1933	65.69	1918	17.51
Talegaon Dabhade	1888-1909	18° 43’	73° 41’	…	38.25	1896	56.52	1899	21.28
Junnar	1878-1940	19° 12’	73° 53’	53.4	28.81	1933	48.46	1918	12.68
Ghod	1878-1940	19° 3’	73° 50’	51.4	29.00	1933	55.06	1918	10.32
Khed	1878-1940	18° 50’	73° 53’	45.1	25.87	1933	48.14	1918	10.26
Alandi	1888-1940	18° 41’	73° 54’	42.9	23.36	1933	41.31	1918	10.97
Pune	18881940	18° 30’	73° 53’	48.1	26.63	1892	50.91	1899	13.20
Saswad	1878-1940	18° 28’	73° 58’	42.9	22.02	1892	43.98	1923	9.26
Daund	1892-1940	18° 28’	74° 34’	33.7	18.14	1892	33.75	1911	9.33
Baramati	1878-1940	18° 10’	74° 39’	37.0	20.02	1892	41.80	1923	8.85
Indapur	1878-1940	18° 8’	75° 5’	36.7	21.76	1916	46.38	1936	7.75
Sirur	1888-1950	18° 49’	74° 23’	33.6	20.05	1916	40.03	1918	9.69
Talegaon Dhamdhere	1888-1950	18° 40’	74° 10’	36.9	21.27	1932	38.21	1936	8.28
Jeluri	1888-1950	18° 18’	74° 8’	36.5	19.84	1892	44.50	1936	10.68

Source: District Gazzetteer of Pune district

Lonavle is situated at the crest of the Sahyadris at the head of the Bor pass, at a distance of about 40 miles west of Pune. As compared to all the other stations in the district, the rainfall at Lonavle, viz., 181" (mean for 52 years), is several times more. Its location is responsible to divide the district into three regions, the western, central and eastern.

The Western region, represented by Paud, Vadgaon (Mawal) and Talegaon-Dabhade and lying between Pune and Lonavle, is situated in the lee of the Sahyadris and consists of its slopes and a few miles beyond to the east. This region falls west of longitude 73' 45'E. It has a certain and fairly sufficient rainfall. The mean is 63.91" for Paud, 40 Vadgaon (Mawal) and 38.25" for Talegaon-Dabhade. During a period of 62 years, Paud had more than 40 inches for 59 years and Vadgaon recorded more than 40" for 30 years and more than 30" for 48 years.

The central region lies between longitudes 73' 45' and 74'E. This region may be further sub-divided into two, viz., the northern, above latitude 19'N., represented by Junnar and Ghod, and the southern represented by Khed, Alandi, Pune and Saswad. The northern sub-region shows a higher mean than the southern one. The mean for Junnar is 53.4" and for Ghod 51.4". The mean for Khed is 25".; for Alandi 22.56" ; for Pune 26.63" ; and for Saswad 24.98". Over a period of 62 years, more than 20" was recorded at Junnar for 54 years and at Ghod for 55 years. Over the same period, Khed and Saswad recorded more than 20" for 53 years and 34 years respectively. Over a period of 52 years, Pune and Alandi recorded more than 20" for 40 years and 36 years respectively. It will be noticed that though the rainfall is less in the central region than in the western region still it is steady.

The part of the district east of longitude 74'E forms the eastern region. This region consists mostly of undulating plains. The range of hills that start from the Sahyadris and go west-east almost slope into these plains. This region is reputed to be a region of uncertain rainfall. But this region may be divided into two sub-regions, one of which is the area round about Daund, Baramati and Indapur. Daund is situated on the Bhima and is 48 miles to the east of Pune. Baramati is situated on the Karha

and is 50 miles south-east of Pune. Indapur is 80 miles south-east of Pune. These three stations from the south-east portion of the district and are between the Bhima and the Nira rivers. The southern part of the triangle comes under the Nira Canal systems. The records for these stations show more rainfall as compared to the other stations in the eastern zone. Daund, Baramati and Indapur have more or less the same mean rainfall, viz., 25". Over a period of 49 years, Daund recorded more than 20" for 19 years and more than 15" for 33 years. Over a period of 62 years Baramati and Indapur recorded more than 20" for 28 years and 35 years respectively, and more than 15" for 50 years and 52 years respectively. Sirur, Talegoan-Dhamdhere, and Jejuri represent the other sub-region of the eastern region. They have a mean rainfall round about 20". Over a period of 62 years, Sirur, Talegaon-Dhamdhere, and Jejuri recorded more than 20" for 24, 31 and 19 years respectively, and more than 15" for 39, 45 and 34 years respectively. The area represented by these three stations has the lowest and most uncertain rainfall in the district.

Temperature:

In contrast to the maritime climate experienced by stations like Mumbai on the west coast, Pune enjoys & continental climate characterised by large diurnal ranges of temperature. The following table is based on observations from 1881 to 1940 and gives the means of daily maximum and minimum for each month for Pune. The table also gives the highest temperature recorded and the lowest recorded in each month.

Table 3.3 : Monthly maximum and minimum temperature range of Pune

Month	Mean (of)		Mean (of)		Extreme			
	Daily Max.	Daily Min.	Highest in the Month	Lowest in the Month	Highest recorded	Dateand year	Lowest recorded	Date & Year
	oF	oF	oF	oF	oF	oF	oF	oF
January	86.5	53.0	91.0	46.7	95	30 1938	35	17 1935
February	90.5	55.1	96.1	47.4	102	27 1886	39	1 1934
March	98.8	72.4	105.7	61.1	110	30 1897	51	2 1903
April	100.9	68.3	105.8	61.1	110	30 1897	51	2 1903
May	98.8	72.4	105.7	66.4	110	7 1889	57	7 1888
June	89.4	73.5	98.7	69.0	107	6 1897	63	6 1920
July	82.5	71.7	88.6	68.5	96	6 1915	66	6 1920
August	81.7	70.5	86.5	67.0	95	24 1932	63	9 1920
September	84.6	68.9	90.3	64.4	96	29 1912	61	27 1901
October	89.4	66.3	93.3	57.7	100	8 1899	52	23 1910
November	86.5	58.5	90.9	49.9	97	7 1896	45	29 1939
December	84.9	53.0	88.8	46.1	95	23 1896	40	23 1940
Annual total Or mean	89.4	64.4	106.	44.0	110	….	35	….

Source: Gazzetteer of Pune district.

The mean temperature is lowest in December. It rises steadily thereafter until the maximum is reached in May. With the onset of the monsoon in June, day temperature suddenly fall and by August the mean maximum temperature reaches its lowest value in the year. From September the temperature begins to rise again until the advent of the cold season in November. The daily range of temperature is least during the months of July and August, while during the cold season it is usually large, the maximum range being in February. During these 60 years the maximum temperature recorded was 110'F on 30th April 1987 and 7th May 1889. The minimum recorded during 1881-1940 was 35'F on 17th January 1935.

Humidity:

The following table gives for Pune the means of dry bulb and wet bulb temperatures, the relative humidity and the vapour pressure for each month. The table is based on figures available at the Meteorological Office, Pune. Average for 8 a.m are based on data for the years 1891-1940 and those for 5 p.m. on data for the years 1936-40.

Table 3.4 : Means of dry and wet bulb temperatures

Month and Time		Mean Dry Bulb	Mean Wet Bulb	Relative Humidity	Vapour Pressure
		oF	oF	%	Mb.
January	8 a.m.	57.0	52.0	69	10.7
	5 p.m.	84.6	62.6	25	10.0
February	8 a.m.	59.7	53.4	64	10.9
	5 p.m.	86.6	63.2	23	9.8
March	8 a.m.	66.9	58.4	57	13.2
	5 p.m.	91.9	64.5	19	8.9
April	8 a.m.	74.8 95.3	64.1	53	15.8
	5 p.m.		67.9	22	11.5
May	8 a.m.	78.2	69.1	61	20.5
	5 p.m.	94.1	71.4	32	16.3
June	8 a.m.	77.0	71.7	76	23.9
	5 p.m.	82.3	72.6	64	23.0
July	8 a.m.	74.7	70.9	82	23.7
	5 p.m.	77.0	71.8	78	24.1
August	8 a.m.	73.1	69.8	84	23.2
	5 p.m.	77.4	71.2	74	23.3
September	8 a.m.	72.8	69.5	84	23.0
	5 p.m.	79.0	71.8	71	23.4
October	8 a.m.	71.6	67.5	80	20.8
	5 p.m.	84.6	69.1	47	17.5
November	8 a.m.	63.7	59.3	76	15.0
	5 p.m.	84.2	65.7	35	13.4
December	8 a.m.	57.7	53.4	74	12.3
	5 p.m.	81.9	62.2	29	10.6

Source: Gazzetteer of Pune district.

Situated as it is on the lee side of the ghats, Pune is much drier than places on the coast line. Even in the monsoon months of June, July, August and September, the

mean monthly relative humidity never exceeds 84 per cent, The diurnal variation of temperature or humidity is least in the monsoon months. The relative humidity is high in the morning but is considerably reduced in the evening in winter and summer months. March and April are the driest months. On a few days in the month of May and sometimes also early in June, before the onset of the monsoon, nights in Pune become rather uncomfortable on account of the high temperature combined with a fairly high percentage of humidity.

Barometric Pressure:

The following table gives the mean pressure at Pune. Averages for 8 a.m. are based on data for the years 1891-1940 and those for 5 p.m. for the years 1936-1940.

Table 3.5 : Mean pressure at pune

Month		Millibars	Month		Millibars
January	8 a.m. 5 p.m.	952.3 948.8	JULY	8 a.m. 5 p.m.	942.5 941.0
February	8 a.m. 5 p.m.	951.2 947.5	AUGUST	8 a.m. 5 p.m.	944.2 942.4
March	8 a.m. 5 p.m.	949.7 945.7	SEPTEMBER	8 a.m. 5 p.m.	946.6 943.9
April	8 a.m. 5 p.m.	948.1 943.8	OCTOBER	8 a.m. 5 p.m.	949.5 946.0
May	8 a.m. 5 p.m.	946.6 943.0	NOVEMBER	8 a.m. 5 p.m.	951.7 948.0
June	8 a.m. 5 p.m.	943.2 940.7	DECEMBER	8 a.m. 5 p.m.	952.7 49.2
			MEAN ANNUAL	8 a.m. 5 p.m.	948.2 945.0

This observation show that from October to March the barometric pressure is over the annual mean and from April to September the pressure is below the annual mean. The month of least pressure is June. Then come July, August, September, i.e., the monsoon months, and May. December pressure is the highest in the year.

Cloudiness:

The mean cloudiness estimated in tenths of sky covered is given in the following table. The average cloudiness in Pune, taking into account all kinds of clouds, low, medium and high, is less than five-tenths (or half of the sky) in all the months except during the monsoon period. On a large number of days during the winter months and also during the early summer, we have blue skies and brilliant sunshine.

Table 3.6 : Mean cloudiness in pune

Month		All clouds	Low clouds	Month		All clouds	Low clouds
January	8 a.m.	1.7	0.1	July	8 a.m.	8.3	6.3
	5 p.m.	2.4	0.9		5 p.m.	9.0	6.3
February	8 a.m.	1.0	0.2	August	8 a.m.	8.0	6.0
	5 p.m.	2.1	0.9		5 p.m.	8.5	6.1
March	8 a.m.	1.0	0.3	September	8 a.m.	6.7	3.5
	5 p.m.	2.6	1.3		5 p.m.	7.8	5.3
April	8 a.m.	1.7	0.8	October	8 a.m.	4.0	1.2
	5 p.m.	3.6	2.5		5 p.m.	4.9	2.8
May	8 a.m.	2.5	0.9	November	8 a.m.	2.4	0.6
	5 p.m.	2.6	1.7		5 p.m.	4.0	1.6
June	8 a.m.	6.7	5.1	December	8 a.m.	1.7	0.4
	5 p.m.	7.8	5.4		5 p.m.	2.9	1.8
				Mean Annual	8 a.m.	3.8	2.1
					5 p.m.	4.8	3.0

Source: Gazzetteer of Pune district.

Winds:

A remarkable feature of Pune winds is their rareness from the south. The direction of the prevailing wind is NW to W in January and February. With the commencement of the hot weather, the direction slowly changes to the west and continues westerly right up to the end of the monsoon in September. October is a month of variable winds, While easterly winds predominate in November and December. During May and the rainy season the direction of the wind throughout the 24 hours is from the west. From the month of October to February calm prevails in

the morning approximately between 8 a.m. and 10 a.m. Before the period of calm the direction of the wind is W. After the calm the easterly wind begins and continues till 7 p.m. in October, November and December. After seven in the ecening the direction changes and the westerly breeze starts. In January, February, March and April the period of easterly winds lasts only for a few hours from 10 a.m. onwards.

Though the Pune district is situated to the east of the ghats, towards evening there is a sudden flow of air-the evening sea breeze-from WNW direction on most days of the months of February, March and April and part of May, characterised by its greater gustiness, humidity and lower temperature.

The following table gives the number of days with wind force (in miles per hour) and the mean wind speed:-

Table 3.7 : Number of days with wind force and mean wind speed in Pune

Month		More than 34 miles p.h.	12-33 miles p.h.	2-11 miles p.h.	0-1 miles p.h.	Mean Wind speed (m..p.h)
January	8 a.m. 5 p.m.	0 0	0 1	6 21	25 9	3.7
February	8 a.m. 5 p.m.	0 0	0 1	15 22	13 5	4.2
March	8 a.m. 5 p.m.	0 0	0 3	12 22	19 6	5.1
April	8 a.m. 5 p.m.	0 0	0 2	17 26	136 2	6.4
May	8 a.m. 5 p.m.	0 0	3 10	26 20	2 1	9.1
June	8 a.m. 5 p.m.	0 0	4 14	25 15	1 1	9.8
July	8 a.m. 5 p.m.	0 0	3 6	28 25	0 0	10.2
August	8 a.m.	0	2	27	2	8.9

Month		More than 34 miles p.h.	12-33 miles p.h.	2-11 miles p.h.	0-1 miles p.h.	Mean Wind speed (m..p.h)
	5 p.m.	0	5	26	0	
September	8 a.m. 5 p.m.	0 0	0 1	23 28	7 1	6.7
October	8 a.m. 5 p.m.	0 0	0 0	15 23	16 8	4.0
November	8 a.m. 5 p.m.	0 0	0 0	10 21	20 9	3.7
December	8 a.m. 5 p.m.	0 0	0 0	7 23	24 8	3.5
ANNUAL TOTAL OR MEAN	8 a.m. 5 p.m.	0 0	12 43	211 272	142 50	6.3

Source: Gazzetteer of Pune district.

The following table gives the percentage number of days for various directions of wind in Pune;

Table 3.8 : Direction of wind in Pune

Month		N	NE	E	SE	S	SW	W	NW	Calm.
January	8 a.m.	1	2	3	2	7	7	4	1	73
	5 p.m.	4	6	8	14	2	4	25	8	29
February	8 a.m.	2	2	2	1	10	14	6	2	61
	5 p.m.	3	3	5	2	2	5	43	20	17
March	8 a.m.	1	1	2	2	10	11	7	5	61
	5 p.m.	4	5	1	3	3	4	43	19	18
April	8 a.m.	1	1	1	2	9	15	20	14	38
	5 p.m.	5	5	2	3	2	5	42	29	7
May	8 a.m.	1	1	1	1	4	14	47	20	13
	5 p.m.	2	3	0	0	1	1	64	26	3
June	8 a.m.	1	1	1	1	3	21	57	11	5
	5 p.m.	0	1	0	0	0	12	75	9	3
July	8 a.m.	1	0	0	0	1	19	68	9	2
	5 p.m.	0	0	0	0	0	8	84	8	0
August	8 a.m.	0	0	0	1	1	16	66	10	7
	5 p.m.	0	0	0	0	0	6	83	11	0
September	8 a.m.	1	1	1	1	2	12	47	11	24
	5 p.m.	2	3	0	0	2	6	66	16	5

October	8 a.m.	2	2	11	5	3	11	8	4	52
	5 p.m.	3	10	14	12	1	5	21	10	24
November	8 a.m.	2	6	15	8	3	5	1	1	60
	5 p.m.	1	6	33	21	3	3	2	0	31
December	8 a.m.	1	6	7	3	4	5	1	1	73
	5 p.m.	1	6	26	19	3	3	14	3	25
Annual total Or mean	8 a.m.	1	2	4	2	5	13	28	7	38
	5 p.m.	2	4	7	6	2	5	47	13	14

Source: Gazzetteer of Pune district.

Thunderstorms Squalls, etc.

The following table gives the frequencies of thunderstorms, hail, squalls and fog at Pune in each month of the year based on observation from 1935 to 1944.

Table 3.9 : Frequencies of weather phenomena at Pune

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.	Annual Total
Number of days with – Thunder	0	0.2	1.2	3	3	4	0.2	0.5	4	5	0.8	0.4	22.3
Hall	0	0	0	0.3	0.1	0	0	0	0	0	0	0	0.4
Dust storm	0	0	0	0	0.1	0	0	0	0	0	0	0	0.1
Squall	0	0	0.2	0.4	0.9	0.7	0	0	0.6	1.0	0	0	3.8
Fog	0.4	0	0	0	0	0	0	0	0.1	1.6	0.4	0.2	2.7

Source: Gazzetteer of Pune district.

Thunderstorms occur generally during the hot months of April and May, before the onset of the monsoon in June, and in September and October associated with the withdrawal of the monsoon. Some of the thunderstorms in April and May are accompanied by squally winds, heavy rain and hail. Morning fog occurs, though very infrequently, in Pune during the month of October and in the winter season from November to January.

Dew and Fog:

Dews appear in the latter part of October and last till the end of February. The difference between the percentages of relative humidity in the morning and in the evening goes on in creasing from October. The wind speed during these months is not more than 4.2 miles per hour. The range of temperature between the daily maximum and daily minimum is fairly high. All these contribute to the formation of dew.

Fogs are rare in the eastern plains. They occur in the early mornings in September, October, November, December and January but disappear by half-past nine. They are generally visible in the valleys on the banks of rivers. In the western hills mists are common from May to September. Sometimes mists rise from the Konkan and fly east with great swiftness. At other times when the air is still, the mist stretches over the Konkan like a sea of milk, the tops of hills standing out like islands. After the monsoon sets in early in June, except during occasional breaks, the western hills are shrouded in drenching mists and rain clouds.

The acreage under different crops in the various talukas of the district in 1942-43 brings out the peculiarities of the sub-regions very clearly.

Table 3.10 : the acrea under different crops in the various talukas of pune district (1942-43)

	Maval	Mulshi	Junnar	Ambegaon	Khed	Haveli
1	2	3	4	5	6	7
Rice	31,726	13,708	19,151	8,144	19,499	5,977
Wheat	8,804	1,619	15,365	1,490	10,900	2,525
Javari	13,592	14,732	46,951	5,090	46,596	83,996
Bajri	2,351	4,882	1,13,629	37,817	88,679	61,330
Ragi	5,146	2,617	3,566	5,468	8,003	1,583
Varai-Sawa	2,928	1,364	…	4,133	3,995	122
Gram	2,048	936	10,885	2,299	10,460	3,797
Tur	809	477	1,924	573	2,299	3,395
Math	4	86	5,129	982	2,332	1,398
Kulthi	126	259	5,937	1,542	3,827	1,769
Groundnut	612	48	2,241	1,876	9,658	950
Safflower	104	119	778	…	271	1,883
Nigerseed	…	775	…	3,310	6,459	1,322
Sugarcane	16	…	676	32	147	1,722
Potatoes	45	…	1,134	1,609	5,594	365
Green Vegetables	83	173	243	117	378	1,730
Mosambi	16	22	679	264	366	280
Other Fruit	49	92	1,522	333	700	1,736

	Purandar	Sirur	Daund	Bhimtadi	Indapur
1	8	9	10	11	12
Rice	4,404	5	54	1,151	268
Wheat	3,500	5,104	973	3,862	2,734
Javari	44,414	1,20,001	1,32,325	1,64,424	1,90,591
Bajri	1,08,893	1,44,796	22,676	32,257	13,356
Ragi	--	. ..	---	---	---
Varai-Sawa	--	2,393	…	---	---
Gram	4,352	2,671	1,676	4,303	3,913
Tur	813	5,190	470	1,966	1,371
Math	4,497	8,076	937	3,071	1,289
Kulthi	3,883	7,708	3,889	4,000	3,898
Groundnut	999	2,246	382	1,018	3,627
Safflower	5,548	14,167	12,665	13,873	18,022
Nigerseed	…	187	65	4	6
Sugarcane	42	88	180	5,811	4,806
Potatoes	122	614	---	1	3
Green Vegetables	756	74	327	187	149
Mosambi	1,593	219	214	265	59
Other Fruit	2,283	943	778	875	248

Source: Gazzetteer of Pune district.

In the case of cereals, the western talukas of Mawal and Mulshi show a predominance of rice. In the central tract, Junnar, Ambegaon, Khed, Haveli and Purandar show a predominance of bajri, while the eastern talukas Sirur, Daund, Bhimthadi and Indapur show a predominance of javari. In the central belt rice though not predominant is important. The western portions of these talukas are rice zones.

In the case of pulses, the central zone shows predominance, the eastern zone comes next and the western zone comes last.

In oil-seeds, the eastern zone leads particularly in the productionof safflower; then comes the central zone; and the western zone comes last.

In the case of sugarcane, the Bhimthadi and Indapur Talukas alone are prominent. This being the Canal Zone this is natural. The Mutha Canals in Haveli also show a concentration of sugarcane there.

In the case of potatoes and other vegetables, the central zone leads the other two zones. The north central zone shows marked predominance in potatoes while the southern zone appears more favourable for green vegetables, mosambi and other fruits.

Natural Resources:

Forests:

The district, except in its western and hilly parts, has not much of a forest area, the total for the whole district being less than 750 sq. miles.

The types of vegetation occuring in the different parts of the district are governed mainly by rainfall and altitude. The forest types are mainly three, viz., scrub, mixed deciduous and evergreen, and all represent and correspond to the eastern, central and western zones of low, medium and high rainfall, varying from 15" to 150".

Scrub:

Starting in the east at a general altitude of 1,000' with an average rainfall below 20" will be found an open forest covered by thorny scrub. Bor (*Zizyphus jujuba*), polati (*Acasia latronum*) Nephtad (*Dichrostachys cinerea*), Hinganbet (*Balanites Roxburghii*), Saundad (*Prosopis spicigera*), Vagati (*Capparis aphylla*) are all typical species of this scrub and thorny area. The growth of these species is

usually small and stunted. Nim (*Azadirachta indica*) is the only tree yielding timber of suitable size. As a notable exception, where the soil is better and blacker and where additional soil moisture is obtained, Babhul (*Acacia arabica*) occurs in pockets.

Decidous Species:

There is a gradual change from scrub to deciduous species at one advances, into the central zone. Certain species are frequently dominant and often occur quite gregariously over considerable area,. Owing to erosion and denudation caused by cutting of trees, excessive grazing and burning of grass-lands by villagers, on the lower slopes of hills almost all the injaili species other than teak have disappeared. Teak remains as an open crop, stunted and chiefly coppice in origin. On the hot, dry southern slopes, Salai and northern slopes, Dhavada (*Anogeissus latifolia*) is often found in the same condition.

Evergreen Forest:

Further towards the west, as rainfall increases, evergreen species mingle with the deciduous. Ain (*Terminalia tomentosa*) occurs very largely in the drier half, while Kindal (*Terminalia paniculata*) and especially Hirda (*Terminalia Chebula*) are found only in the wetter half of the zone. Hirda is preserved on account of the markets for its valuable fruits (Myrobalan). Teak is notably absent. In the extreme west, evergreen forest is the climax. The best examples of this type which remain are near the forest bungalow and below the temple at Bhimashankar and in the temple grove at Ahupe in the Ambegaon Taluka. Anjani (*Memecylon edule*), Jambul (*Eugenia Jambolana*), Pisa, (*Actinodaphne Hookeri*) are the prominent species in this part.

Distribution by Talukas:

Junnar Taluka:

The area of total reserved forest in this taluka is about 93 sq. miles. Of this an area of about 28 sq. miles along the Western Ghats remain unworked, on account of

transport difficulties. The vegetation in this part is of evergreen nature. The central part of the taluka contains mixed deciduous forest comprising mostly teak. The whole of the eastern portion of the taluka is almost without any vegetation.

Ambegaon Taluka:

The area of reserved forest in this taluka is about 62 sq. miles. Of this, an area of about 34 sq. miles if situated along the western border of the taluka. The vegetation in this part is of evergreen nature, and on account of transport difficulties the area has remained unworked. On the western edge of the taluka is the temple of Bhimashankar. A plot of about 725 acres below this temple has been permanently preserved together with other areas which are required as check plots in research in to the regeneration of evergreen forest. These temple groves, which are practically the only representatives of virgin evergreen forest of the Western Ghats, differ markedly from the dwarf or elfin evergreen found along these ghats. The central part of the taluka contains mixed deciduous forests.

Khed Taluka:

The area of total reserved forest in this taluka is about 83 sq. miles. Of this, an area of about 28 sq. miles, situated along the Western Ghats, is of evergreen type, and no exploitations are carried out in this area due to transport difficulties. This tract contains a good deal of Hirda trees, whose fruit forms a valuable forest produce. There is also a valuable growth of bamboos in the velhavli and Bhomale reserves of this area. The deciduous zone starts from Wada and stretches towards the east for about 10 miles and reaches Khed in the centre of the taluka. The forest areas to the east of this belt are more or less open blanks and contain only thorny bushes.

Mawal and Mulshi Talukas:

Mawal has about 86 sq. miles and Mulshi about 68 square miles of reserved forest. Out of these, about 65 sq. miles from Mawal and about 58 sq. miles from Mulshi are situated along the Western Ghats. The vegetation of this part is of

evergreen nature. In this region there are four big lakes, viz., the Andra, Shiravta, Walwan and Mulshi lakes, which have been constructed by the Tata hydro-electric companies for production of electricity. Hirda, Shikekai and bamboos form some of the items of minor forest produce in this zone. The deciduous forests in these talukas are of a poor type. The deciduous zone of the Mawal taluka starts from Kalhat and ends at Talegaon-Dabhade in the centre of the taluka. The deciduous forests in the Mulshi taluka are situated in Ghotavade, Paud, Rihe and Marunji.

Haveli Taluka:

The area of reserved forest in this taluka is about 60 square miles. This taluka, situated to the east of the Mulshi and Mawal talukas, does not contain any evergreen forest.

The vegetation is of mixed deciduous nature comprising mostly teak, Ain and Dhavada. The eastern part of the taluka contains very little forest vegetation, except a few patches of Babhul growth along the banks of the Mula-Sinhgad, Bahuli and Agalambe in the north-west forner of the taluka. The forest reserves situated on the northern slopes of sinhgad Fort are important and valuable. Dharjai, Katraj and Parvati are the most important grass kurans in this taluka.

Purandar Taluka:

The area of reserved forest in this taluka is about 37 sq. miles. The northern and eastern parts of the taluka are bank and have very little vegetative cover. The western part contains mixed deciduous forests with teak as an important species.

Daund, Indapur and Sirur Talukas:

The area of reserved forest in these talukas are: Daund 52 sq. miles ; Indapur 49 sq. miles ; and Sirur 25 sq. miles. Most of these areas, being of no importance as forests, have been classified as pasture forest and handed over to the Revenue Department for management. Small strips along the banks of the Mula-Mutha and the Bhima rivers are Babhul reserves in charge of the Forest Department.

Bhimthadi Taluka:

This taluka contains 37 sq. miles of reserved forests, but all this area is now treated as pasture forest and placed in charge of the Revenue Department.

Bhor Taluka and Velhe Mahal:

The forests of Bhor and Velhe Mahal measure 49 sq. miles and 45 sq. miles respectively. The forests stretching along the western boundaries of these talukas are of evergreen nature, whereas those found in the central and eastern part of the talukas are of mixed deciduous type with teak as the main species. As the Bhor taluka and Velhe Mahal were merged in the Pune Forest Division, only in 1948, survey and settlement have not yet been made of the forest areas of these divisions. There are important forest reserves in the area. Hirda and Udha Bamboo are the important forest produce of this area.

Minor Forest Products: Biodiversity of Bhor and Velhe Mahal

Following is the list of the chief minor forest products :-

Local Name – Botanical Name - Uses

Apta : *Bauhinia racemosa Lam*.- leaves for birds.

Bahva: *Cassia fistula L*.-pods.

Chillari: *Caesalpinia Caesalpinia Roxb*.- bark.

Grass: for cattle food and grazing (many species)

Harda: *Terminalia chebula Retz*.- fruit.

Moha: Madhuca indica Gmel (*Bassia latifolia*)-flowers for distilling.

Sag*: Tectona grandis L*.f-leaves for thatching.

Shemb: *Caesalpinia digyna Rottl*-bark.

Shikekai: *Acacia concinna* DC-pods for hairwash.

Tad: *Borassus flabellifer L*.-leaves for thatching.

Timru: leaves for bidis.

Chief Trees. The following is a list of the chief trees found in Pune :—

Ain or Sadada : *Terminalia crenulata* Roth.

Boma: *Terminalia arjuna* W and A.

Beheda: *Terminalia bellerica* Roxb.

Allu: *Meyna Laxiflora* Robyns (Vangueria spinosa Roxb).

Amba: *Mangifera indica* L.

Ambada: *Spondias mangifera* L.

Ambguli: *Elaeagnus kologa* Schlecht.

Anjir: *Ficus carica* L.

Apta: *Bauhinia racemosa* Lam.

Asan: *Bridelia retusa* Spreng.

Babhul: *Acacia arabica* Willd.

Acacia farnesiana Willd. is Vedi (Wild babhul).

Badam: *Prunus amygdalus* Stokes.

Bahva : *Cassia fistula* L.

Bakul : *Mimusopa elengi* L.

Bartondi: *Morinda citrifolia* Linn.

Bel: *Aegle marmelos* Correa.

Bhokar: *Cordia rothi* R. and S.

Bibbha: *Semecarpus ancacardium* L.f.

Bondara: *Lagerstoemia lanceolata* Wall.

Chakotar : *Citrus decumana* L.

Chandan : *Santalum album* L.

Chapha : *Michelia champaka* L.

Char : *Buchanania lanzan* Spreng.

Chinch : *Tamarindus indica* L.

Dalimb : *Punica grantum* L.

Dhaman : *Grewia tiliaefolia* Vahl.

Dhavda*: Anogeissus latifolia* Wall.

Gehela : *Randia dumetorum* Lam.

Gorakh chingh : *Adansonia digitata* L.

Hallian : *Eriodendron anfractuosum* DC.

Harda or Hirda: *Terminalia chebula* Retz.

Hedu *: Nauclea cordifolia* (Adina cordifolia) Hook f.

Hinganbet : *Balanites roxburghii* Planch.

Hivar : *Acacia leucophloea* Willd.

Jayphal : *Myristica beddomei* King.

Jamb : *Jamboda vulgaris* DC.

Jambhul or Jambhal *: Syzygium cumini* (Link) Skeels.

Kadu Kharik : *Solanum xanthocarpum* Schrad. & Wendl.

Kaju *: Anacardium occidentale* L.

Kalamb or Kadamba : *Mitragyna cordifolia* Korth.

Kamrak : *Averrhoa carambola* L.

Karanj : *Pongamia pinnata* Vent.

Karvand : *Carissa carandas* L.

Kavath or Kut : *Feronia limonia* (F. elephantum) Corr.

Kel : *Musa paradisiaca* L.

Kenjal : *Terminalia alata* Roth.

Khair : *Acacia catechu* willd.

Khajuri or Shindi : *Phoenix sylvestris* Roxb.

Khandul : *Sterculia urens* Roxb.

Lalai : *Albizzia amara* Boiv.

Limb or Nim ; *Azadirachta indica* A. Juss.

Limbu : *Citrus medica* L.

Mahlung :*Citrus medica* L.-var. limotta

Makar nimbori : *Atalantia monophylla* Corr.

Maruk : *Ailanthus excelsa* Roxb.

Moha : *Madhuca indica* Gmel.

Nagchapha : *Mesua ferrea* L.

Nana : *Largerstroemia parvifolia* Roxb.

Naral : *Cocos nucifera* L.

Naring : *Citrus aurantium* L.

Palasa : *Butea monosperma* O. Ktz.

Pangara : *Erythrina indica* Lam.

Papai : *Carica papaya* L.

Papnas : *Citrus decumana* L.

Peru : *Psidium guajava* L.

Phanas : *Citrus decumana* L.

Peru : *Psidium guajava* L.

Phanas : *Artocarpus integra* (L) Merr.

Pila dhotra : *Agremone mexicana* L.

Pimpal : *Ficus religrosa* L.

Pimpri *: Ficus comosa* Roxb.

Ramkanta : *Acacia eburnea* Willd.

Ramphal : *Anona reticulata* L.

Ran Bor : *Zizyphus Lam*. (Z. mauritiana Lank).

Ratambi : *Garcinia purpurea* Retz.

Ray-avla : *Cicca disticha* Linn.

Rui *: Calotropis gigantea* R.Br.

Sag :*Tectona grandis* L.

Sagargota : *Caeaslpinia crista* Linn.

Salai : *Boswellia serrata* Roxb.

Saundad or Shami : *Prosopis spicigera* L.

Savri : *Salmalia malabarica* Schott & Endl.

Shevga : *Moringa oleifera* Lam.

Shivan *Gmelina arborea* Lam.

Siras : *Albizza lebbek* Benth.

Sisu : *Dalbergia latifolia* Roxb.

Sitaphal : *Anona squamosa* L.

Supari : *Areca catechu* L.

Tad : *Borassus flabellifer* L.

Tembhurni : *Diospyros melanoxylon* Roxb.

Tirti : *Capparis erythrocarpus* Isert.

Tivas : *Ougeinia dalbergioides* Benth.

Toran : *Zizyphus regosa* Lam.

Tut : *Morus indica* L.

Umbar : *Ficus glomerata* Roxb.

Vad : *Ficus bengalensis* Linn.

Varas : *Heterophragma quadiloculare* (Roxb) Schumm.

Rich of Bhor and Velhe Forest*

(**The paragraphs on Wild Animals and Birds have been contributed by Shri Salim Ali, Joint Honorarv Secretary, Mumbai Natural History Society.)*

The wild animals are mainly the same as of the adjoining district, and of the Deccan plateau generally. The reclamation in recent years of vast areas of scrub jungle and waster land for cultivation through the introduction of irrigation canals, the ever-growing pressure of population, the development of roads and the advent of the motor car and lorry have had a disastrous effect upon wild life. The increase of firearms and their use in season and out of season, and wholesale unregulated trapping and netting by Pardhis have, in many parts of the district, reduced the numbers of such animals as blackbuck (Kalavita) and here tothe verge of extinction. By the deprivation thus of their natural food supply some species have been driven to crop-rading and in consequence been greatly decimated. The loss of suitable scrub jungle for nesting sites has affected ground nesting birds in a similar way. The process of opening up of remote tracts continues a pace, and with it goes hand in hand the destruction of wild life. The Mumbai Wild Animals and Wild Birds Protection Act (XXIV of 1951 has been enacted and brought into force to make better and adequate provision for the prevention of wild animals and wild birds.)

Mammals: Beasts of Prey

The most prominent among these are the tiger (*Panthera Tigris* Linn.)- H. Bag or Sher; M. Wagh; and the Panther or leopard (*Panthera pardus* Linn.) H. Tendua or Cheeta; M. Karda, Asnea or Bibla-Wagh. The former is rare and only met with occasionally in the heavier forested part of the Sahyadris or Western Ghats such as the Lonavle and Khandale neighbourhoods. Leopards are still fairly plentiful. They

are less intolerant of the heat, and scrub-covered rocky hills with natural caves provide ideal habitats for them. Many of the ruined hill forts, scattered over the district, regularly hold a leopard of two. From here they make forays into the surrounding cultivation for wild pig and porcupine which form their natural food. Village dogs, goats and donkeys are also taken occasionally, and an individual leopard may sometimes become a serious pest to the herdsman. Human beings are as a rule unmolested, and no man-eaters have been recorded within recent years. The encroachment of its natural habitat by cultivation is bringing the leopard increasingly in conglict with the interests of man, in consequence of which its numbers have dwindled and are dwindling considerably. The leopard is perhaps the most effective natural check against that greatest of all four-footed pests of the cultivator, the wild pig, whose ravages-particularly in the parddy and sugarcane growing tracts-are so notorious.

There is no recent authentic record of the cheeta (hunting leopard, Acinonyx jubatus Erxleben) in Pune District. The species-if indeed its inclusion in the old Gazetteer was justified-is now at any rate certainly extinct, as it practically is over the rest of India.

The only other member of the Cat family deserving mention is the Jungle Cat (Felis chaus Guld.)-H. Jungli Billi or Khatas; M. Baul or Baoga. It is sandy grey in colour, slightly larger than the domestic cat, with longer legs and comparatively short tail which is ringed with black towards the end, and block-tipped. It lives in grass land and scrub jungle and is notoriously destructive to poultry.

The Civet family (viverridae) is closely related to the true cats (Felidae). Civet cats have narrow pointed muzzles, long bodies and short legs. Their diet is partly animal small birds, mammals and insects-partly fruits and berries. Under the base of the tail is a gland producting a highly concentrated evil smelling substance which, highly diluted, is used commercially in the manufacture of perfumes. The two principal representatives of this family in the district are:-

1. The small Indian Civet (*Viverricula indica* Geof.) —H. Kasturi ; M.Jawadi-Manjar-greyish-brown, lined, streaked and spotted with black. Nocturnal.

2. The common Palm Civet or Toddy Cat (*Paradoxurus hermaphroditus* Schreber)- H.Lakati or Khatas ; M. Ud. blackish-brown in colour with long coarse hair. Nocturnal. It commonly takes up its abode between the ceiling and roof of inhabited houses, and in hollows of trees.

The Sloth Bear (*Melursus ursinus* Shaw)— H.Bhalu, Reenchh ; M. Asval-being a forest dweller is also restricted to the well-wooded hilly portion of the Ghat country. It lives on roots and fruits of forest trees, and as a rule is not harmful to cultivation, though it has been known to prey on sugarcane and jack-fruit.

Of the Dog tribe (Canidae) the principal representatives in the district are:

(1) The Striped Hyaena (*Hyaena hyaena* Linn.)- H. Lakarbaghar, Churs ; M. Taras-is a dog-like animal with massive head and forepart of body, and sloping weak hindquarters. It is a cowardly scavenger spending the daytime in caves and ravines in rocky hills and prowling in the precincts of villages by night in search of animal carcases.

(2) The Wolf (*Canis lupus* Linn.)-H.Bheriya ; M. Landaga-the prototype of, and similar looking to, the popular Alsatian dog, is now quite rare. It is destructive to lambs and goat kids but owing to its scarcity the overall loss to shepherds from it is negligible.

(3) The Jackal (*Canis aureus* Linn)-H.Geedar ; M. Kolha is like a black-and-buff village dog with longish hair and bushy tail. Abundant, and a useful scavenger about villages; sometimes destructive to poultry, cane and groundnut. The mournful nocturnal concert of howling jackals is one of the most familiar sounds of the Deccan countryside.

(4) The Indian Fox (*Canis bengalensis* Shaw)-H. Lomri; M.Khokada-is a pretty, slim, greyish-brown long-furred animal like the jackal wiht a bushier tail. It

inhabits open country and lives chiefly on field rats and mice, reptiles and insects. There fore, since it seldom attacks poultry, it is a useful ally of the ryot.

(5) The wild Dog (*Cuon alpinus* Pallas)- H. Jungli-Kutta, Bankutta or Son-Kutta; M.Kolasuna, Kolisna, Kolsara-is about the size of the Jackal, reddish-chestnut in colour with a bushy black-tipped tail. It keeps to forest in the Sahyadris, hunts in packs and is highly destructive to sambar and other game animals. The packs move about a great deal scouring large tracts of country and often cleaning them out completely of game.

Of the smaller animals allied to both the Cat and Dog familes, the two that deserve mention here are:

(1) The Common Otter (*Lutra lutra* Linn.)-H. Ud-bilao; M.Panamanjar.

(2) The Common Mongoose (*Herpestes edwardsii* Geoffroy)-H.Marigus, Newla, M.Murigusa.

The former is chiefly aquatic and found in many of the larger rivers and streams, its principal food being fish. The mongoose is well known for its snake-killing propensities, tackling both poisonous and non-poisonous species with equal effect. It is, however; destructive to gound-nesting birds and their eggs, and sometimes becomes a serious menance to the poultry keeper on account of its habit of mass slaughter should it gain entry into a hen coop.

Bats:

Among the bats (Family Chiroptera) the species most prominent on account of its large size and for the great damage it causes to mongoes, figs and other cultivated fruit is the Flying For (*Petropus giganteus*)-M.Waghul-which has a wing-span of 3 to 4 feet flying foxes have favourite roosting trees occupied by a colony for many years in succession, on which hundreds may be seen hanging head downwards during daytime, screeching and squabbling. At sunset they fly to the surrounding

orchards and work havoe among the ripening fruit. Their meat and fat are used in local medicine.

Several species of smaller bats occur in the district, chiefly haunting disused ruins and caves. All are nocturnal, most species being insectivorous and beneficial to man. The pretty little Painted bat (*Kerivoula picta*), sometimes seen hawking insects in the evening twilight, is an outstanding exception as regards its brilliant colouration not only among bats but all Indian mammals as well. Its body fur is bright orange while the wings are vermilion and black.

Rodents:

Among the rodents or gnawing animals the Indian Porcupine (*Hystrix leucura* Gray and Hardwicke)-H.Sayal, Sahi; M. Sayal, Salindar-is common. It lives in burrows dug in the ground on rocky hillsides and is largely nocturnal in habits. It is destructive to groundnuts and other food grain crops. Its flesh is good eating and eagerly sought by local tribes.

The Giant Squirrel of the Ghat forests, *Ratufa indica*-H.Karrat, Rasu; M. Shekra-is one of our most attractive rodents.

It is about 15 inches long with a bushy tail another 2 feet or so; bright reddish brown above, creamy white below with a white-tipped dark tail. It lives among the higher branches of tall forest trees and proclaims its presence by peculiar loud, throaty, chuckling, barks. Young ones taken from the nest become quite tame and make engaging pets. The Five-striped Squrrel (*Funambulus pennanti* Wr.)-H.Gilehri; M.Khar-is ubiquitous in the district being usually fround in the neighbourhood of human habitations.

The Black-napped Hare (*Lepus nigricollis* F.Cuv.)-H. Khargosh; M. Sasa-is a dweller of scrub country bordering cultivation. Its numbers have become depleted everywhere owing to uncontrolled netting by Pardhis.

In addition to the ordinary rats and mice which are commensal with man and found abundantly in his dwellings and warehouses in towns and villages, there are several species of field rats and mice. Perhaps the commonest and most destructive of the former to cultivation is the Indian Mole Rat (*Bandicota bengalensis* Gray and Hardwicke)-H., M.Ghus-whose presence in a locality is "mole-hill" thrown up outside the mouth of its burrow. The animals are dug out of their burrows and avidly eaten by some of the local tribes. One of the commonest mice in and about cultivation is the Indian Field Mouse (*Mus booduga* Gray), sandy greyish brown above, white below.

Of the deer tribe the district possesses several, but they are not common and are confined mainly to forest in theSahyadris. Indiscriminate shooting by illegal methods, without regard to age or sex, has reduced their numbers considerably.

The Sambar (*Rusa unicolor* Kear)-H. Sambar; M. Sambar-restricted to a hill forest habitat, is found here and there in the Sahyadris.

The Spotted Deer (*Axis axis* Erxleban)-H.Cheetal or Jhank. M.Cital-prefers plains and foothills forest in the neighbourhood of cultivation. It has suffered greatly in numbers.

The Barking Deer or Muntjac (*Muntiacus muntijak* Zimm)-H.Khakar ; M. Bhekara, Khitkhita-is also met with in small numbers in the forested portions of the Sahyadris.

The antelopes are represented by three species, namely

(1) The Nilgai or blue bull (*Boselaphus tragocamelus* Pall.) H.and M.Nilga, Rui, Nilgai, Rojh;

(2) The Blackbuck (*Antilope cervicapra* Linn.) - H. Haran; M.Mrga, Harina, Kalvita; and

(3) The Fourhorned Antelope (*Tetraceros quadricornis* Blainv)-H. Chousinga, Doda; M.Bhekara.

The former two are inhabitants of open undulating grassy plains in the neighbourhood of cultivation. They are capable of considerable damage to standing crops. In some districts, e.g., in Gujarat, the Nilgai enjoyed a certain amount of production from the local Hindu population in the mistaken belief that it is closely related to the domestic cow. This spurious sanctity brought about an undesirable increase in its numbers there and the species became a very serious pest ot cultivation. The official name had to be changed to Nil-ghora (blue horse) before professional shikaris were employed to keep its numbers down. In the Pune district.

Little or none of such sentiment prevails and the Nilgai is comparatively uncommon. Enormous herds of blackbuck numbering hundreds of animals, used to roam over the Deccan plains even till as recently as about 40 years ago. Their numbers dwindled steadily with the opening up of the country, construction of roads and increase in motor traffic, which enabled shikaris to reach erstwhile inaccessible areas speedily and with little discomfort or expense. The increase in gun licences and the improvement in firearms has also contributed largely to their destruction. Much of the slaughter still takes place during the rainy season when the black cotton soil becomes clayey and impedes the animal's escape. At the present time some talukas have been completely denuded of blackbuck, and in others a herd of ten is quite an unusual sight. To preserve this interesting species from total extinction a rigid enforcement of the existing game laws against their indiscriminate slaughter is necessary.

The four-horned Antelops is a dweller of deciduous forest. It lives solitary or in pairs, and is not common.

The Indian Gazelle (*Gazella bennetti* Sykes)-H. Cinkara; M. Malathiska-is also found solitary or in small parties inhabiting waste lands broken up by nullah andravines.

The pretty little Chevrotain or Mouse-Deer (*Moschiola memina*)-H.and M. Pisora-standing only 10 to 12 inches at the shoulder, and possessing sharp tusks in the upper jaw instead of horns, is found in forests on the Sahyadris. It is comparatively rare animal and only occasionally seen.

Ant-eater:

A curiosity among the native mammals is the Pangolin or Scaly Ant-eater (*Manis crassicaudata* Geoffr. St. Hilaire)-M.Thirya, Khavli-manjar or Kassoli-manjar. It is about 31/2 ft. long, including tail and about 12" high, shaped rather lika a mangoose, with a narrow head and pointed snout. The body is covered with brownish hard, horny overlapping scales. If feeds on ants and termites by thrusting out and rapidly withdrawing into its mouth the long protrusible worm-like glutinous tongue with the insects adhering to the surface. The animal lives in burrows which it digs in the gound. It is chiefly nocturnal.

Birds :

Aboiut 300 species of birds may be found in the district of which about 90 are winter visitors, seen only between September/October and March/April. These latter include many orders and families, but those of them that come under notice more prominently are the wildfowl (duck and snipe).

Ducks:

The district is not particularly good for duck shooting since it has few of the shallow monsoon-filled depressions with muddy bottoms and partly submerged reed-beds elsewhere known as "jheels," so beloved of wildfowl. Such lakes as there are-Fife, Gibbs, Walwan, Whiting, Mulshi and others-are dep irrigation reservoirs formed by the damming of streams. These open expanses of water lack aquatic vegetation and do not attract ducks except as daytime refuges where they can sleep in comparative safety from shikaris and fly out to forage in the surrounding inundated paddy-fields at night. Unlike in the duck shooting districts, wildfowl here do not

appear to have any local specific names, an indication in itself of their comparative rarity.

The chief species of migratory ducks met with in the cold season are—

- The Common Teal (*Anas crecca*)
- The Garganey or Blue-winged Teal(*Anas querquedula*)
- The Shoveller (*Spatula clypeata*).
- The Pochard or Dun Bird (*Aythya ferina*).
- The Tufted Pochard (*Aythya fuligula*).
- With smaller numbers of several other species.

Of the resident wild ducks, i.e., those that remain with us all the year and nest within the district or in adjoining areas, the most usual -but by no means common or abundant-is the small chinnamon-coloured Lesser Whistling Teal (*Dendrocygna javanica*) and to a lesser extent the large Nukta or Comb Duck (*Sarkidiornis melamotos*), largely glossy black above, white below with a prominent knob or "comb" at base of bill near the forehead. These species as well as the diminutive Cotton Teal or Goose Teal (*Nettapus coromandelianus*) usually nest during the monsoon months in the rotten hollows of tree-trunks standing in or near water where their nests are safe from the flooding frequently caused by heavy downpours. The Cotton Teal is slightly larger than the pigeon and of a colouring and pattern rather like that of thecomb duck.

Snipe:

The two species of snipe normally found in squelchy paddy-fields after the paddy is harvested, and similar marshes, are the Common or Fantail (*Carpella gallinago*) and the Pintail (*C.stenura*). They are difficult to tell apart in flight, but in the hand the atten-uated pin-like outer tail feathers and the closer black barring under

the wing are good diagnostic characters of the Pintail. The larger and darker Woodsnipe (C.nemoricola) is rare but is occasionally shot.

Crane:

A large and conspicuous migratory bird seen in some years in enormous flocks in open cultivation or fallow fields about tanks, etc., is the Demoiselle Crane (*Anthropoids vigro*)- M.Karakoca. It is much sought after by sportsmen, as it combines excellence as a table bird with extreme wariness which requires much skill and patience in bringing it to bag.

The Demoiselle is a handsome long-legged gray bird, standing about 3 ft. high. The head and neck are chiefly black and there are conspicuous pure white ear-trufts behind the eyes. It must be differentiated from the Common Crnae (*Grus g.lilfordi*) which also visits the district in some numbers, often associating with the Demoiselle. It is somewhat larger in size and has a distinctive bald red patch on the nape and to ear-trufts.

Hawks:

Prominent among the many winter immigrants from the Himalayas or the temperate lands beying, i.e., from Eastern Europe acorss the Siberia, are some birds of prey like the harriers, particularly the Pale Harrier (*Circus macrourus*) and Montagu's Harrier (C.cyanus). These slender, long-winged hawks-male, grey and white with black wing tips; female, brown with a whitish patch on the rump-are an enchanting sight as they skim over the standing upon mice, lizards and large grasshoppers.

Rosy Pastor:

A spectacular winter visitor, but of a very different natural order and great economic importance is the Rosy Pastor or Jowari Bird (*Pastor roseus*)-H. Tilyer or

Wyha; M.Bhordya. It is seen in the district between August and March-April, and in particularly large flocks or swarms when the jowar crop is ripening. The swsarms descend upon the standing fields and do great damage to the grain on the cob. But Rosy Pastors are well-known for their predilection for locusts also. Their breeding grounds in Central Asia and Eastern Europe overlap those of the destructive migratory locusts, both Schistocerca gregaria and Dociostaurus moroccanus. During the breeding months the birds and their young subbsist almost exclusively upon these destructive insects in all stages of their growth, and thereby confer an inestimable overall benefaction. It is in recognition of their beneficent services to agriculture that in Afghanistan, where the birds make a temporary sojourn of their northward passage in spring and summer, even the meat-starved inhabitants give the birds rigid protection for their good offices. Few other lawfully edible species, if any, enjoy such immunity from the pot in that country!

The Lark and Yellow buntings:

Among other winter immigrants which attract attention on the countryside by virtue of their abundance, mention must be made of the short-toed Lark (*Calandrella brachydactyla*) and the two yellow buntings-the Black headed (*Emberiza melanocephala*) and Red-headed (*E. luteola*). Swarma of these larks frequent bare open plains and glean grass seeds etc. scattered on the ground. The two buntings feed largely on bajri, jowar and rice in the eat, and cause a certain amount of damage to standing crops.

Weaver Birds:

With them are frequently associated as fellow crop-raiders flocks of Weaver Birds (*Ploceus philippinus*). The last named is a resident species, the size and colouration of the female house sparrow, and widely known for their remarkable hanging retore-shaped nests with long entrance tubes woven out of paddy leaves and other rough-edged grasses. During the monsoon which is their nesting season, the male baya acquires a breeding plumage with the crown of the head and breast a bright

golden yellow. Bayas make interesting pets. They have no song, but they really learn to perform a number of tricks demanding a high degree of skill.

The residednt avifauna of the district in general is the same in character, and largely also in species, as that found on the rest of the Deccan plateau. For a complete list of this, the interested reader can reffered to a paper entiltle "The Hyderabad State Ornithological Survey" published as a serial in the Journal of the Mumbai Natural History Society commencing in Vol.XXXVI, No.2, P, 356, and the supplementary list in Vol. XL, No. 3, P. 497.

Game Birds:

The principal game birds of the district are the Grey Partidge (*francolinus pondicerianus*)-M. Citur or Titur-the Painted Partridge (*F.pictus*)-kala Titur; Green Pigeons (*M. Harial*), particularly the Yellow-legged Green Pigeon (*Crocopus phoenicopterus chlorigaster*); Sandgrouse (*Pterocles exustus erlangenri*) M. Pakorade-and small numbers of the Painted Sandgrouse (*P. indicus*) ; Pigeons-M.Parwa or Paraira-especially the Blue Rock Pigeon (*Columba livia*) commonly inhabiting all hill forts; and Rain Quail (*Coturnix coromandelica*).

Other gallinaceous birds which sometimes find their way into garne bags are the Jungle and Rock Bush Quails (*Perdicula asiatic* and *P. argoondah*)-M. Lhawa.

The Peafowl (*P.cristatus*)-M. Mor (Male) Landor (Female)-the Grey Jungle fowl (Gallus sonnerati)-M.Ran Kombada-, and the Red Sspur Fowl (*Galloperdix spadicea*)-M.Kokatri-are found in the forested areas of the district.

The Great Indian Bustard (*Choriotis nigriceps*)-M. Hum, Karadhonk-which lives on the open grassy and cultivated plains has been getting increasingly rare owing to human persecution, and is now on the point of extinction.

The Lesser Florican (*Sypheotides indica*)-M.Canya Mor-is met with locally in small numbers in tall grassland during the south-west monsoon season.

Birds are beneficial as well as harmful to humans

All ground-living game birds, particularly such species as the Grey and Painted Partridges and the Rain and Jungle Quails are fast decreasing in numbers owing to unregulated, indiscriminate and wholesale netting by professional netters of the Pardhi tribe among other species which have an important bearing on human economics, in addition to the migratory species already described, are:-

(I) The Green Parakeets, largely destructive to fruit and field crops. The three species found the district are-

(1) The Large Indian Parakeet (*Psittacula eupatria*)-M.Popat.

(2) The Rose-winged (*P. karameri*)-M.Raghu.

(3) The Blossom-headed (*P. cyanocephala*)-M. Kir.

(II) The tiny Sunbirds-M. Phulokhi-are largely responsible for pollinating flowers of both harmful and beneficial species of plnts. The propagation of that pernicious plant parasite Loranthus-M. Bandgul-commonly infesting mango trees, and brilliantly plumaged nectar-seeking activities of these beautiful and brilliantly plumaged little birds. Four species are commonly found in the district.

(1) The Purple Sunbird (*Cinnyaris asiatica*).

(2) The Purple-rumped Sunbird (*C.Zeylonica*).

(3) The small Sunbird (*C.minima*) confined to evergreen hill forest (e.g. Bhimashankar, Khandala, etc.).

(4) The Yellow-backed Sunbird (*Aethopyga s.vigorsi*).

(III) The Flowerpeckers take up the work when the sunbirds leave off, i.e., they eat the ripe Loranthus berries and transfer the seed to the branch of some neighbouring tree either with their feces or by wiping it off their bill after removing the epicarp.

The seed adheres to the new host by means of its viscous coating and soon sprouts, boring with its roots into the tissues of the host plant and sucking the vital sap, its life blood.

The two species of Flowerpecker occuring in the district are:-

(1) The Thick-billed (*Dicaeum agile*), and

(2) The Pink-billed or Tickell's (*D.erthrorhynchos*).

Among birds of resplendent plumage, several natural orders and families are reprenented. The species which commonly catch the eye by the brilliance of their colours, to mention a few, are:

(1) The Black-headed Oriole (*Oriolus xanthornus*)-H. Peelak-size Myna; brilliant yellow and black;

(2) Green Parakeets (see above), largely grass-green;

(3) Kingfishers-M.Khandu, Khandya, Ganya, Dicca-White breasted (*Halcyon smyrnensis*)-size Myna, and the small (*Alcedo atthis*) size sparrow, brilliant blue, blue-freen, chocolate and chestnut-brown;

(4) Bee-eaters the Small Green (*Merous orientails*)-M. Tai lingi, Veda-raghu-size sparrow, brilliant grass-green;

(5) Roller or Blue Jay (*Coracias bengalensis*)-M. Tas-size pigeon, brilliant-dark and pale-blue; and

(6) Sunbirds smaller than the sparrow, with the males irridescent-crimson, scarlet, maroon, green and yellow. Flower-nectar is the staple food of sunbirds, and when, in its quest, the birds flit from one brilliant-hued flower to another their colours flash in the sun, turning them into living jewels, Presenting in that setting a spectacle of exquisite charm.

Song Birds:

Of song birds, the district can boast of a few species of exceptional accomplishment and outstanding reputation.

The Sharma (*Copsychus malabaricus*) and its cousins, the Black-capped Blackbird (*Turdus citrina cyanotus*) occur chiefly in the hill forest such as those at Khandale, Bhimashankar and elsewhere.

The rich, mellow whistling song of the Malabar Thrush (*Miyophoneus horsfieldi*) wandering aimlessly up and down the scale, which has earned the bird its name of 'Whistling Schoolboy, frequents the rocky torrential streams in the Ghats where the tumult of the waters forms fitting accompaniment to its lively melody.

The Magpie Robin or Dhayal (*C.saularis*), whose song, delivered from a roof or tree-top, is one of the most familiar sounds on the countryside between Februrary and May, keeps nearer human habitations.

The Spotted Babbler (*Pellorneum ruficeps*), a sober-coloured little bird, slightly larger than the sparrow, is a dweller in scrub tangles in wooded country and seldom shows itself. But it is a remarkable vocal performer and its tuneful and spirited melody proclaims it to be a comparatively common species in all suitable localities.

Resemblance between Western Ghats & Eastern Himalayas:

A biotope of particular interest from the point of view of faunal distribution in the Ghats section of the district is provided by the patches or enclaves of moist deciduous or evergreen forest scattered here and there in the higher hills. As regards their floristics, these pathches bear a close similarity to, or are more or less identical with, the moist evergreen forest in tropical Travancore on the one hand and in the Eastern Himalayas on the other. Zoological investigations suggest that in the geological past, perhaps till the early Pliocene (or about 15 million years ago) there was a more or less unbroken mountain connection between the Western Ghats and

the Eastern Himalayas by way of the Satpuda mountains. The present day Satpudas are merely the worn down stumps of a much loftier chain which by intercepting the south-west monsoon currents produced the rainfall and moisture necessary for the moist ever-green type of forest wherever it now persists. It is presumed, therefore, that such humid-forest birds as are now found in the Western Ghats and along the Satpuda trend are the relic populations of a former distribution which, like the moist forest patches themselves, formerly stretched continuously to the Eastern Himalayas.

Fish :

The rivers and streams of Pune are fairly stocked with fis, From the middle of June, when the south-west monsoon sets in, until the end of October, the rivers and the streams contain sufficient water. With the close of the rains their waters gradually subside, and, by March, they form a series of pools connected by long reaches of feebly running streams. Some of the pools are long, deep and rocky, providing sage sanctuaries for fish; others are shallow, easily netted or emptied in sections with the help of temporary dams. By the end of April the pools are plundered of all their fish-life.

During the monsoon, many a river fish migrates into streams and rivulets which are in spate and breeds in these shallow, sheltered waters. The old practice of fixing basket-traps or bag-nets of minute mesh to capture breeders returning to rivers continues in some places but not on the same extensive or destructive scale as before. Fry and other small fish, prawns, etc., are also captured in this manner. In wider seasonal streams, pairs of dwarf bunds so built as to converge towards each other with only a small outlet are put up in the bed. At these out-lets, duing breaks in the rainfall and in the final shrinking of the rainy-season floods, are set immense bag nets with meshes varying from two inches at the mouth to a quarter of an inch at the cod-end. These nets are usually st for ten to twelve hours and taken out in the morning and evening. As much as 300 pounds of fish, composed of specimens varying from an inch to several feet in length, are often taken from one such net.

A complete survey of the fish fauna of the water-ways of Pune District has not yet been done. Some parts of the Pune water-ways, however, have been surveyed by a few ichthyologists, and from the records it seems that there are in the district over 70 different species of 15 families.

Below is the list of some common species:

Order: Isospondyli.

Family : Notopteridae.

Only one species *Notopterus notopterus* (Pallas), locally known as Chalat, is of some commercial value. In young stages it is useful as larvicidal fish.

Order : Opisthomi.

Family: MASTACEMBELIDAE.

There is only one species *Mastacembelus armatur* (Lacep.), locally known as Vamb, to be found in most rivers of the Pune district. This is a favourite fish of the district, though some people reject it because of its snake-like form.

Order : Apodes.

Family: Angullidae.

Anguilla bengalensis (Gray), which is known as Aheer in Marathi, is the only species from this family inhabiting the Pune rivers. This fish has a slimy glandular skin and is greatly prized by some people as they attribute aphrodisiac properties to its slime and flesh.

Order : Eventognathi.

Family: Cyprinidae.

Sub-family : Abramidinae.

Source: Pune district Gazzetteer

Chela boopis (Day), *Chela clupeoides* (Bl.), *Chela phulo* (Ham.), and *Laubuca laubuca* (Hamilton), are four species belonging to this sub-family. All the three Chela species are locally known as Amli and are small, delicate and silvery forms, greatly appreciated as food. The commonest of them is *Chela clupeoides*. The remaining two are less common, but all of them prefer the same types of habitat. These can also live in still waters of lakes or tanks. the presence of this in large numbers in surface water indicates the presence of game fish like Barbus or Labeo or sub-family : Rasborinae.

Barilius barna (Ham.), *Barilius bendelisis* (Hamilton), *Barilius gatensis* (Cuv. and Val.) are known in Marathi as Theenohr, Jodhie and Jodhie respectively.

Aspidoparia morar (Hamilton) is known as Gor Amblee.

Rasbora daniconius (Ham.), locally known as Ranjannah and *Danio aequipinnatus* (McClelland), locally known as Thook Chatee, are associated together and are found in canals and lakes. These are of some use as larvicidal fish.

Sub-family : Cyprininae.

(a) Barbus (Tor) Khudree (Sykes)- Basara or Phirkee of the fishermen-is the angler's delight. It is known as Mahaseer of the Deccan and is found in most rivers of Pune, particularly parts of rivers frequented by Garra mullya and Labeo species. It prefers rocky-bed and moderately strong current. This fish attains large proportions and reaches a weight of from 30 to 40 pounds. Every year from March to Mar large specimens of this fish, about 30 pounders, are caught in the Mula-Mutha river at Kirkee on balls of whear flour (atta) as bait. Lake Fish of Khandakwasla has a good stock of large sixed fish of this type.

(b) *Barbus* (Tor) *Mussullah* (Sykes)-Musala-is another large sixed carp common in the Indrayani river at Kalumbra village, in the Bhima at

Pargaon and in the Ghod at Sirur. It reaches a length of over three feet and weighs over 20 pounds. This fish is available during August and September in a large pool in the course of the Mula-Mutha river, about 15 miles south-east of Pune. After September it retires to deeper pools further down the river. It is one of the species of Mahaseers and gives good sport to the anglers.

(c) *Barbus* (puntius) *Jerdoni* (Day)- Sufedpari Khadree.

(d) *Barbus* (puntius) *kolus* (Sykes)-Kholus.

(e) *Barbus* (puntius) *sarana* (Ham.)- Lallpari Khadree.

(1) The above species [i.e. (c) to (e)] are medium sixed carps growing from 6 to 18 inches and weighing up to a seer or more and are common in most rivers and lakes of Pune. they are used as food all over the district and are also of some value as semi-game fishes.

(f) *Barbus* (puntius) *ticto* (Ham.)-Debree or Chatee Debree-is a small hardy species often found in some parts of Pune rivers. It has no value as food but is useful as a larvicidal fish of the district.

Others Barbus species are:-

(g) *Barbus* (puntius) *amphibius* (C.V.)-Danghar.

(h) *Barbus* (puntius) *chola* (Ham.)-Dhunsahree.

The following six Labeo species are more or less common in the different parts of the Mula, Mutha, Mula-Mutha and Bhima rivers and the lakes and tanks of Pune. The Labeos, which are common carps of the Pune water-ways, are esteemed as food and game fishes.

Labeo calbasu (Ham.)- Cowchee-prefers parts of rivers with old masonry and sunken trees. It is a game fish which grows to over 3 feet and weighs about 15 pounds.

Other Labeo species are: *Labeo boggur* (Sykes)—Gohrah or Ghor; *Labeo fimbriata* (Bl.)—Tamthee; *Labeo potail* (Sykes)—Tooth; *Labeo kawrus* (Sykes)—Kawrus; *Labeo ariza* (Hamilton)—Kawrus.

Other fishes belonging to this sub-family are :—

Garra mullya (Sykes)-Mallia-is found in large numbers in the rocky sections of the rivers and canals and is used as food.

Garra bicornuata (Rao)-*Nukta mullya*; *Garra gotyla* (Gray)-Mullya; *Cirrhina fulungee* (Sykes)-Peela Kholus or Soor; *Cirrhina reba* (Hamilton)-Lolee; *Crossochilus latius* (Ham.)-Lahoor; *Mystacolencus ogilbii* (sykes)-*Bakhar Massah*; *Parapsilorhynchus tentaculatus* (Annan.); *Rohtee cotico* var. *cunma* (Day)-Deotee, Goordee; *Rohtee neilii* (Day)-Deotee;*Rohtee vigorsii* (Sykes)-Goordee.

Schizmatorhynchus (Nukta) *nukta* (Sykes)-Dootondee-is the two-mouthed fish of the local fishermen-rather a rare variety. It reaches a maximum weight of 3 lbs. In between the nasal apertures lies a conspicuous slit, above the proper oral aperture. This gives the two-mouthed appearance to the fish. Old males show gay colouration, every scale having a pale pink gloss and an apple green margin. The tips of the snout and of the nose are bright vermilion.

It is caught with some difficulty, as it frequents bouldery spots with some current, where it is difficult to net. There is always a great demand for this fish amont fisher folk, as it is believed that it brings luck to the house of the man who is fortunate enough to net it. This is sometimes netted in the Mutha river near the Kharadigaon Village.

Family : Cobitidae.

There are six species in this family, mostly bottom feeders, which dig themselves into fine gravel and are often caught in large numbers from most rivers by the fishermen. Of these *Lepidocephalus guntea* (Ham.)- and *Nemachilus botia* var.

aureus (Day), both locally called Moorhi, are considered as tasty fish but their intestines are full of grit. The other four are:-

Nemachilus ruppelli (Sykes)-Mohra gotia; *Nemachilus dayi* (Hora)-Kala Mooroong; *Nemachilus anguilla* (Annandale)-Mow; *Nemachilus evezardi* (Day)-Moree.

Order : Nematognathi.

Family: Siluridae.

There are three species of the family:- *Ompok bimaculatus* (Bl.)-Goongwaree; *Ompok pabo* (Ham.)-Kalie Goongwaree; *Wallagonia attu* (Bl.)-Shivada or Pahadi.

These fishes are often caught in the rivers and lakes of Pune. The Wallgonia attu, which is a predaceous species growing to huge dimensions, is very destructive to smaller fishes. It is known as the "fresh water shark of India", and, though of carnivorous habit, has considerable commercial value. All the tree are good game fishes and are commonly known as cat fishes.

Family : Bagridae.

Seven speices from this family are recorded from all over the district, most of which have commercial value and some grow to enormous size. Mystus montanus (Jard.)-Kohira-frequents rocky places in the Bhima river at Vadgaon where it is said to rach an enormous sixe. The giant fish often competes with the crocodile for possession of underwater caves in the pools, which both seek to occupy. The other species are :-Mystus bleekeri (Day)-Kala seenghal; Mystus cavasius (Ham.)-Singhara; Mystus gulio (Ham.)-Kala Tengnah; Mystus seenghala (Sykes)-Chotkah; Rita hastata (Val.): Rita pavimentata (Val.) Googoorah.

Family : Sisoridae.

This family is represented by five species, out of which Glypothorax conirostre var.Puneensis (Hora)-Phather chatoo-is more common to Pune and its environs.

The other are:-Gagata itchkeea (Sukes)-Padhnah ; Glypto thorax lonah (Sykes) ; Glyptothorax madraspatnam (Day)-Kengra ; Glyptothorax annandalei (Hora)-Pivala Kengra.

Family : Schilbeidae.

Only one species Proeutropichthys taakree (Sykes)-Munia-is recorded from Pune.

Family : Pangasidae.

Silonopangasius childrenii (Sykes)-locally known as Valunj is fairly numerous in the Indrayani and Bhima rivers. After monsoon floods these fishes along with othere retire to 30 to 40 miles below Pune where speciments weighing about 15 pounds are often caught with rod and line. They occasionally take a spoon and give good fight on light tackle. This fish requires careful handling as the strong spine in its pectoral fin may inflict a deep and painful wound.

Order : Cyprinodontes.

Family: Cyprinodontidae.

The only species Aplochilus lineatus (C.V.)-Jhir-a somewhat delicate fish of the waters is very useful as larvivorous fish. It is widely distributed in the water-ways of Pune district.

Order : Synentognathi.

Family: Xententodontidae

Xenentodon Cancila (Ham.)- Dengwah in Hindi and Kutra Massa in Marathi- is a common fish of the Pune rivers. It has numerous teeth and the snout is drawn out like a beak over one inch in lenghth. It is valued as a delicacy and has commercial value.

Order : Labyrinthici.

Family: Ophiocephalidae.

Three species from this family are recorded from the various water-eays of Pune. The species Ophiocephalus gachua (Ham.)-Daku-is comparatively less common than the other two species, viz., Ophiocephalus leucopunctatus (Sykes) and Ophiocephalus maruilus (Ham.)-both known in Marathi as Murrals. Murrals are highly prized fish of the Deccan. They are hooked throughout the year by anglers in all rivers with cockroach as a bait. Murral shooting with gun or rifle is considered an excellent sport. The proper season for shooting Murral is from November to April when the river water is almost clear and still. The fish has supra-branchial chamber and has taken to partial aerial breathing for which it comes, from time to time, to the surface of water and sticks out its snout to take a whiff of air. This is the time when the Shikari gets a chance to shoot the fish. Murrals grow to big size and may reach a weight of 15 to 20 pounds and have commercial value.

Order : Percomorphi.

Family: Ambassidae.

Only one species Ambassis ranga (Ham.)-locally known as Chandwa is found in midstream in strrong currents and in deep water. They are attractive in appearance, as they are greatly compressed and transparent in body. Being larvicidal and fairly hardy, they may prove useful in anti-mosquito measures.

Order : Gobioidae.

Family: Gobioidae.

Glossogobius giuris (Ham.) Kharpa-is the only species of this family found in the rivers and canals of the district. It is low quality commercial fish.

As the majority of the population of the district eat fish, fish is in demand all the year round. The fish prices, however, have gone so high that this valuble food is hardly at present within the reach of the common man. Cheaper varieties like Amli, Calata, Kutra-masa, Male, and others are sole at Re. 1-4-0 to Rs. 2-8-0 a seer, while Maral, Vamb, Khadra, Sivda and other bigger varieties fetch from Rs. 2 to Rs. 3 a seer. Development of fisheries of the district has recently engaged the attention of the State Government. Thousands of fry (fish-seed) and fingerlings of Catla catla, Lebeo rohita (Rohu) and Cirrhina mrigala (mrigal) imported from Calcutta have been liberated into perennial sheets of water, such as Lake Fife at Khandakvasla, and the Katraj and Pashan tanks. It is expected that these carps reputed for their rapid growth and good flavour will bread and establish themselves in Pune waters. Much of the fame of the fresh water fisheries of Bengal is due to the abundant occurrence of these varieties in the Ganga river and its tributaries. It is, therefore, hoped that with the introduction of the aforesaid varieties into Pune waters, the commercial fish fauna will be considerably enriched.

All sorts of antiquated methods of fish-catching are in vogue in different parts of the district. In some parts fish is speared with spears specially prepared for the purpose. Even bow and arrow is used for shooting fish in the shallow rivulets of Mawal. Various sorts of poisonous substances are used to dope the fish, with the result that there is immense destruction of fish and depletion of fish stock.

Thus the Pune district and its subdivision Talukas and Mahals are very rich with plant and animal biodiversity. The forest are high rich with species diversity. The fauna including birds, fishes and big anomals show high abundance and frequesncy.

CHAPTER-IV

WATER POLLUTION BY INDUSTRIES

Pollution by industrial effluents

Pune is fastest developing city in Maharashtra. Globally Pune is known for Automobile Industry, Education and Information technology Industries and Software Industries. Due to urbanization of Pune city and adjoining area of Pune district and Haveli Tahsil, Paud Tahsil, Bhor Tahsil, Shirur Tahsil and Rajguru Nagar Tahsil. The requirement of water for human settlements Industries and service Industries has increased by many forts in exponential rate of growth. The water supply in Pune district for agriculture, drinking water and Industrial use is supplied from 23 minor, medium and major water reserves. Total storage capacity of this 23 water reserves is 4543.34 million cubic mtr. The main water supply for villages and towns situated on the banks of river is from river water or well.

The following table is explanatory regarding the municipal corporations, municipal councils, containment board villages on river banks and industries which are permitted to drain their sewage water in Bhima river after physical and chemical process. But unfortunately the strangen provision of treatement of seqwage water is not followed as per the bio-chemical norms of water. The above units are permitted to drain their sewage water in Bhima river and their tributariesa after processing ands treating the sewage water by the scientific methodology in the river.

Table 4.1 : Water supply and sewage water production and sewage treatment plant schemes of the various units.

Sewage Water Supply Information

Sr. No.	Village/Town	Population	Water Suply	Sewage Water Produced	MLD	Chemical Sewage Water
Total		**607723**	**1725.19**	**1239.63**	**743.51**	**697.71**
a)	Mahanagar Palika (Total 02)	60,00,000	1410	999	589	549
1	Pimpri-Chinchwad	20,00,000	360	255	207	167
2	Pune	40,00,000	1050	744	497*	382
Total		**60,00,000**	**1410**	**999**	**589**	**549**
b)	Nagar Palika (Total 10)	3,75,528	63.3	48.08	3.69	3.69
1	Lonavala	49,865	21.1	16	3.69	3.69
2	Taleagaon	56,025	9	6.72	0	0
3	Aalandi	40,000	4	2.4	0	0
4	Junnar	24,741	2.2	1.76	0	0
5	Shirur	40,000	5	4	0	0
6	Saswad	26,689	5	4	0	0
7	Jejuri	12,000	3	2.4	0	0
8	Daund	42,208	5	4.2	0	0
9	Baramati	61,500	5.3	4.2	0	0
10	Indapur	22,500	3	2.4	0	0
Total		**3,75,528**	**63.3**	**48.08**	**3.69**	**3.69**
c)	Inspection Zone (Total 03)	3,04,286	47.44	34.9	9.2	6
1	Dehu					
	Urban Residential Area	46,921	9	8.2	0	0
	Defence Residential Area	14,000	1.9	1.5	0	0
2	Khadki					
	Nagri Residential Area	77,473	11.6	6	9.2	6
	Defence Residential Area	16,027	2.14	1.7	0	0
3	Pune					
	Urban Residential Area	79,865	12.8	8	0	0
	Defence Residential Area	70,000	10.0	9.5	0	0
Total		**3,04,286**	**47.44**	**34.9**	**9.2**	**6**
d)	Villages situated near rivers (Total 196)	607,723	24.30	16.93	0	0
	Daund (33 Villages)	111,961	4.47	3.13	0	0
	Haveli (35 Villages)	170,070	6.80	4.7	0	0
	Indapur (19	24,798	0.995	0.697	0	0

Sr. No.	Village/Town	Population	Water Suply	Sewage Water Produced	MLD	Chemical Sewage Water
	Villages)					
	Shirur (11 Villages)	26,753	1.07	0.74	0	0
	Khed (35 Villages)	142,783	5.71	3.99	0	0
Total villages 196		**607,723**	**24.30**	**16.93**	**0**	**0**
e)	Industries at bank of rivers					
1	Industrial Area		145.2	112.5	113.4	110.8
i)	Talegaon	--	2	1.6	4**	1.6
ii)	Chakan	--	6	4.8	4.8	4.8
iii)	Talwade	--	2	1.6	1.6	1.6
iv)	Bhosri (with Pimpri-Chinchwad)	--	100	80	80	80
v)	Hinjwadi	--	3.2	2.5	0.8***	0.8
vi)	Ranjangaon	--	13.5	10.8	10.8***	10.8
vii)	Jejuri	--	1	0.8	0.8	0.8
viii)	Baramati	--	11	9.6	9.6	9.6
ix)	Kurkumb	--	6.5	0.8	1	0.8
Total			**145.2**	**112.5**	**113.4**	**110.8**
2	Total independent Industries 7	--	34.95	28.22	28.22	28.22
Total		**607723**	**1725.19**	**1239.63**	**743.51**	**697.71**

Source: Data collected by Maharashtra Pollution Control Board, Regional office, Pune

Above mentioned graph gives bird's eye view regarding the potentiality of the water pollution of the Bhima river and its tributaries. While interpreting above graph the first inference is the urbanization of the Pune district is a potential cause of water pollution for Bhima river. In the due process of urbanization the first and the formest victims are rivers and its perinial water flow second inference is also hig opening and of serious nature. Very high percentage of sewage water are drained into river which is non purified and untreated. Bhima basin is providing with its tributaries water supply around 1725.19 million ltrs/day for domestic purpose drinking purpose and Industrial purpose. Out of 1725.19 1239.63 is a sewage water and this water is major potential for water pollution. Out of 1239.63, 697.71 MLD sewage water is treated with primary, secondary and in few places tertiary for treatment. Around 541.92 MLD sewage water is added in Bhima and its tributaries which is non purified causing cardinal threats for the ecological balance and flora & fauna. The volume on untreated water is added in Bhima river and indeex of urbanization is directly responsible adding this untreated water in Bhima river. From Pune Metropolitian are 362 MLD (66.80%) Pimpri-Chinchwad 88 MLD (16.24%), for ten municipal council

area 44.39 MLD untreated sewage water (8.2%), from 3 cantonment area 28.9 MLD (5.33%). The villages situated on river banks untreated sewage water 16.93 MLD (3/12%), Hinjawadi Industrial hub 1.7 MLD (0.31%) untreated sewage is added in the Bhima river and its tributaries. Maharashtra Industrial Development Corporation, Talegaon Unit has developed sewage treatment plant having 4 MLD capacity which is providing pivotal services to treat the sewage water and this water is also used for promotions of border and water supply to the trees and saplings.

Maharashtra Industrial Development Corporation is one of the information technology hub. MIDC also trying to develop sewage treatment plant but still it is not fulfilling the requirement as treatment capacity is only for 0.8 MLD. This industrial hub must have treatment plant to help the sewage water around 4MLD and it will reduce the water pollution of the rivers. MIDC units at chakan, Pimpri-CHinchwad, Bhusri Ranjangaon Jejuri Baramati have also develop their own treatement plants with the better innovation the treated water is used for the purpose of gardening watr supply to the trees and can be used for the protection, promotion & preservation of the environment. The critical Analysis of the graph indicates the urbanization of the Pune district is terrible impact of Flora & Fauna of Bhima river which is also supported by Industrial development in the city.

Physical pollution:

Colour:

May be possibly due to substances of mineral origin, such as iron or chromium, or to organic dye stuffs. Colour may not necessarily be harmful, and natural water of peaty origin is often highly coloured, but colour can adversely affect photosynthesis.

Turbidity and suspended matter:

The river water may become turbid due to traces of soil and clay particles. Other causes reduction inof turbudity are sand, ashes, gravel, coal, dust, paper pulp or its constituent fibres. If turbidity is excessive, sunlight can be cut off and plant life in the stream may come in danger. It is even possible for plankton to be coalesced and

deposited; whilst the gills of fish may be damaged and ovodeposition prevented, if the character of the spawning ground is rendered unsuitable.

Temperature:

The rise in temperature caused by warm effluents can cause reduction of dissolved oxygen and also leads to an increased use of oxygen by biochemical reactions occurring in the water. Fishes may be directly affected and die and there may be an adverse effect on fish eggs. Additionally a rise of temperature may have a potentiating effect on toxic substances present in the water at sub-toxic concentrations. The average temperature difference between the influent and effluent of many electricity generating stations is 7º C. This is quite enough to affect the flora and fauna of the river in the immediate neighbourhood of the discharge; but it is probable that the area affected is fairly limited

Froth:

This is increasingly common on many rivers and often results from use of synthetic detergents which pass a sewage works with little biological degradation. Low concentrations of detergents may be toxic to fish, whilst water plants may have their development retarted and oxygen uptake by the water is adversely affected.

Radioactivity:

Natural waters may possess a small quantity of radioactivity largely due to the natural isotope of potassium, but the recent expansion and research into the applications of nuclear energy has lead to public concern about pollution of water in this manner. This concern is increased by the fear that certain radio-isotopes may be stored in plants, fish, etcand cause injuries to them.

Physiological pollution:

Taste:

Peculiar tastes may be imparted to water by various substances such as oil, iron, chlorphenols, etc. Algae and other flora and fauna of water may decompose and give rise to unpleasant tast.

This may be due to the presence of strong smelling chemicals and to decomposition of organic matter.

Biological pollution:

This may result from sewage effluents which cause algae and other water organisms to proliferate. Growths of fungi result from discharge of sewage and other organic effluents, whilst the presence of large quantities of nitrate can also stimulate algae.

Water eourses can be heavily contaminated with bacteria, including pathogenic organisms present in sewage effluents, even those which have been adequately treated. However so far no legal action has been taken on the presence of an altered bacteria flora in a stream or river.

Chemical pollution:

This is probably the most striking aspect of pollution at the present time and merits more consideration. This type of pollution is divided into pollution caused by organic wastes and inorganic wastes.

Organic waste:

The grossly polluting character of many of these effluents is due to the protein content, examples being sewage, food processing, tannery and dairy wastes. Fats and oils prevent aeration of water and occur in wool washing, fat refining, and laundry wastes; but it may often be economical to recover the fat. If there is sufficient dilution most organic compounds can be broken down, but dissolved oxygen is used up

during the process hence with heavy pollution putrefaction occurs and when the dissolved oxygen falls below a level of about 57 per cent saturation then fish mortality is likely to occur.

Inorganic waste :

The normal pH of water will be altered by discharge of acids or alkalies. Salt can have a deleterious effect on fresh water fish, but probably the most damaging pollution is the discharge of traces of metals. These may be precipitated but are often only diluted out of toxic limits and their effects may be apparent over a considerable distance. The actual toxicity of a substance to fish will depend upon the variety age, condition, and size, thus pike may be more tolerant to some poisons than salmon, and small, young fish may be more susceptible than fully grown fish.

Fish have been mentioned frequently in the foregoing paragraphs and this is doubtless due to the fact that dead fish are easily seen hence pollution is readily brought to the notice of an observer. It must not be forgotten that pollution will alter water quality and may thus adversely affect animals that may drink this water or soil and plants which may be irrigated with it.

Referring back to the Acts passed by Henry VIII, which were directed to the protection of navigation; effects of pollution are still seen in this connection as banks of silt may be deposited, which will necessitate dredging in order to maintain navigable channels. Discharge of some wastes will also increase corrosion of metalwork of ships and barges. Some sections of the original Henry VIII Act are still in force, whilst the scope of pollution has been extended in more recent Statutes concerning navigable waters.

Towards the end of the last century considerable progress had been made in the biological purification of sewage and filter beds were replacing land treatment. In 1898 a Royal Commission was appointed to enquire into methods of treating and disposing of sewage and liquids from factories and manufacturing processes. Over a period of seventeen years nine reports and a final report was issued. In these reports, and especially the later ones, recommendations were made regarding standards to be

applied to various types of effluents and these standards are still quoted frequently. They have not been given the general force of law, although certain of them have been incorporated into specific Acts such as the Middlesex County Council Act, 1931, section 13(1); the Wimbledon Corporation Act, 1933, section 32(3); and the Hertfordshire County Council (Colne Valley Sewerage, etc.) Act, 1933, section 46.

The Royal Commission on Sewage Disposal classified effluents into two classes, those in which efficient purification was possible, and those for which, in the then existing state of knowledge, purification was not entirely satisfactory. For the first class, standards of purity of the effluents were laid down, and consisted of the regulation of the amount of suspended solids and the five days' oxygen absorption test. In the second class, standards were suggested or recommendations were made that the effluent should not be discharged into a stream, as an appropriate standard could not be suggested.

4.2 The Royal Commission classification of rivers and effluents according to their Biochemical Oxygen Demand

Very clean	:	0.1 parts	Oxygen	Per 100,000	absorbed	In five days
Clean	:	0.2	”	”	”	”
Fairly clean	:	0.3	”	”	”	”
Doubtful	:	0.5	”	”	”	”
Bad	:	1.0	”	”	”	”

4.3 The usual expression of results at present is in parts per million, bringing the above classification into line

Very clean	.	.	1	ppm	B.O.D.	or less
Clean	.	.	1 to 2	”	”	”
Fairly clean	.	.	3 to 3	”	”	”
Doubtful	.	.	3 to 5	”	”	”
Bad	.	.	10	ppm	B.O.D.	or more

This demand is a laboratory method of assessing the degree of pollution of a stream or effluent by measuring the loss of oxygen in solution from a closed sample kept at 18º C. for five days. As the oxygen is absorbed chiefly by bacterial action and to a lesser extent by chemical reducing agents, it is called the Biochemical Oxygen Demand-usually abbreviated to B.O.D.

It must be borne in mind, however, that it is possible to get a low B.O.D. value from rivers or effluents which contain antibiotic discharges or heavy metals-or, indeed, anything capable of killing-off the organisms which contribute to the biological activity responsible for B.O.D.

Fowler divides effluents into those containing mainly mineral constituents and those consisting largely of nitrogenous matter. The former class is all fairly readily purified, while many of the latter class are susceptible to considerable improvement.

So far as it may be possible, most manufacturers attempt to work up the effluent for the extraction of some particular byproduct which may be of value, or an attempt may be made to find some use for the effluent which may be sold for that purpose; usually, however, the effluent is discharged to the sewers and treated with the town's refuse. It is quite possible that the effluent may increase the difficulty of treating town refuse, as, for example, the presence of grease in the wool industry causes difficulties of filtration, whilst the cyanides present in a gas work's effluent will successfully destroy the biological growths which assist purification.

On account of this, various methods of examination have been proposed, and much work has been published on the toxic and other effects of effluents on possible factors with which the effluent may come into contact.

The factors considered are fish and biological life of the stream into which the effluent is discharged, agricultural, e.g., soil, plants, live stock, possible effect on industries, and also possible pollution of ground and well waters, especially if these are to be used for human supplies.

Effect on live stock:

Whilst cattle may be less susceptible to poisons than humans, the water should be as pure as possible-if possible, as pure as for human consumption. In particulars, with mulch cows impurities may adversely affect the quality of the milk, whilst an excess of purgative salts, e.g., magnesium sulphate, may produce abortion in pregnant animals. Stock eating fodder which has been grown on land contaminated with noxious effluents may affect health.

Fitch has found that "water-bloom," a blue-green alga, produces poisoning of cattle, sheep, dogs, horses, and fowls. Putrefaction of the alga leads to the disappearance of the toxic symptoms and tests indicate that the toxicity is due to the presence of an organic compound. This has been confirmed by Olson and by Stewart and his co-workers. High salt concentrations can be harmful to animals, although brackish waters containing up to 1 per cent salt may be tolerated by cattle, but an increase to 1.5 per cent produces toxic systems. Water with 1 per cent salt would be harmful to pigs.

With regard to domestic sewage, no toxic compound has yet been found in it, and experiments on Ayrshire cattle have shown that sewage effluents are non-toxic. This has been confirmed by Robinson, who concluded that water containing human sewage was not harmful to cattle; in fact they may appear to prefer drinking it.

The presence of poisons, such as arsenic, in water would preclude the use of this water by cattle in the same way as it would preclude the use by humans of such water. In fact deaths of cattle and illness of humans have been recorded when the water was contaminated with arsenic derived from a potato haulm destroyer.

The wide use of pesticides of the chlorinated hydrocarbon type *e.g.,* D.D.T. on farms, has led to drainage from such farms containing traces of these substances. The only way to remove them from the water appears to be by activated charcoal.

On a farm, water is used for a variety of purposes, but a major use is in connection with cattle and dairying processes. The Milk and Dairies Regulations, 1949, came into existence. The consumption for dairy purposes increased greatly, and the water consumption per cow or calf increased from 10 gals per day to 15 gals per

day. The Regulations require a suitable and sufficient water supply to ensure adequate cattle watering and cleanliness of all buildings, utensils, persons etc. This requires water of the quality of a normal public supply.

Injurious effects of industries:

This also has to be considered, but as yet not given much importance in practice. Since the community or industry discharging the effluents usually regarded it as the liability of the industry, taking up the water to treat it in a manner fit for its particular use; otherwise it is possible for the consumer to abandon his source and still leave the purification as charge on the person discharging the effluents. This is one of the arguments against the sterilisation of a sewage effluent passed into a stream which is used further down as an intake for drinking purposes. Also the water in its course naturally takes up bacteria.

Use has been made of proflavine and actiflavine in dilution of about 1.5 ppm. to inhabit sulphate-reducing bacteria, which cause hydrogen sulphide production and hence serious industrial troubles. Industries may raise objection to the method on account of other difficulties which might arise from the slight colour in the water.

Navigation or passage of vessels is an important industrial use of water in some coastal and estuarine areas, and although polluted water are suitable for the purpose some constituents are objectionable, such as acids which may help or cause corrosion, alkali which may damage woodwork, hydrogen sulphide which discolours paint and reacts with copper and brass as well as corroding concrete.

It was reported that a discharge of warm effluents was containing chromates, sulphuric acids, and volatile organic sulphur compounds. Vessels which regularly used a berth adjacent to the discharge began to show peeling and discoloured paintwork together with corrosion of the underlying metal. Metal structures on the berth were affected and also the bronze propellers of the vessels. Compensation was paid to the owner of the vessels. Navigation may of course be hindered by suspended matter which may require dredging in order to maintain a clear channel.

Effect on the soil:

The soil may be affected in various ways, and thus affect the crops produced on it. This latter is difficult to prove as some substances are metabolized by plants and hence undergo change, whilst others may be absorbed in small or large quantities. However has experimented on the watering of soils, with plants in acid, neutral and alkaline, soils treated with waters which have been lime-soda softened, treated with zeolite to give various grades of water, and also with distilled water. The results produced showed that the various waters used had no detectable effect on soil reaction or plant development.

On soil the effluent may act by conveying substances which are directly injurious, or it may deposit suspended matter which clogs up the pores of the soil and causes the soil to become acid and thus injuriously affect vegetation. Some effluents contain free mineral acids or acidic salts which exert a solvent action on soil constituents; hence the soil steadily becomes poorer in some constituent, especially calcium. The presence of chlorides effects a closer packing of soil particles which makes the ground heavier and less fertile as well as increasing the difficulty of aeration.

Colloidal and other suspended matter can have an adverse effect on siol structure by filling up interstices and so preventing access of oxygen. Due to the use of copper in water treatment some attention has been paid to the effect of copper on crops. In particular, corn is affected 1.2 ppm is fatal to maize, and 1 part per 700,000,000 retards the growth of wheat . On the other hand, 1 ppm is not fatal to cress.

With more intensive cultivation, increasing use is made of irrigation either with water or sewage effluents. Plants vary enormously in their requirements of water and may be as low as 1 gal. per season per lettuce up to 75 gals per season for each separate tomato plant.

Most of this water is needed during the summer months when energy has to be dissipated. If there is a restricted uptake of water by the plant it is possible for photosynthesis to stop, even if there is much sunlight, also the leaves begin to heat

up, and if they become too hot death of the plant may result, although wilting will have occurred before this

The requirements of water have been discussed by Wilcox, and dependent on the crops grown, permissible limits for boron, sodium, and soluble solids, etc., exist. Boron whilst essential for plant growth in minute quantities may become toxic when the boron content reaches 0.5 to 1.0 ppm. An excess of sodium causes the soil to become alkaline due to formation of sodium carbonate, and even in low concentrations this is harmful to plant life, whilst, of course, toxic ions will also be injurious.

As many crops are used for human consumption, it is advisable for irrigation water to be of satisfactory bacteriological quality. Thus water used for irrigating water-cress beds should be of high quality as the cress is often consumed without further treatment on the part of the consumer. Some growers do wash the cress with a dilute hypochlorite solution as a safety precaution, but this may adversely affect the quality of the cress if long journeys are involved. Russell and Tincker and Johnson discussed this issue in their research. Europe is not alone in having pollution problems as the great rivers of the U.S.A. show similar effects, but due to the volumes of fresh water available for dilution the results of such pollution have only been seen to the full in recent years.

According to a newspaper report Federal and State Governments have instructed St Louis to stop polluting the Mississippi by 1967. A Citizens' Committee approved the construction of proper sewage treatment plant which will cost something in the region of £ 35,000,000 ($ 95,000,000), but had the problem been tackled at an earlier date the cost would not have been as high and the river would have recovered much sooner.

It is understood that the town of Cincinnati some years ago prevented pollution of the Cincinnati river by means of an injunction against a firm discharging an effluent containing dyestuffs. The method of obtaining this injunction was based on Common Law, i.e., the right of a riparian owner to receive the water in an uncharged condition; hence any alteration of colour, temperature, composition, or

other factor would suffice for a successful case in the U.S.A., as it does in the United Kingdom. This facet of Common law is the basis for the success of the Anglers' co-operative Association in many of its prosecutions.

About Bhima river

Bhima river is a major river in Southern India. It flows southern for 861 kilometres (535 ml) through Maharashtra, Karnataka, and Telangana States, before entering the Krishna river. After the first sixty-five kilometers in a narrow valley through rugged terrain, the bank open up and form a fertile agriculture area which is densely populated. The river is prone to flooding due to heavy rainfall during the monsoon season. In 2005 there was severe flooding in Solapur, Bijapur and Gulbarga districts.

Course:

Fig 4.1 : Confluence of Indrayani and Bhima river at Tulapur

The Bhima river flows southeast for a long journey of 861 kilometres (535 m), with many smaller rivers as tributaries. It originates near Bhimashankar Temple in the Bhimashankar hills in Ambegaon Taluka on the western side of the Western Ghats, known as Sahyadri, in Pune District, Maharashtra state, at 19°04′03″N 073°33′00″E. It flows through Bhimashankar Wildlife Sanctuary where it enters Khed Taluka and is soon joined by its tributary, the Aria

river from the right (west) which flows into the Chas Kaman Reservoir. Upstream on the Aria is the Rajgurunagar-Kalmodi Dam impounding the Kalmodi Reservoir. The Chas Kaman Reservoir is impounded by the Chas Kaman Dam, the most upstream dam on the Bhima river proper. The village of Chas is on the left bank some 16 km below the dam. Some 5 km along the river below the bridge on the Bhirma at Chas, the Kumandala river enters from the right.

From there it is 8 km along the river to the railroad bridge at the town of Rajgurunagar (Khed) on the left bank. In 18 km further along the river, the Bhima river enters from the right just above the village of Pimpalgaon on the left bank. From there to Siddhegavhan along the river is 10 km. Siddhegavhan is the last village in Khed Taluka on the left.

After leaving Khed Taluka, the Bhima forms the boundary between Havali Taluka on the right (south) and Shirur Taluka on the left (north). From the Bhima's intersection to the Indrayani river, which also enters from the right, is 14 km along the river. At the confluence is the town of Tulapur on the right bank in Havali Taluka. The Bhima, Indrayani and Mula-Mutha riversare the major tributaries of the Bhima that drain western Pune. After the Indrayani, in about 4 km down stream the Dhomal river enters from the right, at the village of Wadhu Budruk. Shortly thereafter (3.5 km) the Bhima passes under the SH 60 bridge at the town of Koregaon Bhima. From Koregaon going east, downstream 16 km, is the confluence with the Vel river (Wel river) from the left (north) and the village of Vittalwadi. The Vel river also arises in Ambegaon Taluka, east of the Bhima, and flows through Khed Taluka and into Shirur Taluka before flowing into the Bhima. With Vittalwadi on the left, the right side of the river leaves Haveli Taluka and enters Daund Taluka.

From Vittalwadi the Bhima meanders northwest and 14 km after the Vel river enters from the left, the Kamania river (Kamina) enters from the left at the village of Parodi. After the Kamania river enters, the river meanders back southeast for 23 km to the confluence with the Mula-Mutha river from the right at the village of Ranjangaon Sandas. The Mula-Mutha river flows from the city of Pune where it is a combination of the Mula river and the Mutha river.

31 km after the Mula-Mutha river, the Ghod river enters from the left (north) across the Bhima from the village of Nanvij (Nanwij). The Ghod river is the last of the Western Ghat tributaries of the Bhima. Shirur Taluka stops at the Ghod river, and Shrigonda Taluka of Ahmednagar District continues on the left (northeast) side of the river. Downstream just 6 km from the Ghod river, is the city of Daund on the right (southwest) bank.

Chandani, Kamini, Moshi, Bori, Sina, Man, Bhogwati and Nira are the major tributaries of the river in Solapur District. Of these, the Nira river meets with the Bhima between Nira Narsingpur in Pune District and Malshiras Taluka in Solapur district. Bhima merges into the Krishna along the border between Karnataka and Telangana about 24 km north of Raichur. At the point where the two rivers meet, the Bhima is actually longer than the Krishna in length.

Major tributaries of Bhima river :

- Sina river
- Nira river
- Mula-Mutha river
- Chandani river
- Kamini river
- Moshi river
- Bori river
- Man river
- Bhogwati river
- Indrayani river
- Kumandala river

- Ghod river
- Bhama river
- Pavna river

Source: Irrigation department of Maharashtra.

Bhima basin:

The total area of the Bhima basin is 70,614 km². The population living along the banks of Bhima is approximately 12.33 million people (1990) with 30.90 million people expected by 2030. Seventy-five percent of the basin lies in the state of Maharashtra.

Temples on the bank of Bhima river:

- Bhimashankar one of the twelve esteemed Jyotirlinga shrines.
- Siddhatek, Siddhivinayak Temple of Ashtavinayak Ganesh
- Pandharpur Vithoba Temple in Solapur district.
- Sri Dattatreya Temple, Ganagapura, Gulbarga district, Karnataka.
- Shri Kshetra Ghattargi Bhagamma, Ghattargi, Gulbarga District, Karnataka.
- Sri Kshetra Hulakantheshwar Temple, Heroor (B), Gulbarga District, Karnataka.
- Shri Kshetra Rasangi Balabheemasena Temple in Rasanagi, Jevargi Taluka, Gulbarga district, Karnataka

Dams:

There are twenty-two dams in basin of Bhima river. The first dam is the Chas Kaman Dam in Khed Taluka, Pune district. The largest dam by capacity is Ujjani Dam, near Tembhurni, Solapur District. Total Water storage capacity of Bhima basin

is about 300 TMC in Maharashtra state. Nearly 30 barrages are constructed across the main Bhima river from the downstream of Ujjani dam in Maharashtra and Karnataka states to harness all the water available in the river in excess of Krishna Water Disputes Tribunal allocations.

Dams	**- Capacity [river]**
Ujjani	- 118 TMC [Bhima]
Bhatghar	- 23.50 TMC [Yelwandi]
Mulashi	- 18.47 TMC [Mula]
Varasgaon	- 12.82 TMC [Mose]
Dimbhe	- 12.49 TMC [Ghod]
Nira Devdhar	- 11.73 TMC [Nira]
Panshet	- 10.65 TMC [Ambi]
Manikdoh	- 10.17 TMC [Kukadi]
Veer	- 9.41 TMC [Nira]
Pawana	- 8.51 TMC [Pawana]
Bhama Askhed	- 7.67 TMC [Bhama]
Chas Kaman	- 7.58 TMC [Bhima]
Ghod (Chinchani)	- 5.47 TMC [Ghod]
Pimpalgaon Joge	- 3.89 TMC [Aarala]
Temghar	- 3.71 TMC [Mutha]
Andhra	- 2.92 TMC [Indrayani]
Yedgaon	- 2.80 TMC [Kukadi]

Khadakwasala	- 1.98 TMC [Mutha]
Kalamodi	- 1.51 TMC [Aarala]
Vadaj	- 1.17 TMC [Meena]
Vadivale	- 1.07 TMC [Indrayani]
Visapur	- .90 TMC [Hanga]
Gunjavani	- .69 TMC [Gunjavani]
Nazare	- .59 TMC [Karha]
Kasarsai	- .57 TMC [Pawana basin]
Walwan	- [Indrayani]
Chilewadi	- [Kukadi basin]
Pushpawati	- [Kukadi basin]
Thitewadi	- [Vel]
Sina Nimgaon	- 2.2 TMC Approx[Sina]
Sina Kolegaon	- 5.0 TMC Approx.[Sina]

Source: Irrigation department of Maharashtra, Pune office.

CHAPTER-V

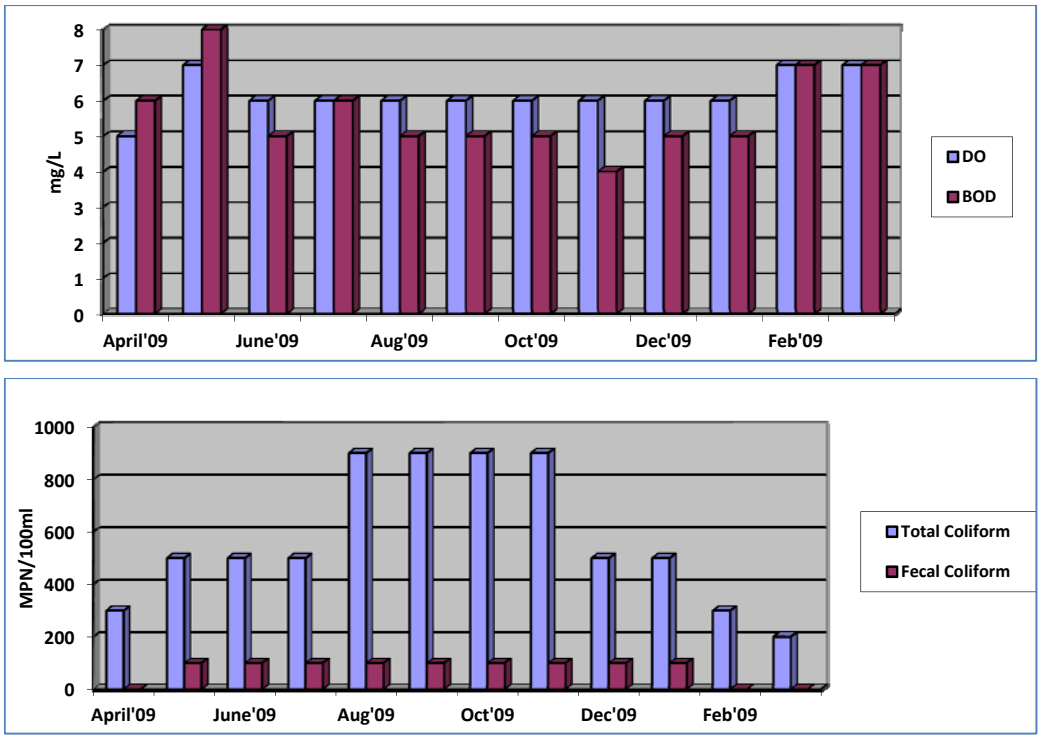
DRINKING WATER QUALITY

The Bhima river and its tributaries passes in rural as well as urban settlements. The Bhima basin and its tributaries have also lot of potential for industrial development. The major challenge for Bhima river pollution is rate of increase in Urbanization, Industrialization and lack of Infrastructure and logistic for treatment of sewages water.

As per the report of Maharashtra Pollution control board the municipal corporation, cantonment area, municipal council and villages settle on the bank of Bhima river and its tributaries creates potential amount of sewage water the un-treated sewage water is major and cardinal source of water pollution of Bhima river and its tributaries. There is a dam constructed on Bhima river at Ujani on the border of Pune and Solapur district, as per the report of MPCB the day by day quality of Bhima reservoir is deteorating in context of dissolved oxygen and bio-chemical oxygen demand.

The sample survey of water collected from upper Bhima basin by the Maharashtra pollution control board and with the help of aid and assistance by state and central government, water samples were collected and tested in the laboratory, which are the basic fundamentals and data source for the research work. The outcomes and findings and inference of the tested water from different 25 places for the period of April' 2009 to March' 2010. The inferences are self explanatory and findings are based on dissolved oxygen, bio-chemical oxygen demands, nitrate, total & fical coli-form, findings of Maharashtra Pollution control Board are given below which are self explanatory for the gradient of water pollution of the rivers.

Fig. 5.1 Mutha river drinking water quality

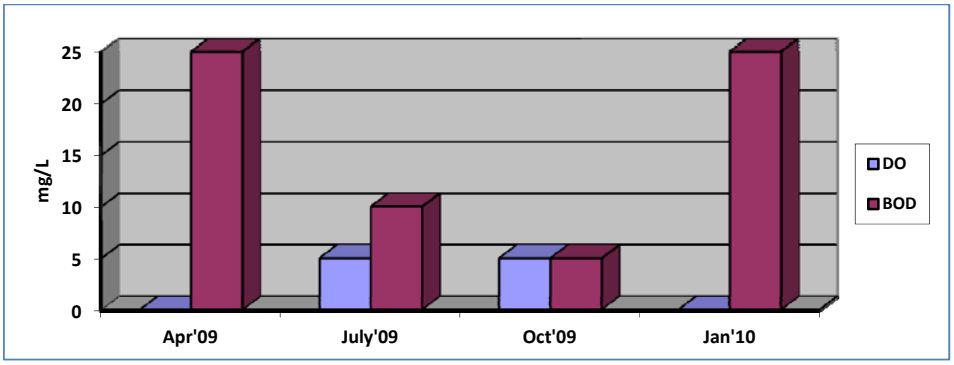


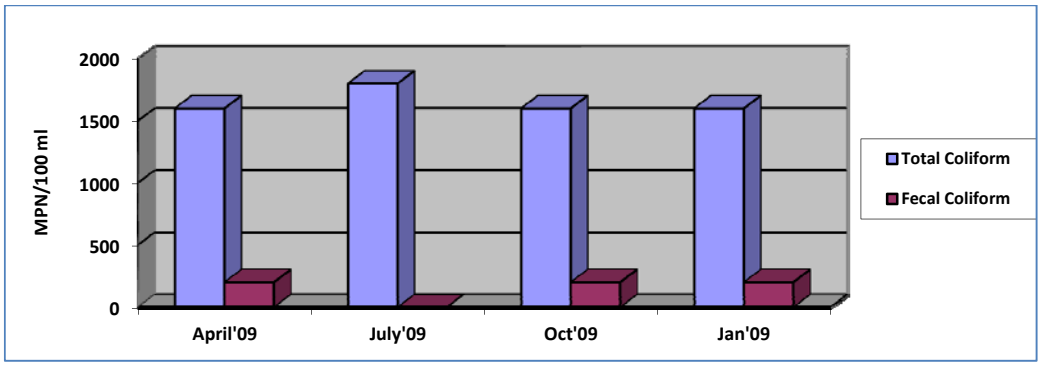
Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

Khadakwasla:

The samples were collected near khadakwalsa dam, Pune. In Khadakwasla Dam the percentage of dissolved oxygen was approximate 5-7 mg/l and bio-chemical oxygen demand was about 4-8 mg/l. Total coli-form and fical coli-form was about MPN 200-900/100 ml. S, the water from Khadakwasla dam is not fit for human consumption without purification. After purification the water may be fit for human drinking by proper disinfection.

Fig. 5.2 Mutha river drinking water quality



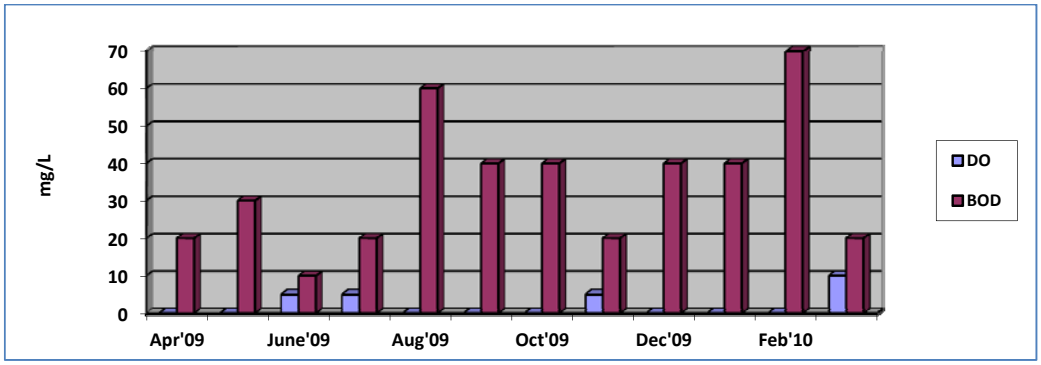


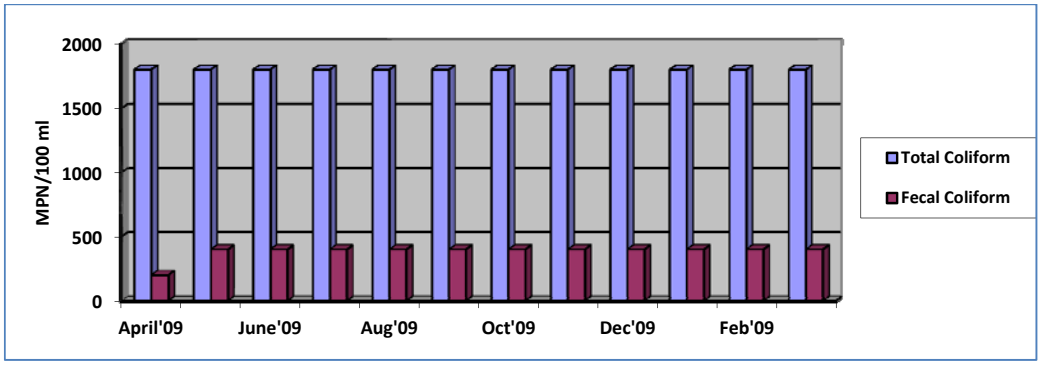
Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

Near Vitthalwadi, Pune:

The sample of water were collected other than rainy season as the flow of river is stagnated and not as a free flow. In sample near Vitthalwadi, Pune DO is 1-2 mg/l. and BOD is 8-25 mg/l. Which is absolutely abnormal for human health index. In sample total coli-form & fical coli-form was estimated and percentage was 1600-1800/100ml of water. It itself indicate that this water is highly unhygienic for human consumption as the parameters are absolutely subnormal, this water is not even portable after due process for water purification and dis-infection.

Fig. 5.3 Mutha river drinking water quality



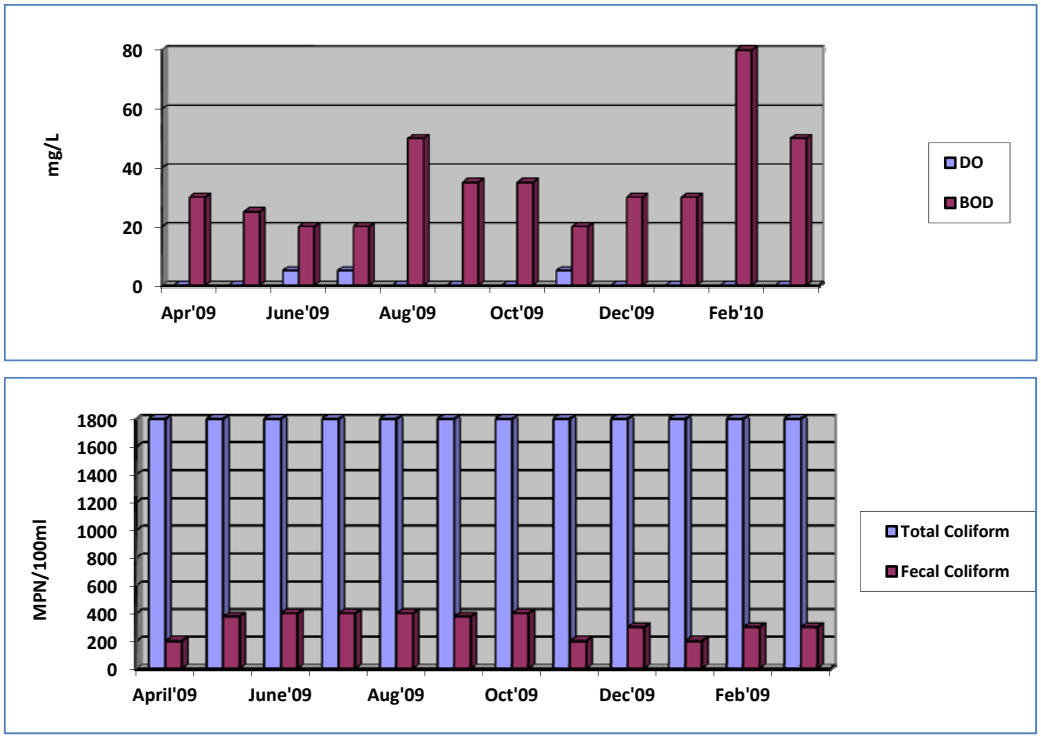


Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

Near Deccan, Pune:

Water samples were collected in non monsoon season. The percentage of DO was 2-7 mg/l. The percentage of BOD was also 10 to 70 mg/l and total chloroform and fecal chloroform percentage is MPN/100 ml. it was more than 1800 and 200-450 because of which water is disinfected and not suitable to drink.

Fig. 5.4 Mutha river drinking water quality

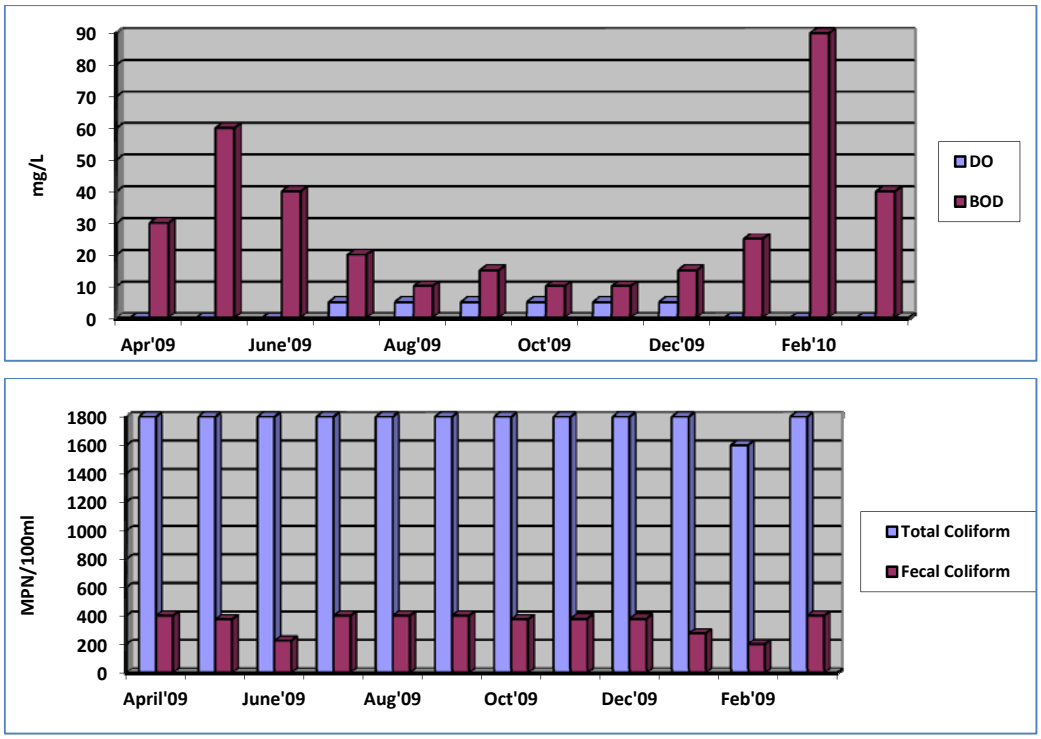


Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

Near Veer Savarkar , Pune:

Water samples were collected in non monsoon season. The percentage of DO was 2.5-4 mg/l. The percentage of BOD was also 15 to 85 mg/l and total chloroform and fiacl chloroform percentage is MPN/100 ml. it was more than 1800 and 275-450 because of which water is disinfected and not suitable to drink.

Fig. 5.6 Mula river drinking water quality

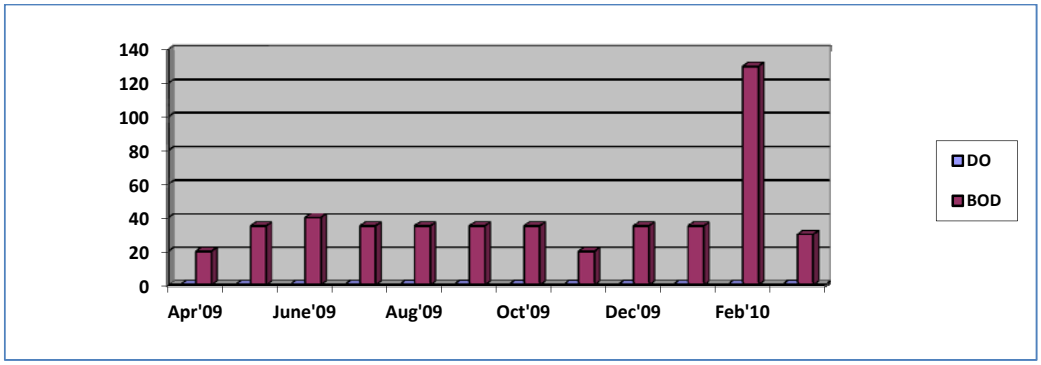


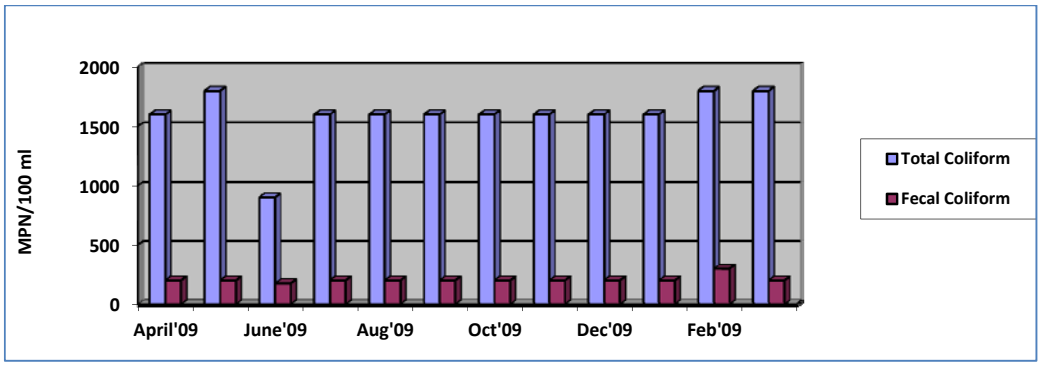
Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

Near Aundh, Pimpri:

Water samples were collected in non monsoon season. The percentage of DO was 1.5-4.5 mg/l. The percentage of BOD was also 10 to 90 mg/l and total chloroform and fiacl chloroform percentage is MPN/100 ml per 800-1800 (more than 1800) and 140-425 because of which water is dis-infected and not suitable to drink.

Fig. 5.7 Mula river drinking water quality



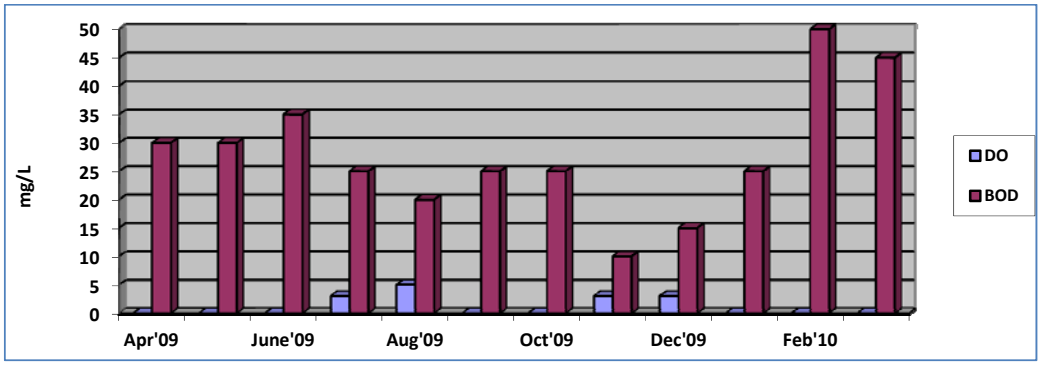


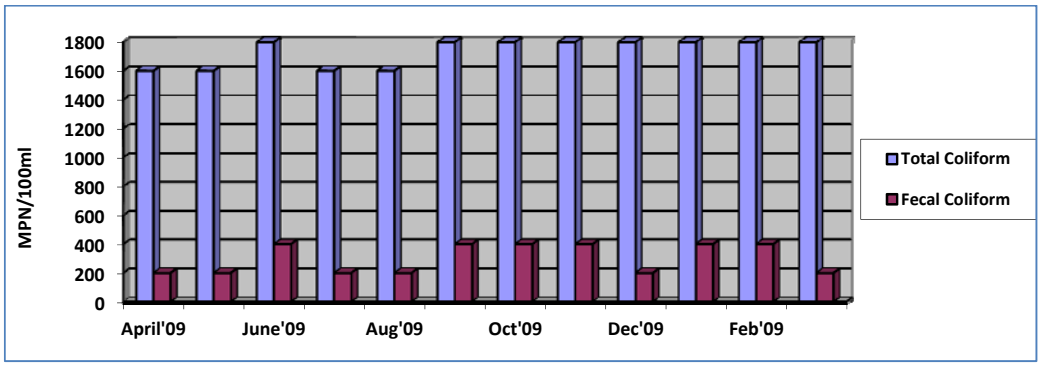
Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

Near Sangvi Village, Pimpri:

Water samples were collected in non monsoon season. The percentage of DO was 0.5-2.5 mg/l. The percentage of BOD was also 15 to 130 mg/l and total chloroform and fiacl chloroform percentage is MPN/100 ml per 800-1800 (more than 1800) and 150-300. Because of which water is dis-infected and not suitable to drink.

5.8 Mula-Pauna river





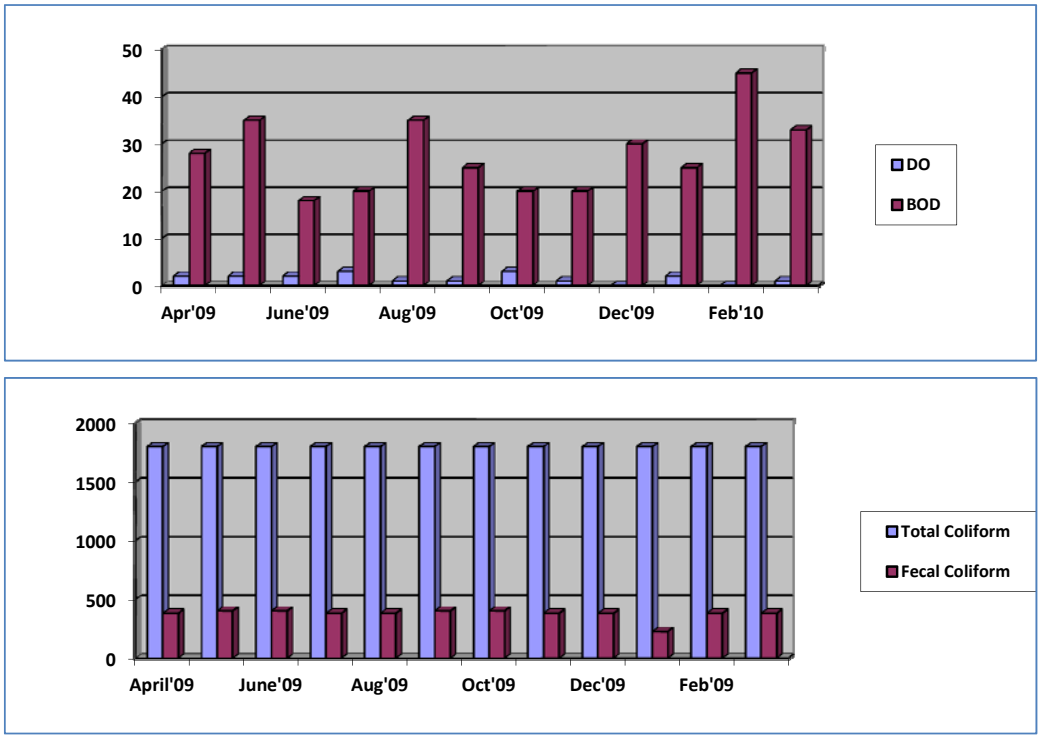
Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

Near Harison Flyover, Pimpri:

Water samples were collected in non monsoon season. The percentage of DO was 0-3.55 mg/l. The percentage of BOD was also 10 to 55 mg/l and total chloroform

and fical chloroform percentage is MPN/100 ml per 1600-1800 (more than 1800) and 200-425. Because of which water is dis-infected and not suitable to drink.

5.9 Mula-Pauna river

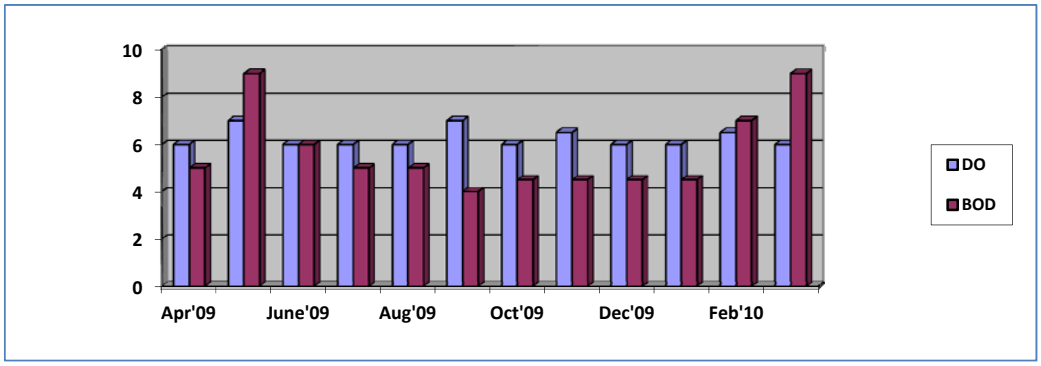


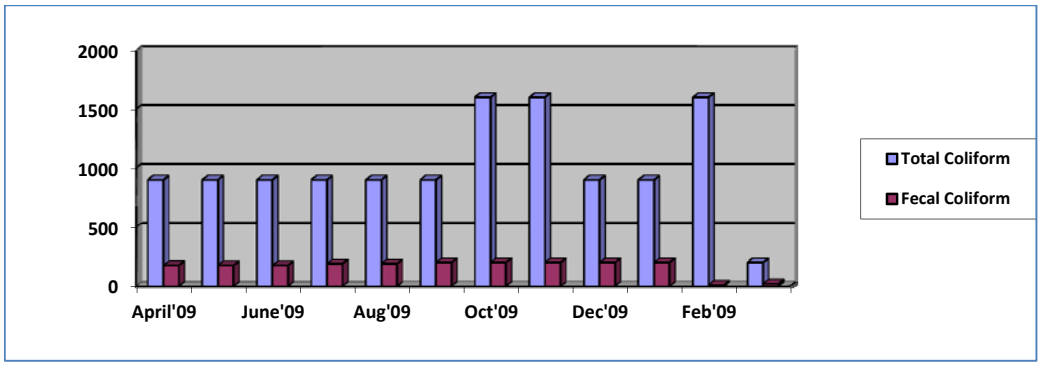
Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

Near Dapodi, Pimpri:

Water samples were collected in non monsoon season. The percentage of DO was 0.5-3 mg/l. The percentage of BOD was also 15 to 45 mg/l and total chloroform and fical chloroform percentage is MPN/100 ml per 1800 - more than 1800 and 275-425. Because of which water is dis-infected and not suitable to drink.

5.10 Pauna river



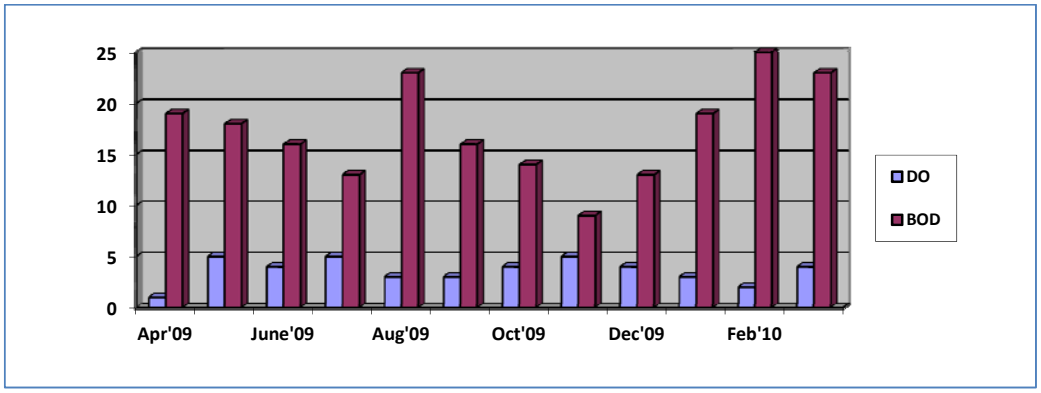


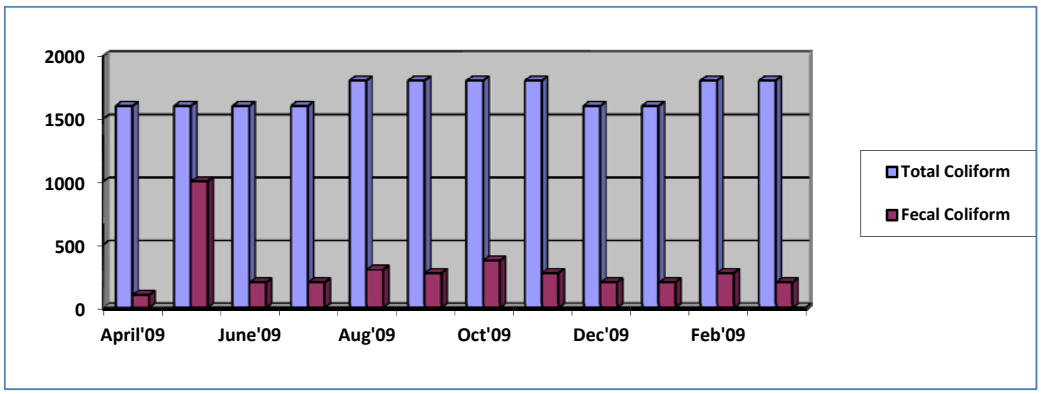
Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

Rawet Bhanda, Pimpri:

Water samples were collected in non monsoon season. The percentage of DO was 6-7 mg/l. The percentage of BOD was also 4 to 10 mg/l and total chloroform and fical chloroform percentage is MPN/100 ml per 200-1600 and 40-200 because of which water is dis-infected and not suitable to drink.

5.11 Mula-Pauna river



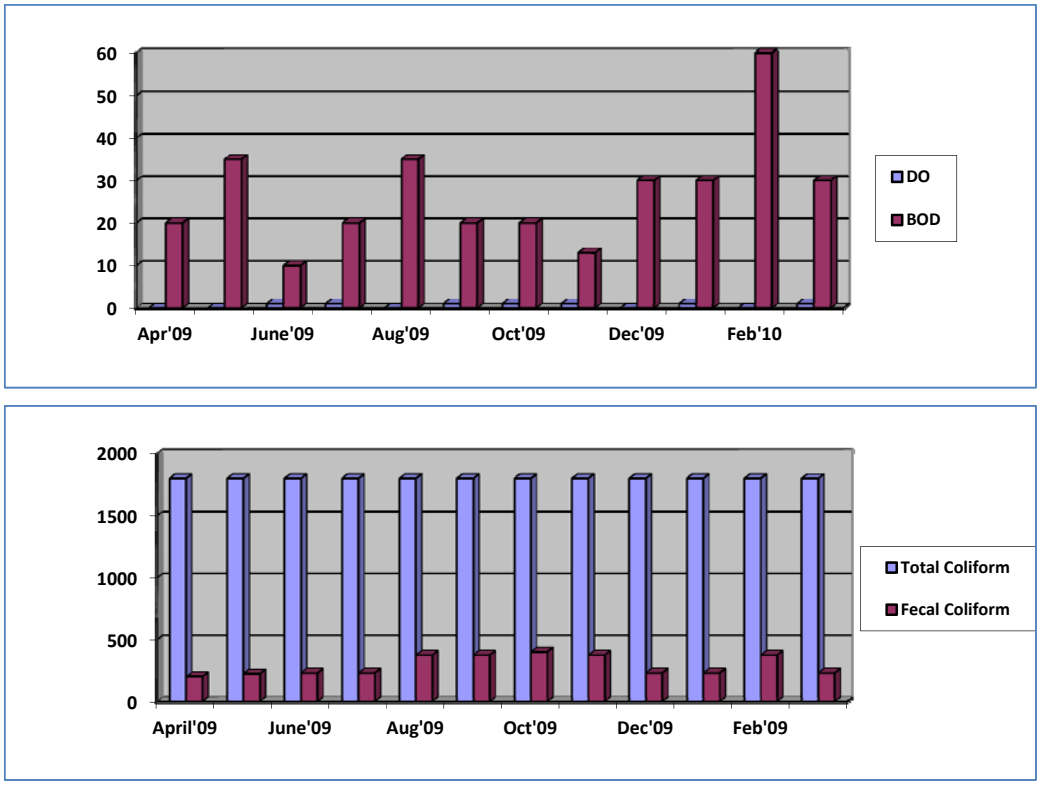


Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

Near Chinchwad VIllage, Pimpri:

Water samples were collected in non monsoon season. The percentage of DO was 1.5-5.0 mg/l. The percentage of BOD was also 8 to 25 mg/l and total chloroform and fical chloroform percentage is MPN/100 ml per 1600 - 1800 and 100-1000. Because of which water is dis-infected and not suitable to drink.

5.12 Mula-Pauna river

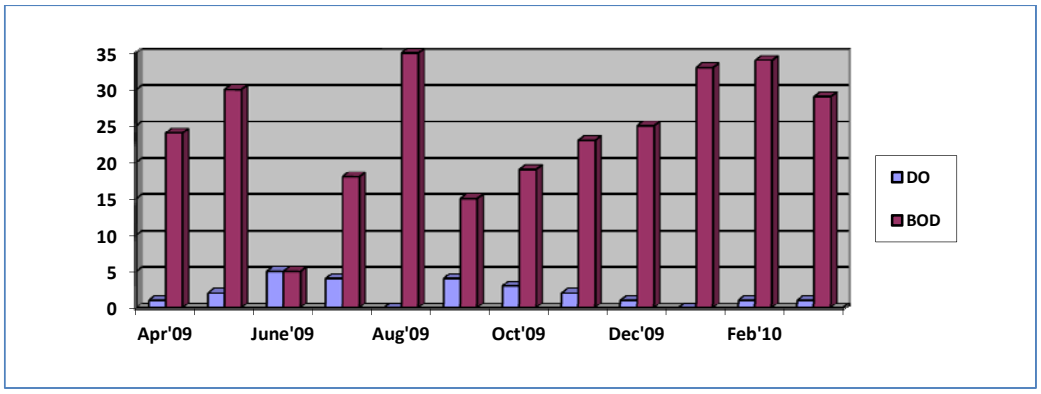


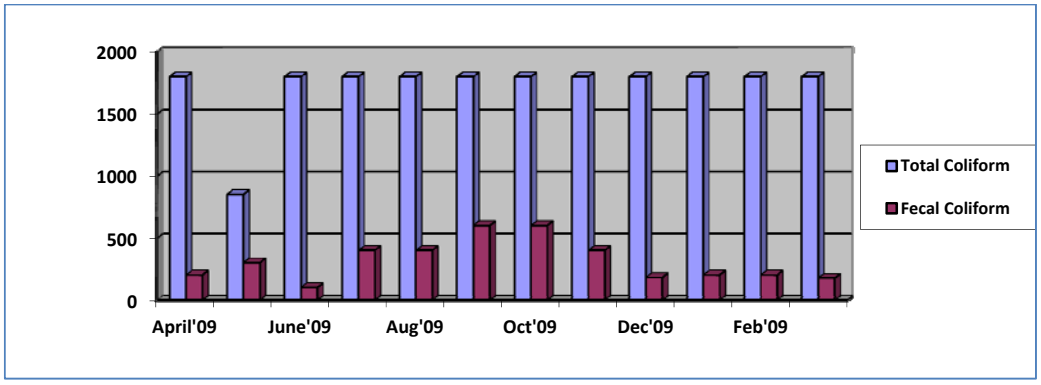
Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

Near Pimpri Village, Pimpri:

Water samples were collected in non monsoon season. The percentage of DO was 0.5-3.0 mg/l. The percentage of BOD was also 10 to 60 mg/l and total chloroform and fical chloroform percentage is MPN/100 ml per 1800 - 1800 and 170-425. Because of which water is dis-infected and not suitable to drink.

5.13 Mula-Pauna river



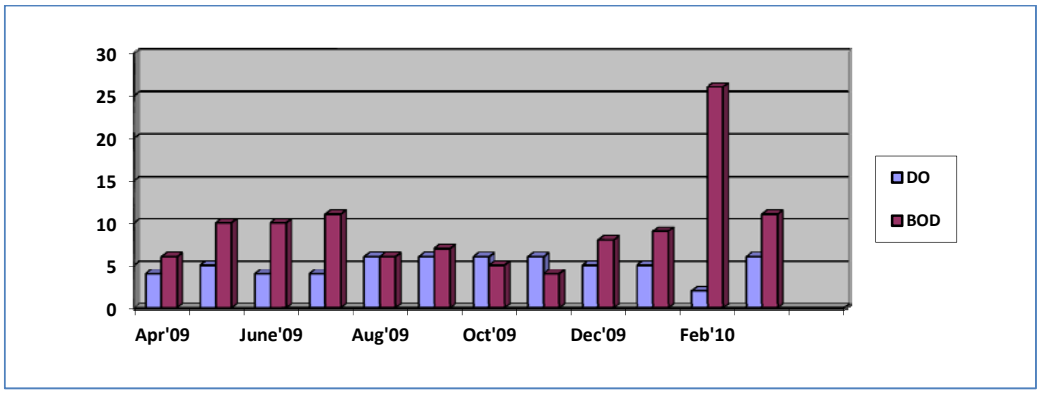


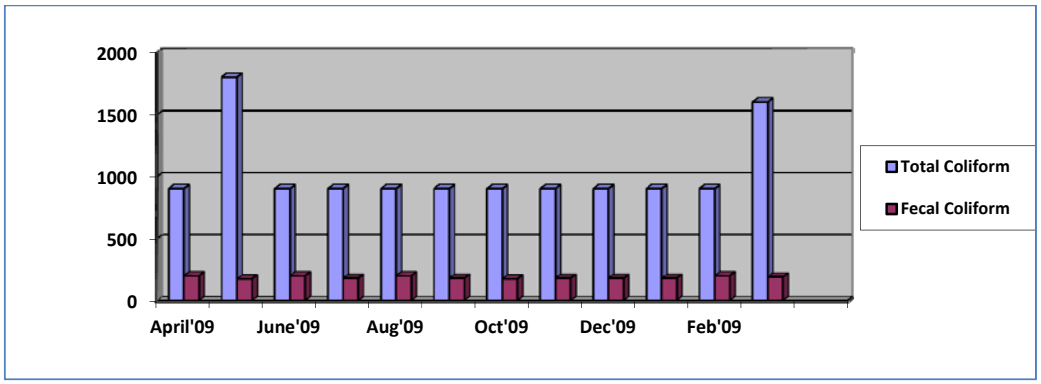
Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

Near Kasarwadi, Pimpri:

Water samples were collected in non monsoon season. The percentage of DO was 0.5-6.5 mg/l. The percentage of BOD was also 5.5 to 40 mg/l and total chloroform and fical chloroform percentage is MPN/100 ml per 900 - 1800 and 140-550. Because of which water is dis-infected and not suitable to drink.

5.14 Indrayani river



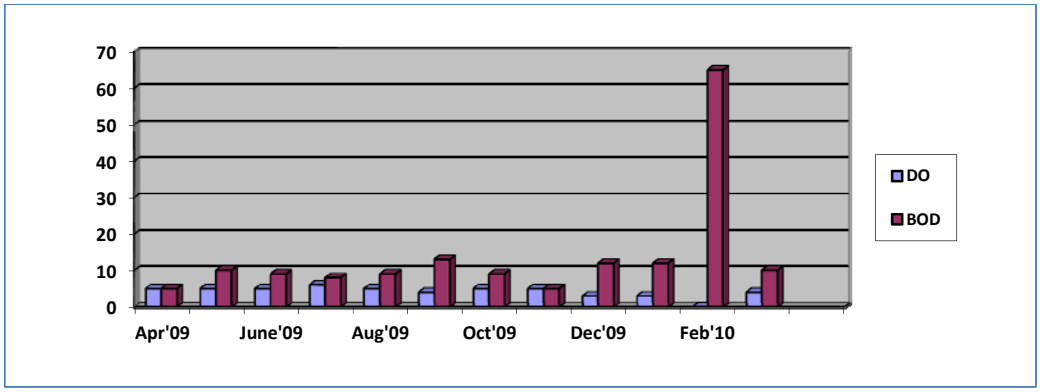


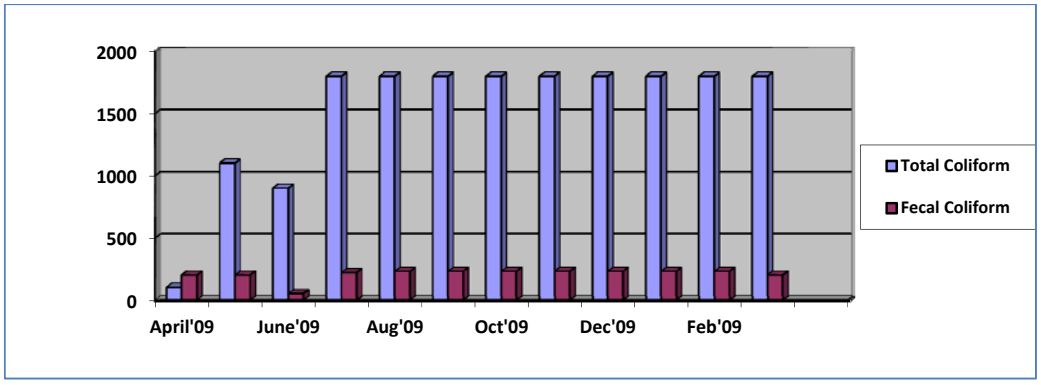
Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

Near Moshi (U/s):

Water samples were collected in non monsoon season. The percentage of DO was 1.5-7.0 mg/l. The percentage of BOD was also 3.5 to 30 mg/l and total chloroform and fical chloroform percentage is MPN/100 ml per 900-1800 and 115-200. Because of which water is dis-infected and not suitable to drink.

5.15 Indrayani river



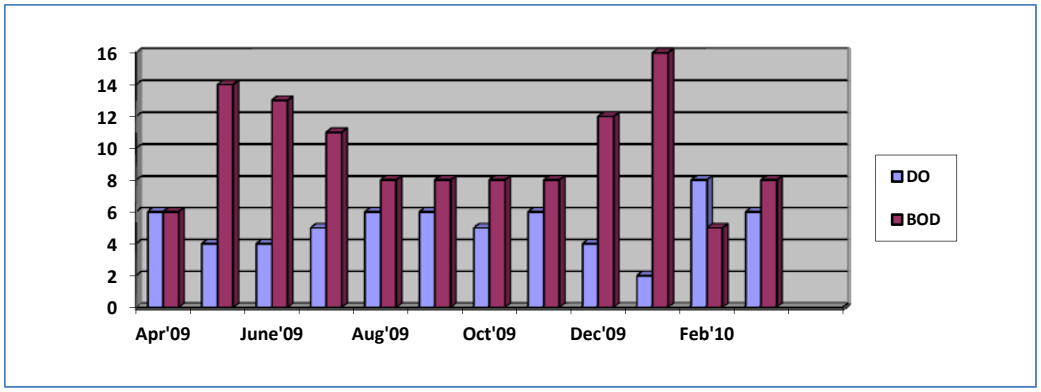


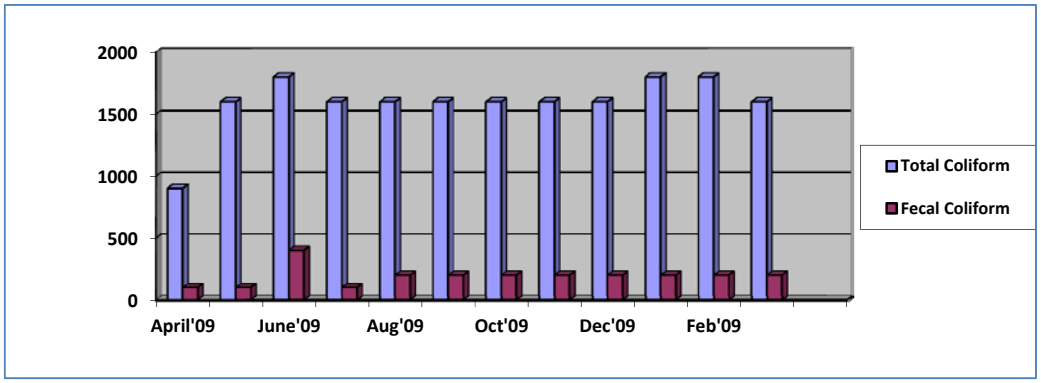
Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

Near Moshi (D/s):

Water samples were collected in non monsoon season. The percentage of DO was 0.5-6 mg/l. The percentage of BOD was also 4.5 to 70 mg/l and total chloroform and fical chloroform percentage is MPN/100 ml per 900-1800 and 90-275. Because of which water is dis-infected and not suitable to drink.

5.16 Indrayani river



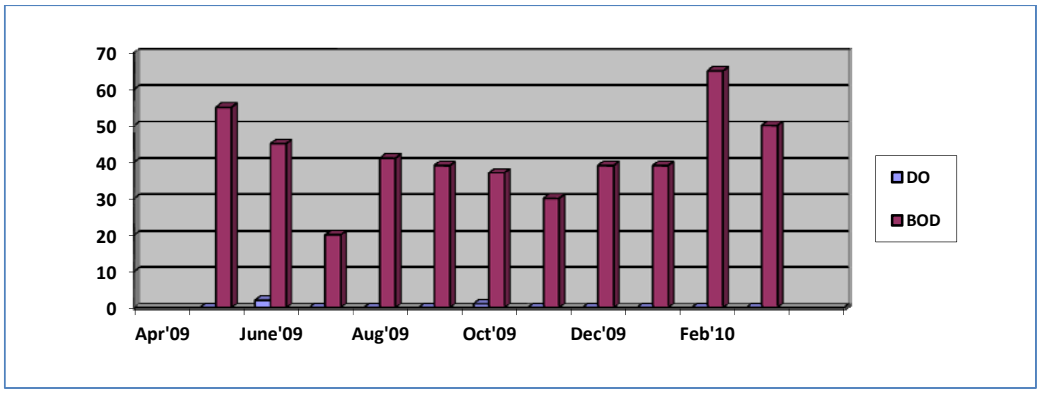


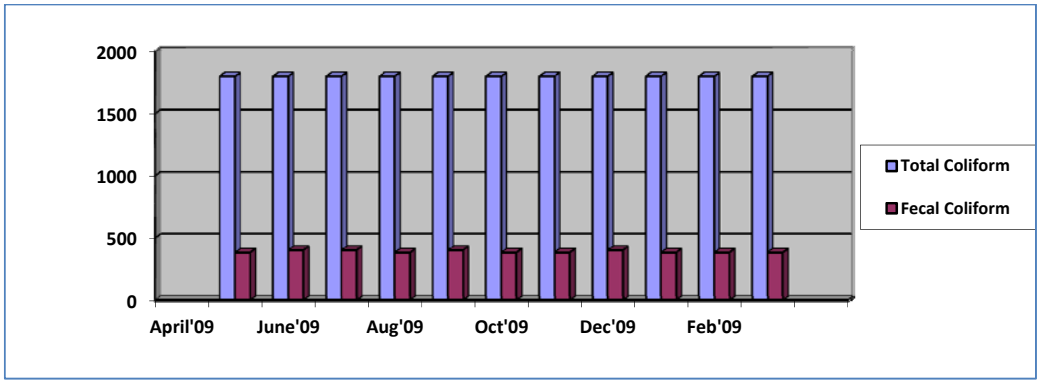
Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

Near Aalandi:

Water samples were collected in non monsoon season. The percentage of DO was 2-8 mg/l. The percentage of BOD was also 5 to 17 mg/l and total chloroform and fical chloform percentage is MPN/100 ml per 900-1800 and 100-350. Because of which water is dis-infected and not suitable to drink.

5.17 Mula-Mutha river



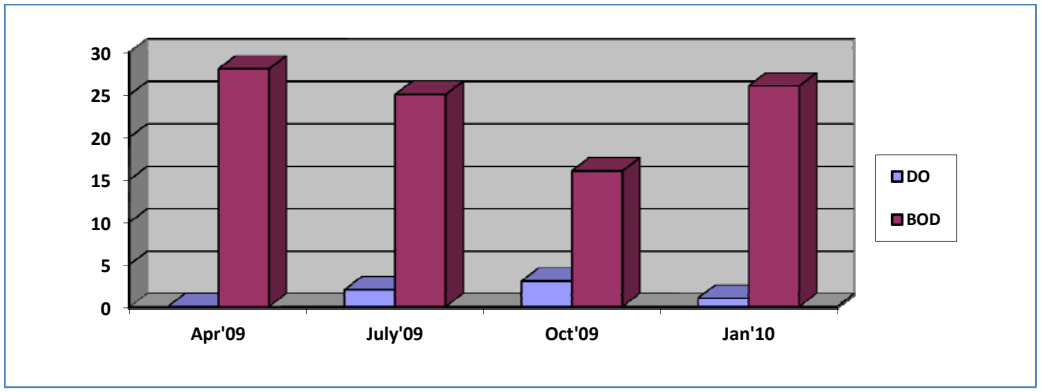


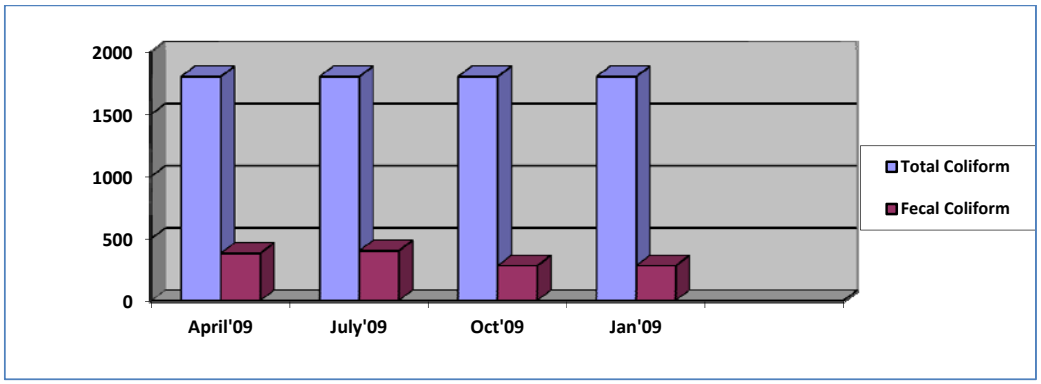
Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

Near Sangam Flyover:

Water samples were collected in non monsoon season. The percentage of DO was 0-3 mg/l. The percentage of BOD was also 20 to 70 mg/l and total chloroform and fical chloroform percentage is MPN/100 ml per 1800-1800 and 350-425. Because of which water is dis-infected and not suitable to drink.

5.18 Mula-Mutha river



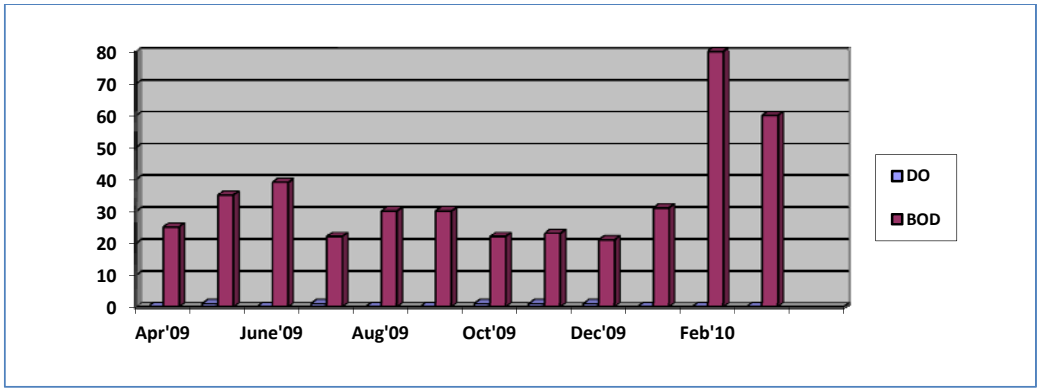


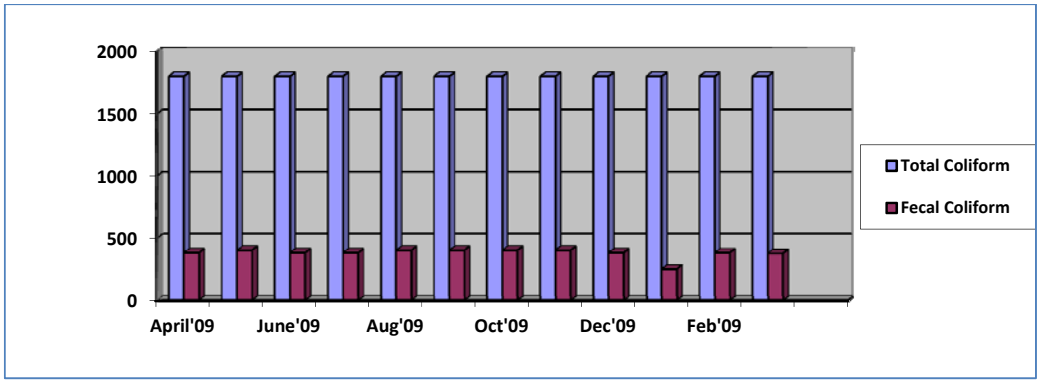
Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

Near Band Garden:

Water samples were collected in non monsoon season. The percentage of DO was 1-3 mg/l. The percentage of BOD was also 15 to 30 mg/l and total chloroform and fical chloroform percentage is MPN/100 ml per 1800-1800 and 275-425. Because of which water is dis-infected and not suitable to drink.

5.19 Mula-Mutha river



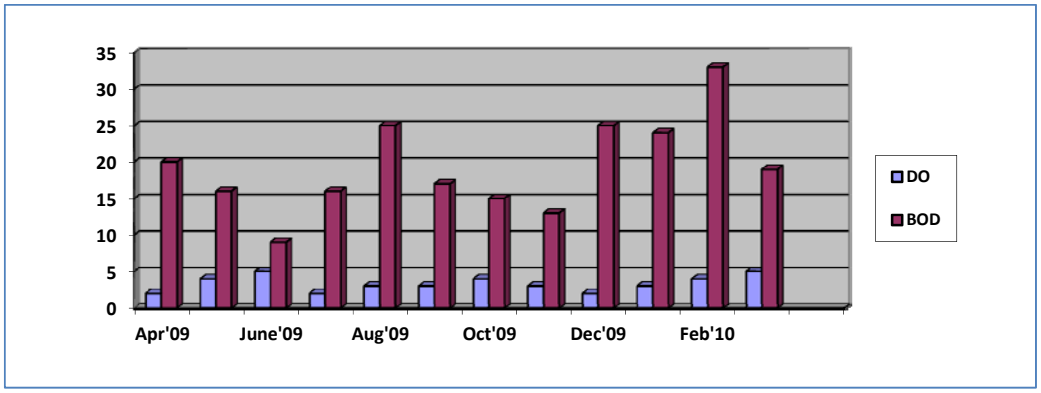


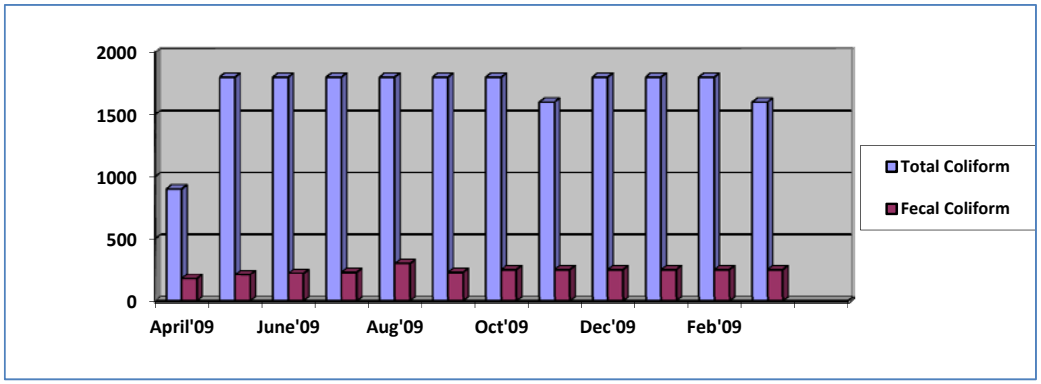
Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

Near Mundwa Flyover:

Water samples were collected in non monsoon season. The percentage of DO was 0.5-2.5 mg/l. The percentage of BOD was also 20 to 80 mg/l and total chloroform and fical chloroform percentage is MPN/100 ml per 1800-1800 and 275-425. Because of which water is dis-infected and not suitable to drink.

5.20 Mula-Mutha river



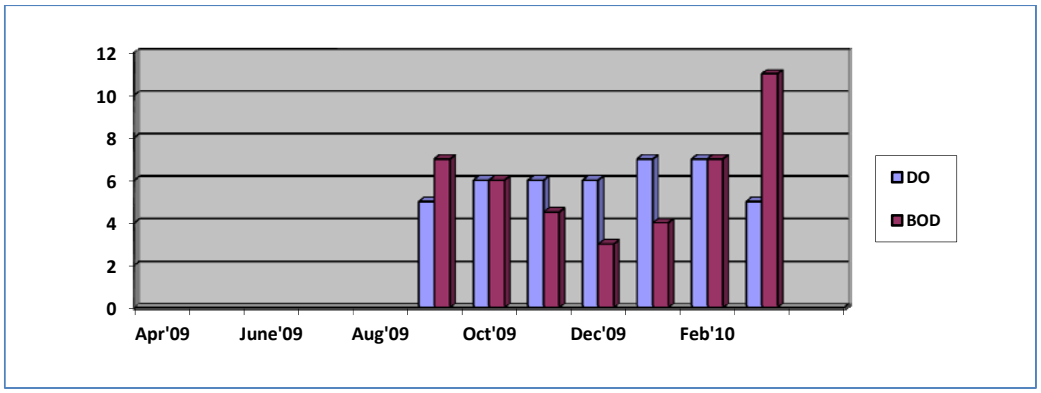


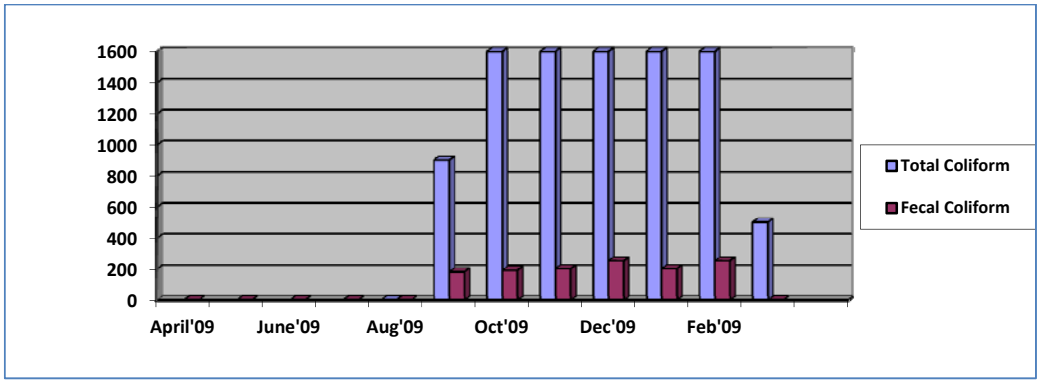
Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

Near Theur, Haveli, Pune:

Water samples were collected in non monsoon season. The percentage of DO was 1-5 mg/l. The percentage of BOD was also 9 to 35 mg/l and total chloroform and fical chloroform percentage is MPN/100 ml per 900-1800 and 100-350. Because of which water is dis-infected and not suitable to drink.

5.21 Wale river



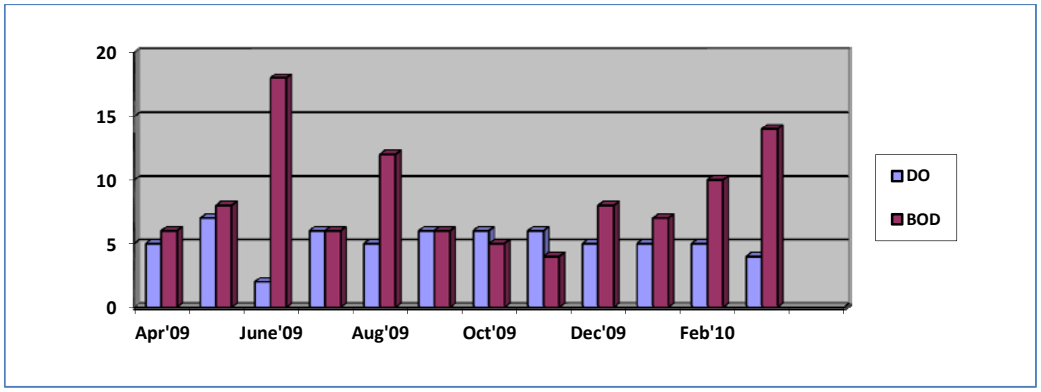


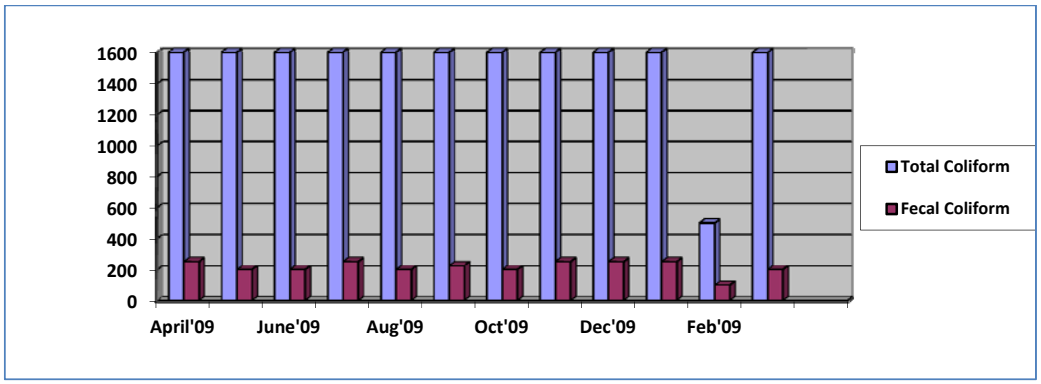
Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

Near Shikrapur, Pune:

Water samples were collected in non monsoon season. The percentage of DO was 5.5-6.5 mg/l. The percentage of BOD was also 3 to 11 mg/l and total chloroform and fical chloroform percentage is MPN/100 ml per 500-1800 (More than) and 10-300. Because of which water is dis-infected and not suitable to drink.

5.22 Ghod river



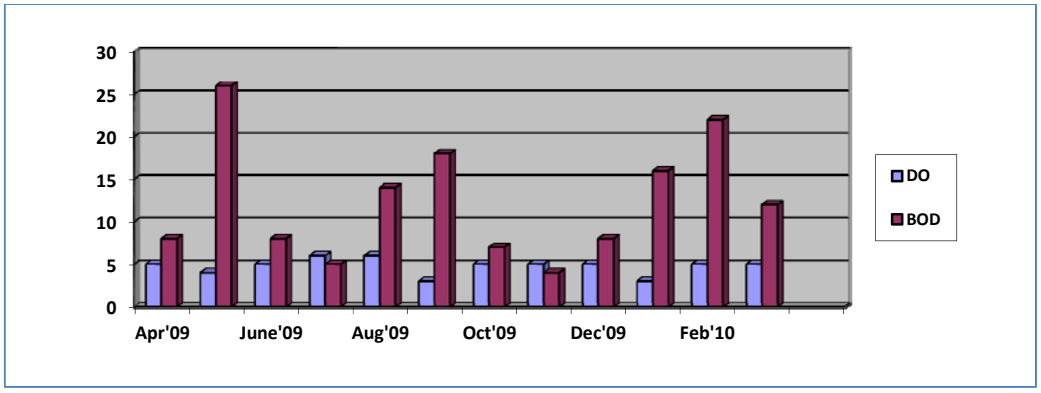


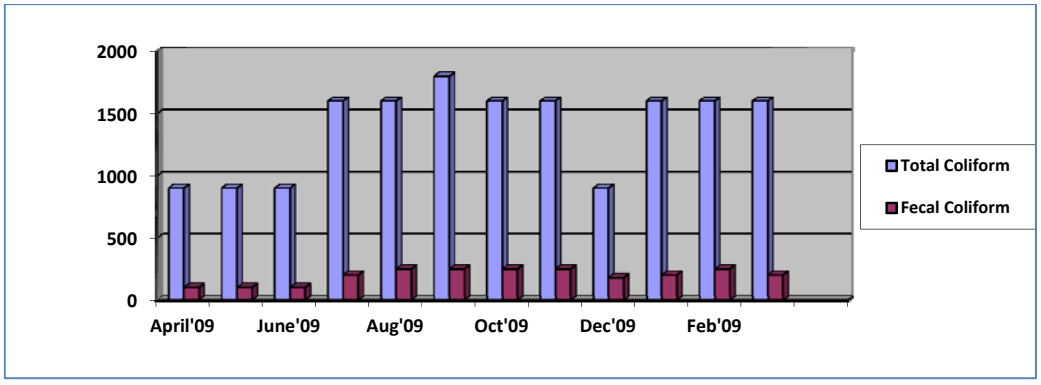
Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

Near Shirur, Pune:

Water samples were collected in non monsoon season. The percentage of DO was 2.5-7 mg/l. The percentage of BOD was also 4 to 19 mg/l and total chloroform and fical chloroform percentage is MPN/100 ml per 500-1800 (More than) and 10-300. Because of which water is dis-infected and not suitable to drink.

5.22 Bhima river



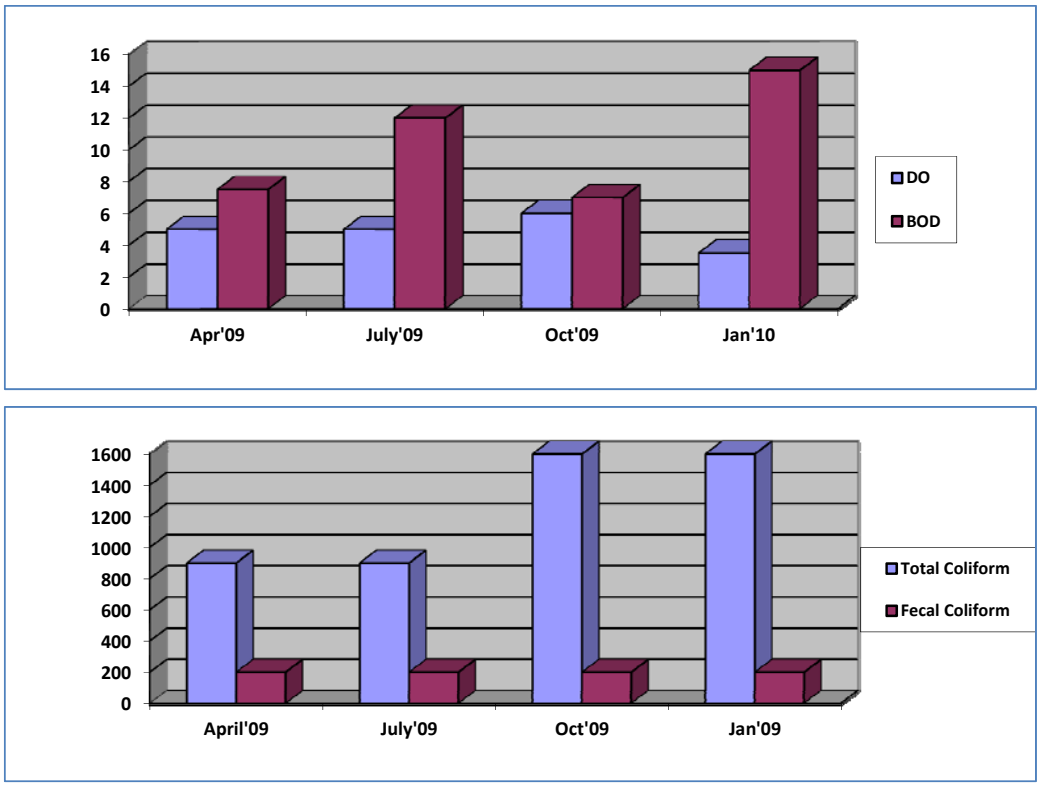


Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

Near Koregaon Flyover, Pune:

Water samples were collected in non monsoon season. The percentage of DO was 2.6-6.5 mg/l. The percentage of BOD was also 3.4 to 18 mg/l and total chloroform and fical chloroform percentage is MPN/100 ml per 800-1800 (More than) and 100-300. Because of which water is dis-infected and not suitable to drink. It is necessary to built water purification equipments.

5.23 Bhima river

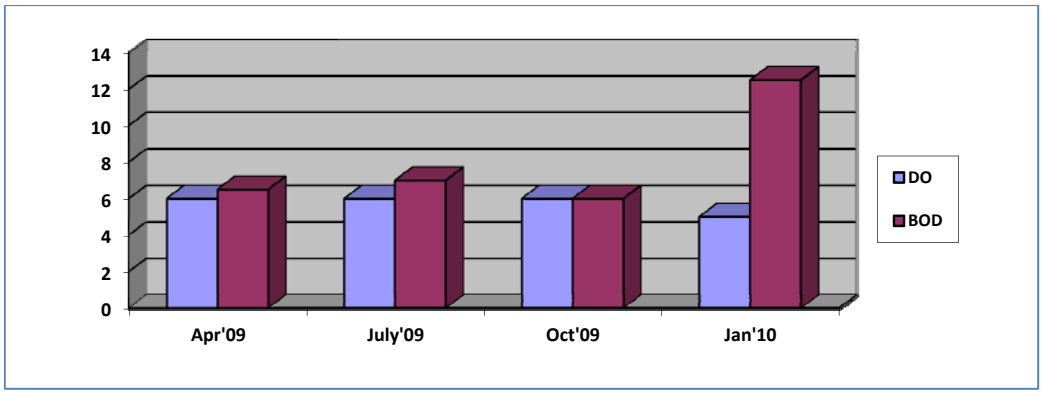


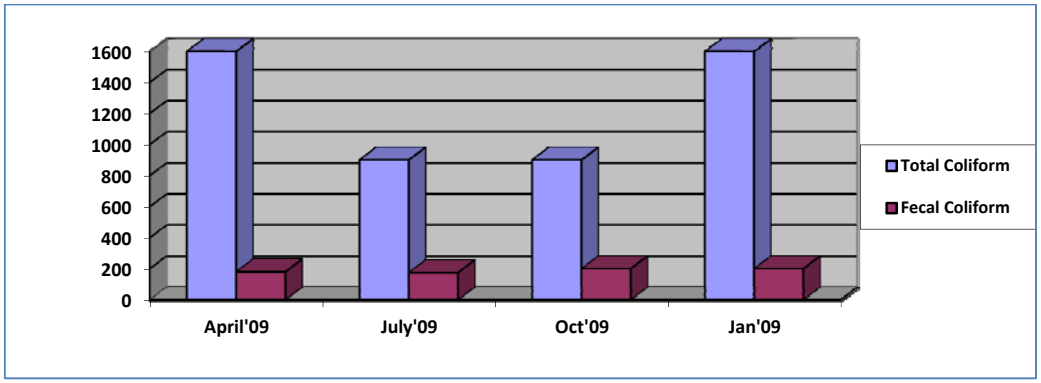
Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

Near Pargaon, Pune:

Water samples were collected in non monsoon season. The percentage of DO was 3.0-6.5 mg/l. The percentage of BOD was also 6 to 15 mg/l and total chloroform and fical chloroform percentage is MPN/100 ml per 900-1600 and 180-225. Because of which water is dis-infected and not suitable to drink. It is necessary to built water purification equipments.

5.24 Bhima river



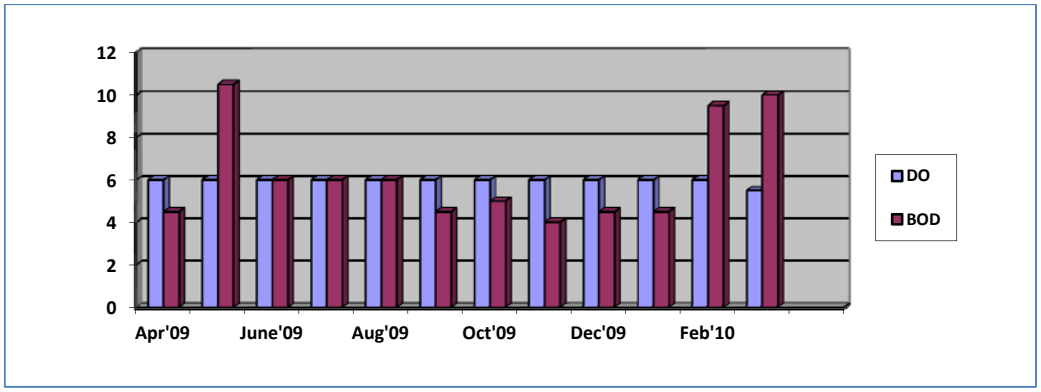


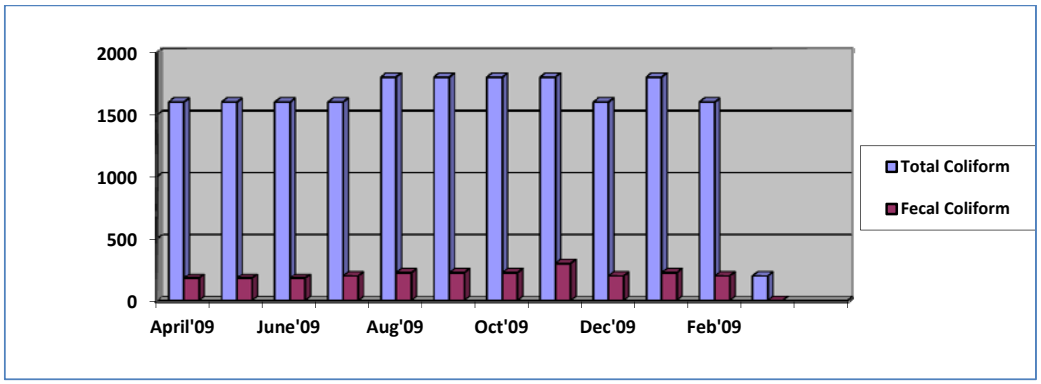
Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

Near Daund, Pune:

Water samples were collected in non monsoon season. The percentage of DO was 4.5-6.5 mg/l. The percentage of BOD was also 6 to 15 mg/l and total chloroform and fical chloroform percentage is MPN/100 ml per 900-1600 and 100-225. Because of which water is dis-infected and not suitable to drink. It is necessary to built water purification equipments.

5.25 Bhima river





Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

Near Banks of Ujani Dam:

Water samples were collected in non monsoon season. The percentage of DO was 5.5-6.5 mg/l. The percentage of BOD was also 4 to 10.5 mg/l and total chloroform and fical chloroform percentage is MPN/100 ml per 200-1600 and 10-400. Because of which water is dis-infected and not suitable to drink. It is necessary to built water purification equipments.

Table 5.1 Water supply, Sewage water and Sewage water treatment

Sr.No.	Description	MLD
1	Total water supply	1725.19
2	Sewage water	1239.63
3	Processed sewage water	697.71
4	Untreated & Unprocessed Sewage Water	541.92
A	Pune City	352 (66.80%)
B	Pimri-Chinchwad City	88 (16.24%)
C	10 Municipal Council	44.39 (8.20%)
D	Contonment Area	29.9 (5.33%)
E	Villages situated on river banks	16.93 (3.18%)
E	Hinjawadi MIDC Centre	1.7 (0.31%)

5.2 Data Regarding Water Supply, Production of Sewage Water & Its Treatment

Sr. No.	Name of Village/City	Population	Water Supply (MLD)	Sewage Water Produced (MLD)	Capacity of the Plant	Processed & Treated Sewage Water	Percentage (%)
Total		607723	1725.19	1239.63	743.51	697.71	56.28
a)	Municipal Corporations (Total 02)	60,00,000	1410	999	589	549	54.95
1	Pimpri-Chinchwad	20,00,000	360	255	207	167	65.49
2	Pune	40,00,000	1050	744	497*	382	54.34
Total		60,00,000	1410	999	589	549	54.95
b)	Municipal councils (Total 10)	3,75,528	63.3	48.08	3.69	3.69	7.67
1	Lonavala	49,865	21.1	16	3.69	3.69	23.06
2	Taleagaon	56,025	9	6.72	0	0	0
3	Aalandi	40,000	4	2.4	0	0	0
4	Junnar	24,741	2.2	1.76	0	0	0
5	Shirur	40,000	5	4	0	0	0
6	Saswad	26,689	5	4	0	0	0
7	Jejuri	12,000	3	2.4	0	0	0
8	Daund	42,208	5	4.2	0	0	0
9	Baramati	61,500	5.3	4.2	0	0	0
10	Indapur	22,500	3	2.4	0	0	7.67
Total		3,75,528	63.3	48.08	3.69	3.69	17.19
c)	Cantonment boards Zone (Total 03)	3,04,286	47.44	34.9	9.2	6	0
1	Dehu						0
	Civil settlement area	46,921	9	8.2	0	0	100
	Cantonment board	14,000	1.9	1.5	0	0	0
2	Khadki						0
	Civil settlement area	77,473	11.6	6	9.2	6	0
	Cantonment board	16,027	2.14	1.7	0	0	0
3	Pune						0
	Civil settlement area	79,865	12.8	8	0	0	0
	Cantonment board	70,000	10.0	9.5	0	0	0
Total		3,04,286	47.44	34.9	9.2	6	0
d)	Villages situated near riverbank (Total 196)	607,723	24.30	16.93	0	0	0
	Daund (33 Villages)	111,961	4.47	3.13	0	0	0
	Haveli (35 Villages)	170,070	6.80	4.7	0	0	0

Sr. No.	Name of Village/City	Population	Water Supply (MLD)	Sewage Water Produced (MLD)	Capacity of the Plant	Processed & Treated Sewage Water	Percentage (%)
	Indapur (19 Villages)	24,798	0.995	0.697	0	0	0
	Shirur (11 Villages)	26,753	1.07	0.74	0	0	0
	Khed (35 Villages)	142,783	5.71	3.99	0	0	0
Total villages 196		607,723	24.30	16.93	0	0	0
e)	MIDC at Bank of rivers						
1	Industrial Area		145.2	112.5	113.4	110.8	98.48
i)	Talegaon	--	2	1.6	4**	1.6	100
ii)	Chakan	--	6	4.8	4.8	4.8	100
iii)	Talwade	--	2	1.6	1.6	1.6	100
iv)	Bhosri (with Pimpri-Chinchwad)	--	100	80	80	80	100
v)	Hinjwadi	--	3.2	2.5	0.8***	0.8	32
vi)	Ranjangaon	--	13.5	10.8	10.8***	10.8	100
vii)	Jejuri	--	1	0.8	0.8	0.8	100
viii)	Baramati	--	11	9.6	9.6	9.6	100
ix)	Kurkumb	--	6.5	0.8	1	0.8	100
Total			145.2	112.5	113.4	110.8	98.48
2	Total Independent MIDC	--	34.95	28.22	28.22	28.22	100
Total		607723	1725.19	1239.63	743.51	697.71	56.28

Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

5.3 Qualitative analysis of Sewage Water added in Bhima river and its Tributaries

Local Independent Society	Name	PH	DO	BOD	COD	Suspe-nded Solids	Sulp hate	Chlo rides	Nitrate	Hard enes
Pune Municipal Corporation	Tanajiwadi	8.19	1.52	45.7	132	36	25.27	--	0.192	140
	Ambil Aunda	8.21	2.11	21.6	60	45	26.76	44	0.281	104
	Yerandwana	8.2	2.35	20.4	60	28	26.19	66	0.281	110
	Near Mhatre Bridge	8.03	0.00	48.9	140	28	35.11	60	0.508	110
	Vitthalwadi	8.07	3.32	16.7	48	55	19.78	66	0.216	156
	Warje Malwadi	8.16	2.62	13.9	40	32	18.98	88	0.181	158
	Bahiroba	8.14	1.06	57.5	164	85	37.85	84	0.298	150
Pimpri Chinchwad Municipal Corporation	Kiwle	7.89	4.28	8.5	28	16	63.13	90	0.862	296
	Walhekar Wadi	7.77	2.78	37.5	108	22	30.99	84	0.926	146
	Gokhale Park	7.64	0.00	43.5	124	25	72.05	105	0.728	148
	Thergaon Park	7.62	0.66	56	160	24	69.53	90	1.28	180
	Garware Colony	7.74	3.2	18.5	52	17	35.11	76	0.668	140
	Linkroad	7.7	3.1	16.3	48	18	64.73	90	0.572	180
	Garware	7.68	3.98	13.8	40	16	75.71	84	0.602	210
	Nala	7.7	3.26	16.7	48	24	146.38	110	0.772	200
	Bhairoba	7.65	0.79	52.8	148	164	73.19	112	1.42	244

Local Independent Society	Name	PH	DO	BOD	COD	Suspe-nded Solids	Sulp hate	Chlo rides	Nitrate	Hard enes
	Nashik Phata	7.48	3.35	15.5	44	27	13.95	64	0.446	140
	Sandwik	7.21	1.86	48.3	140	40	29.73	96	1.28	152
	Sanghvi Gaon	7.58	1.24	41.9	120	23	53.52	84	1.12	160
Talegaon	Katvi	7.56	2.5	29.5	128	16	108.64	45.99	0.11	--
Dehu	Shelarwadi	7.75	0.00	35	100	22	41.17	65.98	0.194	--
	Kiwle	7.55	0.00	75	208	20	28.02	125.96	0.149	--
	Kinhe	7.77	0.00	60	172	26	58.55	117.96	0.268	--
Pune	Moravde	7.63	4.79	4.2	12	30	16.24	50	0.102	90
	Manic	6.64	0.00	25.3	72	44	19.78	45	0.158	130
	Bhairoba	6.75	0.00	36.2	104	68	50.04	72	0.279	164
Khadki	Civil Area Ammunition Factory	7.13	0.00	23.7	68	116	44.6	7	0.337	344
	STP Civil Area	6.94	0.00	22.9	64	82	35.34	47.5	0.229	124
	GE Office	6.91	0.00	46.5	132	96	27.68	62.5	0.332	204
	Bajaj Park	7.2	0.00	20.9	60	34	56.72	52.5	0.253	236
	CB Office	7.67	3.97	9.8	28	24	148.67	0.393	340	64
	Sarpress	7.37	0.87	14.2	40	30	28.25	32.5	0.192	116
	Near Hindu Crematorium	7	0.00	67	204	106	38.31	156	0.356	240
	Near Rajiv Gandhi Resident	6.88	0.00	186	568	76	37.85	168	0.65	260

Local Independent Society	Name	PH	DO	BOD	COD	Suspe-nded Solids	Sulp hate	Chlo rides	Nitrate	Hard enes
	Near Gadi Adda	7.36	0.00	55.8	168	114	92.06	112	0.296	264
	Gawli Wada	7.36	0.00	127	388	266	44.37	145	1.164	234

Source: Study report of Maharashtra Pollution Control Board, Regional office, Pune.

CHAPTER-VI

WATER POLLUTION DUE TO SOLID WASTE

In 19th century the biggest challenge in urban area is solid waste management for the 20th century. It is not a problem of Pune district but solid waste management is a global problem. Big cities and small cities from developed and developing country faces major challenges in dealing with waste management. The problem of urban solid waste management is neither unsolved nor unsolvable. But in few developed countries successful waste management is also achieved using better discipline and appropriate technology. Solid waste management specially in urban area is a job of municipal corporation and local self government which is existing in the period under the guidelines of state & central government.

Types of solid waste

1. Organic : food scraps, flowers, wastage at the time of festival celebrations, dead animals, medical waste etc.
2. Paper : waste newspapers, card board, wrapping papers, seeded papers etc.
3. Plastics : bottles, packing material, containers, fertilizer bags, cement bags etc.
4. Glass : broken glasses, bottles, utensils, light bulbs, tube lights, foil, cosmetic bottles, cans etc
5. Others : Cloths, textiles, rubber, leather goods, ash, decries etc.

Classification of Solid Waste

It is broadly done as per source of solid waster management, genieses of solid waste management, its composition or its taxation. The macro classification of solid waste is as follows :

a) Domestic solid waste : the waste which is generated from various activities of household

b) Industrial solid waste : The solid waste which is genetrated from industrial activities is called industrial solid waste

c) Agriculture solid waste : The solid waste which is genetrated from industrial activities is called agriculture solid waste. Just like agriculture by products are known as agriculture solid waste.

d) Hospital solid waste : In urban area hospital is also a source of contemn solid waste such as imputed body parts, blood stain cloth, used cotton & linen empty bottles of pharmaceuticals, hospital waste management is also a problem of the urban area.

e) Demolition depress : In urban area lot of construction and development activities are undertaken to established. It create lot of depress may be due to demolition of buildings. It creates significant quantity of wastes. The classification of solid waste is also done on the basis of nature of toxicity, nature of hazardousness. According to the previous agencies hazardous waste is potentially dangerous to or potentially harmful to health of human being, cattle's and aquatic animals. This hazardous waste is sometime dissolves in the water and latently it impacts on flora & fauna.

Toxic or Hazardous Solid Waste :

- Industrial chemicals : Many chemicals like acetone belgium, sulphur, plastic termocols, soda which are used in industrial units are treated as Industrial waste.
- Pesticides
- Waste from oil industries
- batteries, bulbs, tubes, medical waste, misguided pharmaceutical products
- wastage of cement factories, misguided asbestos.

Disposal of solid waste and its management

There are legal provision for disposal of toxic / hazardous solid waste for hospitals, dispensaries, laboratories, bio-medical waste (Management & Disposal rule 1998), this enactment has promo regulated for disposal work toxic and hazardous solid waste from hospitals. The solid waste which is originated from Industrial units is governed by the rule. Solid waste management and disposal is hazardous handling rule 1989. Pune is a major hub for IT Industries. The rate of growth of IT industries in Pune is competitive with comparison to many metropolitian cyber cities. E-solid waste mainly constituting of old computers disguised mobiles batteries where licaium and canadium metals are used. The old TV sets, parts of the computers, this E-Solid waste is also a challenge. In the basins of Bhima river many industrial units, IT units, agro based industries, are operating. The basic guidelines for disposal of hazardous

solid waste management are given in the rule 1989 for disposal of solid waste. But major cities like Pune, Pimpri-Chinchwad and municipal council in the basin of Bhima river still have not developed proper system for the disposal thof solid waste and its management.

Table 6.1 : The Volume and Amount of Solid waste in Municipal Corporation Council and Containment Boards

Sr. no.	Name of local body	Waste produced MT	Chemical wastes MT	Without Chemical waste MT
a) Mahanagar Palika				
1	Pimpri – Chinchwad	550	30	520
2	Pune	1070	570	500
Total		1620	600	1020
b) Municipal Councils				
1	Lonawala	25	0	25
2	Talegaon	10.5	0	10.5
3	Aalandi	06	0	06
4	Junnar	06	0	06
5	Shirur	05	00	05
6	Saswad	05	0	05
7	Jejuri	02	0	02
8	Daund	6.5	0	6.5
9	Baramati	16	0	16
10	Indapur	3.5	0	3.5
Total		85.5	0	85.5
c) Inspected area				
1	Dehu			
	Local residential area	7.2	0	7.2
	Defence residential area	2.2	0	2.2
2	Khadki			
	Local residential area	30	0	30
	Defence residential area	2.5	0	2.5
3	Pune			
	Local residential area	12.2	0	12.2
	Defence residential area	11.0	0	11.0
Total		**65.1**	**0**	**65.1**
d) Villages near rivers		46.0	0	46.0

Sr. no.	Name of local body	Waste produced MT	Chemical wastes MT	Without Chemical waste MT
Total		**1816.6**	**600**	**1216.6**

Source: Data Collected by Maharashtra Pollution Control Board, Pune.

Legislation for waste management:

India has a suite of legislation that deal with water management. The following are the key legislations dealing with solid waste management in India:

1. Hazardous Waste (Management and Hazardous) Rules, 1989 amended in 2008.
2. Biomedical waste (Management and Handling) Rules, 1989.
3. Municipal Solid wastes (Management and Handling) Rules, 2000.
4. E-Waste (Management and Handling) Rules, 2011

The significant omission in waste management in India is the laws dealing with asbestos. Asbestos has been banned from being imported or manufactured in a number of countries and many countries which had used asbestos in the past are putting very stringent conditions insisting on its removal and disposal. In India asbestos is still significant threats as a solid waste management.

Fig 6.1 Management of solid waste

Management approach for dealing with solid waste :

3 R approach: It is very rational way of solid waste management, reduction reuseds and recycle are cardinal implementation of solid waste.

- **Reduction:** The management of solid waste is continuous basis. When they will reduce solid waste in our technological procedure are bound to reduce solid waste will be treated as eco-friendly processes. Reduction of solid waste is better than solid waste. This procedure will reduce the pressure of solid waste.
- **Reuse:** The solid good products are generated from solid waste organic solid waste if properly used can be useful for agriculture sector to maintain the fertility of the land. There is also new creation method from inorganic & organic solid wastes. Preparing for reuse is also decongesting the pressure of the natural resources.
- **Recycle:** Recycling also very economical eco-friendly way of solid waste management. Solid waste management will recycle products and by-products are also usable alternative resources of energy. But main construct of recycling is whether it is a economical physical or no.

Separation of Solid Waste :

This is a better method for Solid waste management. In this method wet & dry bio-degrading solid waste and dry solid waste inorganics are divided and put separately. Accordingly, wet bio-degraded solid waste can be processed and used as a manure or in few countries it is also used for organic chemicals. As per rule 2000 Municipal Corporations should devide the solid waste divided in 3 broad categories;

a) Organic solid waste

b) Re-used after recycling solid waste

c) Inorganic solid waste

Management of organic solid waste :

a) It get decomposed due to bacteria's and process of decomposition is also cataloes by humid and warm temperature. Decomposition of wet organic solid waste may be converted into organic manual and it is useful for Organic farming. Wet solid waste which is having carbo-hydrate based can also be used for making various organic compounds which can be used in different ways. In this process aerobic

composting earthworm manual project vessel composting, are also few alternative. This is one of the best option to convert solid organics waste into usable form of the residues. These methods can also be used in small villages and even at the level of house units.

b) Sanitary landfills: This is oldest method of disposal of solid waste management as waste from municipality or industries are disposed in a pit or hole in the grounds. But now it is and increased realization that land filling is neither environment appropriate. Landfills which were not purposely filled in terms of ground water pollution. Land filling is also not a treatment of solid waste but it is a disposal option. The most exciting area in the land fill area is urban mining. Which is used for dumping of solid waste. There are certain guidelines from central pollution control boards rule, 2000. The solid waste must be properly processed and shall be handle and disposed in the eco friendly manners.

CHAPTER-VII

EFFECT OF POLLUTED DRINKING WATER ON HUMAN HEALTH AND REMEDIAL MEASURES

Introduction:

Pune district is the fastest urbanized industrialized and developing district. The impact of urbanization and industrializations are prudently visible and this is a necessity of time to minimize the effect of water pollution control. Zilla parishad Pune, water supply dept, health dept, has conducted studies and surveys for the affected village in the basin of Bhima river which significantly, put light on the gravity and magnitude of the water pollution of Bhima river. As per survey 196 villages are situated on the bank of Bhima river and its tributaries and water supply is around 24.30 MLD. When various tests were conducted regarding purity of drinking water and its source 70 villages were affected with the infected water supply which is a potential threat for health of public who are settled on the banks of Bhima river and its tributaries.

The polluted water contains several microorganisms, worms, bacteria which infect the human beings and many animals causing health problems. In human majority of deceases are water bournes. These deceases if not properly and timely controlled they are fetal causing death of consumers. Not only humans but other aquatic animals like fishes and related species are badly affected by these influenced bacteria, viruses and fungi. Hence the quality of drinking water should be tasted for presence of various harmful microns and pathogenic bacteria creating several pathological disorders in consumers.

Table 7.1 : Water Quality standards for Best Designated Usages

Category of Fresh Water	A1	A2	A3	A4
Best usage	Unfiltered public water supply after approved disinfection	Public water supply with approved treatment equal to coagulation sedimtation & disinfection	Not fit for human consumption Fish & wildlife Propagation	Fit for agriculture Industrial cooling & Process water
Chemical Qualitites : Maximum allowable concentration				
1.Toxic Substances				
Arsenic (As)	0.3mg/l	0.3 mg/l	1.0 mg/l	0.1 mg/l
Cadmium (Cd)	0.01 mg/l	0.01 mg/l	-	-
Chromium (Cr +6)	0.05 mg/l	0.05 mg/l	0.05 mg/l	0.2 mg/l
Cyanide (CN)	0.05 mg/l	0.1 mg/l	0.05 mg/l	0.2 mg/l
Lead (Pb)	0.1 mg/l	0.1 mg/l	-	0.1 mg/l
Boron (B)	-	-	-	2.0 mg/l
Mercury (Hg)	0.001 mg/l	0.001 mg/l	0.001 mg/l	-
Gross alpha activity	3 PCI/L	10-9 uc/ml	3 PCI/l	3PCI/l
Gross Beta activity	30 PCI/l	10-8uc/m	30PCI/I	3 PCI/I
2. Substances affecting health				
Fluroide (F)	1.5mg/l	1.5mg/l	-	1.0mg/l
Nitrate (NO3)	45mg/l	45mg/l	-	-
3. Substances affecting the potability of water				
pH	6.5 to 8.5	6.5 to 8.5	6.5 to 9.0	6.5 to 9.0
TDS	-	TDS	TD	-
Total Solids	1500 mg/l	1500 mg/l	-	-
Total Suspended Solids	25 mg/l	-	-	-
Total Hardness (CaCO3)	50 mg/l	-	-	-
Total Residual Chlorine	-	-	-	-
Electrical conduct at 25.C	-	-	1000x10-6 mhos	3000x10-6mhos
Free carbon Di Oxide	-	-	1.2 mg/l	-
Free Amonical Nitrogen	-	-	1.2 mg/l	-
Oil & Grease	-	-	0.1 mg/l	-
Pesticides	-	-	0.02 mg/l	-
Biotic Index	-	-	6.0 mg/l	-
Total Ammonical Nitrogen	1.5 mg/l	1.5 mg/l	-	50 mg/l
Chlorides (Cl)	600 mg/l	600 mg/l	-	mg/l
Sulphates	400 mg/l	400 mg/l	-	1000 mg/l
Copper (Cu)	1.5 mg/l	1.5 mg/l	-	-
Manganese (Mn)	0.5 mg/l	3.0 mg/l	-	-
Iron (Fe)	1.0 mg/l	5.0 mg/l	-	-
Sodium	-	-	-	-
Zinc (Zn)	15.0 mg/l	1.5 mg/l	5.0 mg/l	5.0 mg/l
Phenolic Compounda	0.002 mg/l	0.002 mg/l	0.05 mg/l	-
Alkyl Benzene sulphates	1.0 mg/l	1.0 mg/l	-	-
Mineral oil	0.3 mg/l	0.3 mg/l	-	-
Ammonia	1.5 mg/l	1.5 mg/l	-	-
BOD (5days 20.C)	2.0 mg/l monthly average of atleast 10 samples)	5.0 mg/l (monthly average of atleast 10 samples))	10 mg/l	30mg/l
COD	-	-	-	150 mg/l
DO	Not less than 5 mg/l average of atleast 100 samples)	4.0mg/l	Not less than 3 mg/l	Not less than 2 mg/l
Bacteriological standards: (MPN/100)	Coliform Bact. 250	Not greater than 5000	-	-

Source: Data collected by Maharashtra Pollution Control Board, Pune

The water bourne diseases is viz diarrohoea, dicentry, thyphoid, jaundice, colleria are the water born diseases and people are volurnable and sustanible for

water born diseases. Secondly, the industrial pollutions which are also one of the threats will increase the toxicity of water. The metal ions like mercury, sulphure, zinc and not metal pollutants as well as heavy metals in drinking water are highly toxic to human and animals.

Table 7.2 : Effect of polluted water on population of different villages settled on the bank of Bhima river

Sr. No	Taluka	Villages on Bank of Bhima river	Population	Affected villages near river	Population near infected villages	Water required for infected villages
1	Daund	33	111961	29	93428	964280
2	Haveli	35	170070	1	2233	22330
3	Indapur	19	24897	19	24897	248970
4	Khed	35	142783	14	66009	660090
5	Shirur	11	26753	7	15768	157680
6	Mawal	63	131259	--	---	---
Total		196	607723	70	222335	2223350

Table 7.3 : Villages adjoining to bank of Bhima river & it's tributaries in Pune District

Taluka : Daund

Sr. No.	Name of Villages	Population	Water Supplied	Sewage water	Capacity of Sewage Treatment Plant	Whether Drinking water is polluted Yes / No
1	Miravdi	2184	87.4	61.2	--	Yes
2	Nandur	2208	88.3	61.8	--	--
3	Dahitne	1918	76.7	53.7	--	Yes
4	Khamgaon	6887	275.5	192.83	--	--
5	Undavdi	2293	91.7	64.2	--	Yes
6	Rahu	9987	399.5	279.6	--	Yes
7	Pimpalgaon	5720	228.8	160.2	--	--
8	Delwadi	3725	149.0	104.3	--	--
9	Pargaon	8661	346.4	242.5	--	Yes
10	Nangaon	6934	277.4	194.2	--	Yes
11	Hathwalan	2272	90.88	63.62	--	Yes
12	Nanabij	3249	129.9	90.9	--	Yes
13	Sonawadi	3828	153.1	107.2	--	Yes
14	Khorwadi	228	109.1	76.4	--	Yes
15	Hingani Bedi	3491	139.6	97.7	--	Yes
16	Shirapur	2159	86.4	60.5	--	Yes
17	Wadgaon Bunde	1461	58.4	40.9	--	Yes
18	Kore Bhivar	1310	52.4	36.7	--	Yes
19	Khanota	2455	98.2	68.7	--	Yes
20	Naigaon	488	19.5	13.7	--	Yes
21	Vatluj	2025	81.0	56.7	--	Yes
22	Kangaon	6377	255.1	178.5	--	Yes
23	Telewadi	1741	69.6	48.7	--	Yes
24	Panavli	827	33.1	23.2	--	Yes
25	Pilanwadi	2468	98.7	69.1	--	Yes
26	Aalegaon	2701	108.0	75.6	--	Yes
27	Taakli	1419	56.7	39.7	--	Yes
28	Patethan	1687	67.4	47.2	--	Yes
29	Rajegaon	5101	204.0	142.8	--	Yes
30	Kurkumb	4480	179.2	125.4	--	Yes
31	Pandrewadi	2146	85.8	60.1	--	Yes
32	Malad	3005	120.2	84.1	--	Yes
33	Ravangaon	4026	161.0	112.7	--	yes
Total		**111961**	**4396.98**	**3134.65**	--	--

Taluka : Haveli

Sr. No.	Name of Village	Population	Water Supplied MLD	Sewage Water MLD	Capacity of Sewage Treatment Plant MLD	Whether Drinking water is polluted Yes / No
1	Kondve Dhavde	4675	187.0	130.0	--	--
2	Shivane	6661	266.4	186.5	--	--
3	Uttamagar	6473	258.9	181.2	--	--
4	New Kopre	2976	119.0	83.3	--	--

5	Khadakvasla	7056	282.2	197.5	--	--
6	Kirkitwadi	4334	173.3	121.3	--	--
7	Dhayri	18611	744.4	521.1	--	--
8	Nanded	5839	233.5	163.4	--	--
9	Narhe	3859	154.3	108.0	--	--
10	Ambegaon Bu	5767	230.6	161.4	--	--
11	Ambegaon Khu	1579	631.6	442.1	--	--
12	Keshavagar	14934	597.3	418.15	--	--
13	Manjri Bu	24509	980.3	686.2	--	--
14	Manjri Khu	3021	120.8	845.8	--	--
15	Kolavdi	4210	168.4	117.8	--	--
16	Theur	9228	369.1	258.3	--	--
17	Bivri	1050	42.0	29.4	--	--
18	Koregaon Mul	3608	144.3	101.0	--	--
19	Bhavrapur	1254	50.1	35.1	--	--
20	Ashtapur	3237	129.4	90.6	--	--
21	Hingangaon	1573	62.9	44.0	--	--
22	Khamgaon Tek	832	33.2	23.2	--	--
23	Dehu	10000	400.0	280.0	--	--
24	Nirgudi	711	28.4	19.9	--	--
25	Wadgaon Shinde	2668	106.7	74.7	--	--
26	Bhavdi	1476	59.0	41.3	--	--
27	Tulapur	2039	81.5	57.0	--	--
28	Phulgaon	1651	66.0	46.2	--	--
29	Wadu Khu	1309	52.3	36.6	--	--
30	Perne	5181	207.2	145.0	--	--
31	Dongargaon	2233	89.3	62.5	--	Yes
32	Burkegaon	1870	74.8	52.3	--	--
33	Pimpri Sandas	3031	121.2	84.8	--	--
34	Sangvi Sandas	1255	50.2	35.1	--	--
35	Nhavi Sandas	1360	54.4	38.0	--	--
Total		170070	7370	5918.75	--	--

Taluka : Indapur

Sr. No.	Name of Village	Population	Water Supplied MLD	Sewage Water MLD	Capacity of Sewage Treatment Plant MLD	Whether Drinking water is polluted Yes / No
1	Bhavdi	900	36.0	25.2	-	Yes
2	Chandgaon	865	34.6	24.2	--	Yes
3	Kalthan No. 1	2062	82.	57.7	--	Yes
4	Agothi No. 1	1400	56.0	39.2	--	Yes
5	Kalthan No. 2	1200	48.0	33.6	--	Yes
6	Gangawalan	650	26.0	18.2	--	Yes
7	Hingangaon	1200	48.0	33.6	--	Yes
8	Taratgaon	475	19.0	13.3	--	Yes
9	Kandalgaon	2025	81.0	56.7	--	Yes
10	Ajoti	400	16.0	11.2	--	Yes
11	Pimpri Khurd	2300	92.0	64.4	--	Yes
12	Padstal	1080	43.2	30.2	--	Yes
13	Takralwadi	2000	80.0	56.0	--	Yes
14	Kumbargaon	1545	61.8	43.2	--	Yes
15	Dalaj No. 2	1420	56.8	39.7	--	Yes
16	Dalaj No. 1	1220	48.8	34.1	--	Yes
17	Dalaj No. 3	1000	40.0	28.0	--	Yes

18	Diksal	1580	63.2	44.2	--	Yes
19	Kolewadi No. 1	1575	63.0	44.1	--	Yes
Total		24897	995.8	696.8	--	--

Taluka : Khed

Sr. No.	Name of Village	Population	Water Supplied MLD	Sewage Water MLD	Capacity of Sewage Treatment Plant MLD	Whether Drinking water is polluted Yes / No
1	Daunde	3790	151.6	106.1	--	--
2	Vadgaon Patole	2262	90.4	63.3	--	--
3	Chandoli	2242	89.6	62.7	--	Yes
4	Rajguragar	17636	705.4	493.8	--	Yes
5	Shiroli	4250	170.0	119.0	--	Yes
6	Kharpuda Khu	1450	58.0	40.6	--	Yes
7	Manjrewadi	1622	64.8	45.4	--	--
8	Kharpuda Bu	4582	183.6	128.5	--	--
9	NImgaon	2811	112.4	78.7	--	--
10	Davdi	6237	249.4	174.6	--	--
11	Daundkarwadi	1063	42.5	29.7	--	Yes
12	Shelpimpalgaon	5939	237.5	166.2	--	Yes
13	Koyali Chakan	3378	135.0	94.5	--	--
14	Siddhigavhan	780	31.2	21.8	--	Yes
15	Bahul	3960	158.4	110.8	--	Yes
16	Aaskhed Khu	1150	46.0	32.2	--	--
17	Aaskhed Bu	900	36.0	25.2	--	--
18	Chandus	1980	79.2	55.4	--	--
19	Vaki Khu	3000	120.0	84.0	--	--
20	Rohkal	1910	76.4	53.4	--	--
21	Chakan	21674	866.9	606.8	--	--
22	Shelgaon	922	36.8	25.8	--	--
23	Sangurdi	1350	54.0	37.8	--	--
24	Yelwadi	1530	61.2	42.8	--	Yes
25	Khalubre	1530	61.2	42.8	--	Yes
26	Nighoje	3310	132.4	92.6	--	--
27	Moi	3000	120.0	84.0	--	--
28	Ku Ruli	8000	320.0	224.0	--	Yes
29	Chimbli	3410	136.4	95.4	--	Yes
30	Kelgaon	3669	146.7	102.7	--	--
31	Charholi Khu	5973	238.9	167.2	--	--
32	Dhanore	2569	102.7	71.9	--	--
33	Solu	5900	236.0	165.2	--	Yes
34	Golegaon	2500	100.0	70.0	--	Yes
35	Markal	5600	224.0	156.8	--	--
Total		142783	5710.4	3996.8	--	--

Taluka : Shirur

Sr. No.	Name of Village	Population	Water Supplied MLD	Sewage Water MLD	Capacity of Sewage Treatment Plant MLD	Whether Drinking water is polluted Yes / No
1	Koregaon Bhima	3077	123.0	86.1	--	Yes
2	Vitthalwadi	1682	67.2	47.0	--	Yes

3	Aalegaon Paga	1772	70.8	49.6	--	Yes
4	Nangargaon	1543	61.7	43..2	--	Yes
5	Vadgaon Rasai	4074	162.9	114.0	--	Yes
6	Ganegaon Dumaa	2537	101.4	71.0	--	Yes
7	Mandavgan Faratha	2388	95.5	66.8	--	Yes
8	Tandli	1671	66.8	46.7	--	--
9	Jamgaon	2498	99.9	69.9	--	--
10	Darekarwadi	1311	52.4	36.7	--	--
11	Shikrapur	4200	168.0	117.6	--	--
Total		26753	1069.6	748.6	--	--

Taluka : Mawal

Sr. No.	Name of Village	Population	Water Supplied MLD	Sewage Water MLD	Capacity of Sewage Treatment Plant MLD	Whether Drinking water is polluted Yes / No
1	Kale	1360	54.4	38.0	--	--
2	Yelse	1450	58.0	40.6	--	--
3	Mahagaon	1640	65.6	45.9	--	--
4	Kadadhe	1250	50.0	35.0	--	--
5	Karunj	2164	86.5	60.5	--	--
6	Chikalse Ahirwade	1972	87.8	55.2	--	--
7	Baur	2122	84.8	59.4	--	--
8	Aadhe	880	35.2	24.6	--	--
9	Ozarde	1161	46.4	32.5	--	--
10	Urse	3582	143.2	100.2	--	--
11	Parandwadi	1631	65.2	45.6	--	--
12	Somatne	4200	168.0	117.6	--	--
13	Shirgaon	3250	130.0	91.0	--	--
14	Gahunje	2292	91.6	64.1	--	--
15	Waru	856	34.2	23.9	--	--
16	Brahmanoli	648	25.9	18.1	--	--
17	Koturne	1152	46.0	32.2	--	--
18	Chinchwadi (Koturne)	1480	59.2	41.4	--	--
19	Shivli	1631	65.2	45.6	--	--
20	Yelghol	692	27.6	19.3	--	--
21	Dhagavhan	465	18.6	13.0	--	--
22	Bhadavli	428	17.1	11.9	--	--
23	Thugaon	700	28.0	19.6	--	--
24	Aadharv	400	16.0	11.2	--	--
25	Malvandi Dhore	900	36.0	25.2	--	--
26	Shivane	2719	108.7	76.1	--	--
27	Sadavli	825	33.0	23.1	--	--
28	Bebadovhol	2155	86.2	60.3	--	--
29	Pimplekhute	925	37.0	25.9	--	--
30	(Chandkhed) Chandawadi	600	24.0	16.8	--	--
31	Sathe	3902	156.0	109.2	--	--
32	Done	971	38.8	27.1	--	--
33	Dhamne	1468	58.7	41.1	--	--
34	Godumbre	1310	52.4	36.6	--	--
35	Salumbre	1226	49.0	34.3	--	--
36	Darumbre	1505	60.2	42.1	--	--
37	Sangavde	1329	53.1	37.2	--	--

38	Takve Khu	1296	51.8	36.2	--	--
39	Kadkale Kamshet	15000	600.0	420.0	--	--
40	Taje	948	37920	26544	--	--
41	Pimploli	964	38.5	26.9	--	--
42	Pathargaon	497	19.8	13.9	--	--
43	Nane	3500	140.0	98.0	--	--
44	Kanhe	5535	221.4	154.9	--	--
45	Naigaon	1240	49.6	34.7	--	--
46	Sai	622	24.8	17.4	--	--
47	Nanoni	536	21.4	15.0	--	--
48	Paravdi	410	16.4	11.4	--	--
49	Ghonshet	1952	78.0	54.6	--	--
50	Wadgaon	11364	454.5	318.1	--	--
51	Katvi	678	27.1	18.9	--	--
52	Rajpuri	920	36.8	25.7	--	--
53	Varale	3346	133.8	93.6	--	--
54	Shiv Shankar & Bhima Shankar colony	1600	64.0	44.8	--	--
55	Aambi	1215	48.6	34.0	--	--
56	Mangrul	842	33.6	23.5	--	--
57	Malwadi	3748	149.9	104.9	--	--
58	Indori	9350	374.0	261.8	--	--
59	Mundaware	393	15.7	11.0	--	--
60	Jambul	2750	110.0	77.0	--	--
61	Amble	1273	50.9	35.6	--	--
62	Warangwadi	1200	48.0	33.6	--	--
63	Waksai	2839	113.5	49.4	--	--
Total		131259	43130.7	30190.3	--	--
Total (196 Villages)		607723	62673.48	44685.9	--	--

Source: Data collected by Maharashtra Pollution Board, Pune

Diarrohoea:

Bacterial gastro-infection is caused by bacteria such as Shigella, salgolony thypic & Airecinia. Diarrohoea is also one of the water born diseases where bacteria and viruses are entered in the intestine of humans.

Dycentry: Amoebiasis, shygellosis, choleria are also water bourne deceases.

Infective Hepatitis: Hepatits-E is water born diseases.

Thyphod: It is caused by Salmenora thyphod and salmenora para-thypod. The people also suffer by metallic and non metallic poisoned pollutants due to water pollution.

Remedial measures for purifying polluted drinking water :

The remedial measures for water purification has began at most important as the water has become non-potable quality due to presence of bacteria, high BOD. Health department also conducted the survey and come to conclusion that the water of Bhima river and its tributaries is no fit for human consumption without treatment. In survey of water sample total dissolve solid (TDS), pH value of water, salinity of water, presence of nitrate and chlorides are much more at higher side than existing

norms of water quality. Following water born diseases become very common due to presence of pathological bacteria. Following water born diseases were very common in population of different villages which were settled on bank of Bhima river and its tributeries.

The putification of drinking water is primary important task to restore the pure water supply to the affected villages. The remedial measures have two broad prospective one is short term and another is long term plan.

Rivers Osmosis: This is a metallic method for filtration of water. It is used for desalination of water where harmful excess salt is removed from water.

Electrolysis: In this water purification system electric current is used. The positive and negative electrodes are activated. The salt particles which are having negative charge attracts towards positive electrons and sustained salt particle having negative charge are attracted towards positive electrons. Electrolysis is a method where charged salt particles are nullified and percentage of dissolved salt particles becomes less and water can be used for drinking.

Iron exchange resin: This method depends on nature & percentage of salt dissolved in that water. Various types of membranes are used for purification of waters. It is used as a filter where salt particles get confined. Membrane technology is widely used all over the world for purification of water.

Water Purification Plant: This method is used for water purification in many municipal corporation and municipal councils, it is thumb rule method for water purification. This method is indigenious and very much eco-friendly. It involves steps aggulation i.e. chlorification, filtration and disinfection.

Provision of pure water supply is not a work of single agency. It is complex task various departments viz. Zilla Parishad, Maharashtra Jeevan Pradikaran, Panchayat Samiti and Maintenance shall be by village Panchayats.

Table 7.4 : Approximate expenditure for Supply of Pure drinking Water

Sr. No.	Facilities to be Provided	Expected Expenses (in Lakhs)
A.	Short Term & immediate measures Pure Water supply by Quick RO units.	1220.70
B.	Long Term Remedial Measures Erection of water treatment plant. Construction of new water supply scheme.	2456
Total		**3676.70**

Table 7.5 : Water Supply, Production of Sewage Water and Disposal

Sr. No.	Particulars	MLD
1	Total Water Supply	1725.19
2	Sewage water created	1239.63
3	Treated Sewage Water	697.71
4	Untreated Sewage water added in Bhima river	541.92
A	Pune City	362 (66.80%)
B	Pimpri-Chinchwad City	88 (16.24%)
C	10 Municipal Councils	44.39 (8.20%)
D	Cantonment Board Area	29.9 (5.33%)
E	Villages on river Banks	16.93 (3.18%)
F	Hinjwadi Industrial Area	(0.31%)

Source: Data collected by Maharashtra Pollution Board, Pune

For Prevention of water pollution of Bhima river bio-logical decomposition process following systems can be operated for effective implementation of water pollution.

Activated sludge process, Sequacial batch reactor, Muvable bed bio reactor, Up-flow an arobic sludge blanket, Phytoremediation and Soak pit system

Municipal Corporation, Cantonment Board, Municipal Council ought to develop underground drainage system and small and medium sewage treatment plants which are decentralized in various wards and monitored centrally. In villages soak pits and bunds are very useful as well by construction of bunds and diversion of water for agriculture purpose can be used.

Table 7.6 : Expenditure for Bhima river Pollution Control Action Plan

Sr. No.	Particulars	Short Terms and immediate measures (in Lakhs)	Long Terms and immediate measures (in Lakhs)	Total (in Lakhs)
1	Preventing river Pollution	20773.92	62119.87	82893.79
2	Providing safe and Pure water supply in affected villages	1220.70	2456.0	3676.70
Total		**21994.62**	**64575.87**	**86570.49**

Table 7.7 : Expenditure for Bhima river Pollution Control Action Plan

Sr. No.	Name of Cities/Villages	Immediate Action Plan			Long Term Action Plan		
		Particulars	Expected Expenses (Rs. In (Lakhs)	Expected Time (Mths)	Particulars	Expected Expenses (Rs. In Lakhs)	Expected Time (Mths)
1	Pimpri - Chinchwad	i) STP Project mentioned below have reached last stage & will commence in action soon. a) Ravet – 30 M.L.D b) Kasarwadi Phase 3-40 M.L.D	 1375 3014.0	 2 2	i) STP Project delayed to commence. a) Sanghvi–20 M.L.D b) Akurdi-20 M.L.D c) Charoli-20 M.L.D	1644.0 789.4 2833.0	 12 (Work In Progress)
		ii) To Continue old STP Project.	--	--	ii) Pimpri Chinchwad Municipal corporation should maintain to build Gutters in all areas.	Work In Progress	- 12
		iii) To join the maintenance of Gutter with STP Projects.	--	--	iii) STP Projects regarding Sewage Water is in third stage and use the Sewage Water by recycling it.	Agreement Under G.T.Z. is under Progress	
		iv) Drainage Lines Chambers should be checked & repaired regularly under STP Projects.	Work In Progress		iv) Trunk Silver Line should be build at bank of rivers to stop the flow of sewage water. a) Talawade to Charoli (40% Complete) Parellel to Indrayani. b) Walhekarwadi to Chichwad (60% Complete) Parellel to Pawna river.	Work In Progress	12
2	Pune	i) STP Projects mentioned below are in last stage and about to commence. a) New Naidu – 115 M.L.D, (Project is ready & under survey) b) Baner–30	 4000 3000 8613	 01 01 12	i) Commencing SPT Project. a) Bhairoba - Capacity should be increased from 30 MLD to 90 MLD. b) New Warje – 16 MLD c) Tanajiwadi – 13 MLD	 27100 (Pune Municipal Corp. State Committee Have sanctioned 70%	 36

Sr. No.	Name of Cities/Villages	Immediate Action Plan			Long Term Action Plan		
		Particulars	Expected Expenses (Rs. In (Lakhs)	Expected Time (Mths)	Particulars	Expected Expenses (Rs. In Lakhs)	Expected Time (Mths)
		MLD c)Kharadi–40 MLD			d) Bopode – 9 MLD e)Batnical Garden – 9 MLD f) Kalyani Nagar – 50 MLD g) Vishrantwadi Mental Hospital – 20 MLD	Is still Proposed)	
		ii) Old STP Projects should be maintained properly	--	--	ii) 21 Gutters in different areas should be joined to STP Projects. Instructions are mentioned in annexure 6-B.	10961	36
		iii) Drainage lines chambers related with STP Projects should be maintained regularly.	Work In Progress		iii) Pune Municipal Corporation should prepare subway gutter projects in all areas.	Procedure to store Sewage Water in Municipal Corporation is completed nearly 90% area. Remaining area is under construction.	
					iv) Areas having 150 or more residency should compulsory build sewage water project.	--	
A) Municipal Corporation							
1	Lonavala	Sewage water flowing towards river direction should be stopped and should be recycled and used for Farming work.	10	6 to 8	Should start subway gutter projects. Capacity 4 MLD & 6.5 MLD	2080	12
		If required CWLT related gutter-garden procedure should be done.			Related Hotel Management should be ordered to prepare own STP Projects and use sewage water in their hotel garden.	--	--
2	Talegaon	Sewage water flowing towards river direction should be stopped and should be recycled and	10	15 Days	Subway-Gutters should be maintained in every area.	--	--

Sr. No.	Name of Cities/Villages	Immediate Action Plan			Long Term Action Plan		
		Particulars	Expected Expenses (Rs. In (Lakhs)	Expected Time (Mths)	Particulars	Expected Expenses (Rs. In Lakhs)	Expected Time (Mths)
		used for Farming work.					
		If required CWLT related gutter-garden procedure should be done.			Related Hotel Management should be ordered to prepare own STP Projects and use sewage water in their hotel garden.	2931	48
3	Alandi	Sewage water flowing towards river direction should be stopped and should be recycled and used for Farming work.	106	15 Days	Subway-Gutters should be maintained in every area.	2500	36
4	Junnar	Sewage water flowing towards river direction should be stopped and should be recycled and used for Farming work.	2.5	6	Subway-Gutters should be maintained in every area.	1300	36
		If required CWLT related gutter-garden procedure should be done.					
5	Shirur	Approximately STP Projects work having 6 MLD capacities is in progress & is aspected to be completed within 6 months.	--	06	Subway-Gutters should be maintained in every area.	300	Work In Progress
6	Saswad	Sewage water flowing towards river direction should be stopped and should be recycled and used for Farming work.	10	01	Subway-Gutters should be maintained in every area.	1708	48
		If required CWLT related gutter-garden procedure should be done.					

Sr. No.	Name of Cities/Villages	Immediate Action Plan			Long Term Action Plan		
		Particulars	Expected Expenses (Rs. In (Lakhs)	Expected Time (Mths)	Particulars	Expected Expenses (Rs. In Lakhs)	Expected Time (Mths)
7	Jejuri	Sewage water flowing towards river direction should be stopped and should be recycled and used for Farming work. If required CWLT related gutter-garden procedure should be done.	10	01	Subway-Gutters should be maintained in every area.	1025	48
8	Daund	Sewage water flowing towards river direction should be stopped and should be recycled and used for Farming work. If required CWLT related gutter-garden procedure should be done.	10	01	Subway-Gutters should be maintained in every area. (Fund is available under U.I.D.S.S.M.T Scheme)	2400	12
9	Baramati	Sewage water flowing towards river direction should be stopped and should be recycled and used for Farming work. If required CWLT related gutter-garden procedure should be done.	10	01	Subway-Gutters should be maintained in every area. (Fund is available under U.I.D.S.S.M.T Scheme)	1162	24
10	Indapur	Sewage water flowing towards river direction should be stopped and should be recycled and used for Farming work.	10	01	Subway-Gutters should be maintained in every area.	1025	48
A) Survey Area							
Dehu							
	Urban Settlement	Sewage Water near Shelarwadi, Kiwale &	10	01	i) STP Projects should be commenced at Kisan Nagar	60	18

Sr. No.	Name of Cities/Villages	Immediate Action Plan			Long Term Action Plan		
		Particulars	Expected Expenses (Rs. In (Lakhs)	Expected Time (Mths)	Particulars	Expected Expenses (Rs. In Lakhs)	Expected Time (Mths)
		Kinahe under CWLT Projects should be used in garden.			Kiwale. ii)STP Projects should be commenced at Shelarwadi. iii) STP Projects should be commenced at Kinahe.	30 30	18 18
	Cantonment Board	If required CWLT related gutter-garden procedure should be done.	10	01	STP Projects should be commenced. (Proposal not yet submitted)	150	24
Khadki							
	Urban Settlement	Sewage Water Projects should be maintained regularly.	--	--	Chemical Sewage Water should be used for gardening purpose. (Proposal not yet submitted)	--	--
	Cantonment Board	If required CWLT related gutter-garden procedure should be done.	10	01	STP Projects should be commenced. (Proposal not yet submitted)	150	24
Pune							
	Urban Settlement	--	--	--	Sewage Water Pune Municipal Subway-Gutter Projects should be adjoined to Pune Municipal Corporation Projects.	--	--
	Cantonment Board	STP Project having capacity of 1.5 MLD should be build at Moraid Gutter.	350	09	In order to adjoin Cantonment Board area in Pune Municipal Corporation with J.L.N.U.R.M., Military Engineering Services has submitted the proposal to Pune Municipal & its been decided to pay expenses in Partnership.	--	--

Source: Data collected by Maharashtra Pollution Board, Pune

Immediate Measures for prevention of Water Pollution of Bhima river:

Immediate measures to prevent Water Pollution of Bhima river and its tributaries: the source of water pollution is from containment boards, municipal

council, Municipal Corporation. The nalas which are confluiencing to Bhima river and its tributaries and add water to Bhima river. The bunds shall be constructed on the process units of the technology. The sewage water shall be CONSTRUCTED WET LAND TECHNOLOGY and used for agriculture and developments of gardens in city area. All Sewage treatment plants shall be operated of full potential. Villages which are situated on the bank of Bhima river and its Tributaries the soak pit shall be constructed which is very indigenous and environment friendly measures. Nala Gardens shall be developing and treated water shall be used for gardening construction activities and after proper treatment recycle water for industrial purpose.

The short term plans can also be used by constructing

Continuous Flow tanks

Quiescent Tanks

Septic Tanks

Contact Beds

Straw Filters

7.8 **Long term & Short term Planning for Villages for Sewage Water Treatment**

Sr. No.	Name of Cities/Villages	Immediate Action			Long Term Plan		
		Particulars	**Expected Expenses (Rs. In (Lakhs)**	**Expected Time (Mths)**	**Particulars**	**Expected Expenses (Rs. In Lakhs)**	**Expected Time (Mths)**
A) Villages situated near Banks of river							
Taluka - Daund							
1	Miravdi	Construction of Soaking Pits	0.52	2	Construction of Soaking Pits	1.75	2
2	Nandur	Construction of Soaking Pits	0.53	2	To construct Bund & Water to Agriculture	3.00	6
3	Dahitne	Construction of Soaking Pits	0.46	2	To construct Bund & Water to Agriculture	3.50	6
4	Khamgaon	Construction of Soaking Pits	1.65	2	To construct Bund & Water to Agriculture	3.00	6
5	Undavdi	Construction of Soaking Pits	0.55	2	To construct Bund & Water to Agriculture	3.00	6
6	Rahu	Construction of Soaking Pits	2.40	2	To construct Bund & Water to Agriculture	5.00	6
7	Pimplegaon	Construction of Soaking Pits	1.37	2	To construct Bund & Water to Agriculture	3.00	6
8	Delwadi	Construction of Soaking Pits	0.89	2	To construct Bund & Water to Agriculture	3.50	6
9	Paargon	Construction of Soaking Pits	2.08	2	Construction of Soaking Pits	6.20	5
10	Naangaon	Construction of Soaking Pits	1.66	2	Construction of Soaking Pits	5.50	5
11	Hathvalan	Construction of Soaking Pits	0.55	2	Construction of Soaking Pits	1.80	2
12	Nanvij	Construction of Soaking Pits	0.78	2	To construct Bund & Water to Agriculture	3.00	6
13	Sowadi	Construction of Soaking Pits	0.92	2	Construction of Soaking Pits	3.10	3
14	Khorwadi	Construction of Soaking Pits	0.65	2	Construction of Soaking Pits	2.20	3
15	Hinganiberdi	Construction of Soaking Pits	0.84	2	Construction of Soaking Pits	2.80	3
16	Shirapur	Construction of Soaking Pits	0.52	2	Construction of Soaking Pits	1.75	2
17	Wadgaonbunde	Construction of Soaking Pits	0.35	2	Construction of Soaking Pits	1.50	2
18	Kore. Bhivar	Construction of Soaking Pits	0.31	2	Construction of Soaking Pits	1.10	2
19	Khanota	Construction	0.59	2	Construction	2.00	2

Sr. No.	Name of Cities/Villages	Immediate Action			Long Term Plan		
		Particulars	Expected Expenses (Rs. In (Lakhs)	Expected Time (Mths)	Particulars	Expected Expenses (Rs. In Lakhs)	Expected Time (Mths)
		of Soaking Pits			of Soaking Pits		
20	Naigaon	Construction of Soaking Pits	0.12	2	Construction of Soaking Pits	0.50	1
21	Watlunj	Construction of Soaking Pits	0.49	2	Construction of Soaking Pits	1.70	2
22	Kangaon	Construction of Soaking Pits	1.53	2	To construct Bund & Water to Agriculture	3.00	6
23	Telewadi	Construction of Soaking Pits	0.42	2	Construction of Soaking Pits	1.40	2
24	Pawali	Construction of Soaking Pits	0.20	2	Construction of Soaking Pits	0.80	1
25	Pilanwadi	Construction of Soaking Pits	0.59	2	Construction of Soaking Pits	2.00	2
26	Aalegaon	Construction of Soaking Pits	0.65	2	Construction of Soaking Pits	2.20	2
27	Taakli	Construction of Soaking Pits	0.34	2	Construction of Soaking Pits	1.25	2
28	Patethan	Construction of Soaking Pits	0.40	2	Construction of Soaking Pits	2.00	2
29	Rajegaon	Construction of Soaking Pits	1.22	2	To construct Bund & Water to Agriculture	3.00	6
30	Kurkumb	Construction of Soaking Pits	1.08	2	To construct Bund & Water to Agriculture	4.00	6
31	Pandrewadi	Construction of Soaking Pits	0.52	2	Construction of Soaking Pits	2.00	2
32	Malad	Construction of Soaking Pits	0.72	2	To construct Bund & Water to Agriculture	3.00	6
33	Rawangaon	Construction of Soaking Pits	0.97	2	To construct Bund & Water to Agriculture	3.00	6
Haveli							
1	Kondve Dhawade	Construction of Soaking Pits	1.00	2	Commence Sewage Water Project	500.00	36
2	Shivane	Construction of Soaking Pits	1.00	3			
3	Uttam Nagar	Construction of Soaking Pits	1.00	3			
4	U Kopare	Construction of Soaking Pits	1.00	3			
5	Kadakwasla	Construction of Soaking	1.00	3	Commence	700.00	48

Sr. No.	Name of Cities/Villages	Immediate Action			Long Term Plan		
		Particulars	Expected Expenses (Rs. In (Lakhs)	Expected Time (Mths)	Particulars	Expected Expenses (Rs. In Lakhs)	Expected Time (Mths)
		Pits			Sewage Water Project		
6	Kirkitwadi	Construction of Soaking Pits	1.00	3			
7	Dhayri	Construction of Soaking Pits	1.00	3			
8	Nanded	Construction of Soaking Pits	1.00	3			
9	Narhe	Construction of Soaking Pits	1.00	3			
10	Ambegaon-Bu	Construction of Soaking Pits	1.00	3			
11	Ambegaon-Khu	Construction of Soaking Pits	1.00	3			
12	Keshavagar	Construction of Soaking Pits	2.00	5	Adjoin to Municipal Corporation Projects	10.00	09
13	Manjuri-Bu	Construction of Soaking Pits	2.00	5	Sewage Water Project	100.00	24
14	Manjuri-Khu	Construction of Soaking Pits	1.00	3	To construct Bund & Water to Agriculture	5.00	6
15	Kolwadi	Construction of Soaking Pits	1.00	3	To construct Bund & Water to Agriculture	5.00	6
16	Theyur	Construction of Soaking Pits	1.00	3	To construct Bund & Water to Agriculture	5.00	6
17	Bivari	Construction of Soaking Pits	0.25	3	Construction of Soaking Pits	1.00	2
18	Koegaon Mul	Construction of Soaking Pits	1.00	3	To construct Bund & Water to Agriculture	3.00	6
19	Bhavrapur	Construction of Soaking Pits	0.30	3	Construction of Soaking Pits	1.00	2
20	Ashtapur	Construction of Soaking Pits	1.00	3	To construct Bund & Water to Agriculture	3.00	6
21	Hingangaon	Construction of Soaking Pits	0.40	3	Construction of Soaking Pits	1.26	2
22	Khamgaon Tek	Construction of Soaking Pits	0.21	3	Construction of Soaking Pits	1.00	2
23	Dehu	Construction of Soaking Pits	1.00	3	Sewage Water Project	100.00	24
24	Nirgudi	To construct Bund & Water to	0.20	3	Construction of Soaking Pits	1.00	2

Sr. No.	Name of Cities/Villages	Immediate Action			Long Term Plan		
		Particulars	Expected Expenses (Rs. In (Lakhs)	Expected Time (Mths)	Particulars	Expected Expenses (Rs. In Lakhs)	Expected Time (Mths)
		Agriculture					
25	Wadgaon Shinde	Construction of Soaking Pits	1.00	3	To construct Bund & Water to Agriculture	1.00	6
26	Bhavdi	Construction of Soaking Pits	0.37	3	Construction of Soaking Pits	1.18	2
27	Tulapur	Construction of Soaking Pits	0.51	3	Construction of Soaking Pits	1.63	2
28	Phulgaon	Construction of Soaking Pits	0.41	3	Construction of Soaking Pits	1.35	2
29	Wadu-Khu	Construction of Soaking Pits	0.33	3	Construction of Soaking Pits	1.10	2
30	Perne	Construction of Soaking Pits	1.00	3	To construct Bund & Water to Agriculture	5.00	6
31	Dongargaon	Construction of Soaking Pits	0.45	3	Construction of Soaking Pits	1.85	2
32	Burkegaon	Construction of Soaking Pits	0.75	3	Construction of Soaking Pits	1.50	2
33	Pimpri Sandas	Construction of Soaking Pits	1.00	3	To construct Bund & Water to Agriculture	3.50	6
34	Sanghvi Sandas	Construction of Soaking Pits	0.31	3	Construction of Soaking Pits	1.00	2
35	Nhavi Sandas	Construction of Soaking Pits	0.34	3	Construction of Soaking Pits	1.10	2
		Indapur					
1	Bhavdi	Construction of Soaking Pits	0.21	3	Construction of Soaking Pits	1.20	2
2	Chandgaon	Construction of Soaking Pits	0.22	3	Construction of Soaking Pits	0.80	2
3	Kalthan No. 1	Construction of Soaking Pits	0.52	3	Construction of Soaking Pits	1.70	2
4	Agoti No. 1	Construction of Soaking Pits	0.35	3	Construction of Soaking Pits	1.05	2
5	Kalthan No. 2	Construction of Soaking Pits	0.30	3	Construction of Soaking Pits	1.05	2
6	Gangawalan	Construction of Soaking Pits	0.16	3	Construction of Soaking Pits	0.50	1
7	Hingangaon	Construction of Soaking Pits	0.30	3	Construction of Soaking Pits	1.00	2
8	Taratgaon	Construction of Soaking Pits	0.12	3	Construction of Soaking Pits	0.50	1

Sr. No.	Name of Cities/Villages	Immediate Action			Long Term Plan		
		Particulars	Expected Expenses (Rs. In (Lakhs)	Expected Time (Mths)	Particulars	Expected Expenses (Rs. In Lakhs)	Expected Time (Mths)
9	Kandalgaon	Construction of Soaking Pits	0.51	3	Construction of Soaking Pits	2.00	3
10	Ajoti	Construction of Soaking Pits	0.10	3	Construction of Soaking Pits	0.50	1
11	Pimpri Khurd	Construction of Soaking Pits	0.60	3	To construct Bund & Water to Agriculture	3.00	6
12	Padstal	Construction of Soaking Pits	0.27	3	Construction of Soaking Pits	1.20	2
13	Takralwadi	Construction of Soaking Pits	0.50	3	Construction of Soaking Pits	1.70	2
14	Kumbargaon	Construction of Soaking Pits	0.39	3	Construction of Soaking Pits	1.20	2
15	Dalaj No. 2	Construction of Soaking Pits	0.36	3	Construction of Soaking Pits	1.20	2
16	Dalaj No. 1	Construction of Soaking Pits	0.31	3	Construction of Soaking Pits	1.00	2
17	Dalaj No. 3	Construction of Soaking Pits	0.25	3	Construction of Soaking Pits	0.80	2
18	Diksal	Construction of Soaking Pits	0.40	3	Construction of Soaking Pits	1.25	2
19	Kalewadi No. 1	Construction of Soaking Pits	0.39	3	Construction of Soaking Pits	1.20	2
Khed							
1	Daunde	Construction of Soaking Pits	1.31	3	To construct Bund & Water to Agriculture	4.00	6
2	Wadgaon Patole	Construction of Soaking Pits	0.68	3	Construction of Soaking Pits	2.10	3
3	Chandoli	Construction of Soaking Pits	0.65	3	Construction of Soaking Pits	2.10	3
4	Rajgurugar	Gutter Yojana	7.5	8	To create Sewage Water Project	50.00	24
5	Shiroli	Construction of Soaking Pits	1.07	3	To construct Bund & Water to Agriculture	4	6
6	Kharpuda-Khu	Construction of Soaking Pits	0.43	3	Construction of Soaking Pits	1.2	2
7	Majrewadi	Construction of Soaking Pits	0.48	3	Construction of Soaking Pits	1.5	2
8	Kharpuda-Bu	Construction of Soaking Pits & Gardens	1.65	3	To construct Bund & Water to Agriculture	4.5	6

Sr. No.	Name of Cities/Villages	Immediate Action			Long Term Plan		
		Particulars	Expected Expenses (Rs. In (Lakhs)	Expected Time (Mths)	Particulars	Expected Expenses (Rs. In Lakhs)	Expected Time (Mths)
9	Nimgaon	Construction of Soaking Pits	0.85	3	Construction of Soaking Pits	2.25	2
10	Dawadi	Construction of Soaking Pits & Gardens	2.1	5	To construct Bund & Water to Agriculture	4	6
11	Daundkarwadi	Construction of Soaking Pits	0.32	3	Construction of Soaking Pits	1.5	2
12	Shelpimpalgaon	Construction of Soaking Pits	1.9	3	To construct Bund & Water to Agriculture	3.75	6
13	Koyali-Ta-Chakan	Construction of Soaking Pits	1.5	3	To construct Bund & Water to Agriculture	4	6
14	Siddhi-Gavhan	Construction of Soaking Pits	0.23	3	Construction of Soaking Pits	0.7	
15	Bahul	Construction of Soaking Pits	1.65	3	To construct Bund & Water to Agriculture	4	6
16	Aaskhed-Khu	Construction of Soaking Pits	0.34	3	Construction of Soaking Pits	1	2
17	Aaskhed-Bu	Construction of Soaking Pits	0.37	3	Construction of Soaking Pits	0.8	1
18	Chandus	Construction of Soaking Pits	0.60	3	Construction of Soaking Pits	1.9	2
19	Waki-Khu	Construction of Soaking Pits	1.35	3	To construct Bund & Water to Agriculture	4	6
20	Rohkal	Construction of Soaking Pits	0.57	3	Construction of Soaking Pits	1.95	2
21	Chakan	Construction of Soaking Pits / Gutters	17	5	To create Sewage Water Project	65	2
22	Shelgaon	Construction of Soaking Pits	0.27	3	Construction of Soaking Pits	0.8	1
23	Sangurdi	Construction of Soaking Pits	0.41	3	Construction of Soaking Pits	1.2	2
24	Yelwadi	Construction of Soaking Pits	0.72	3	Construction of Soaking Pits	1.5	2
25	Khalubre	Construction of Soaking Pits	0.46	3	Construction of Soaking Pits	1.75	2
26	Nighoje	Construction of Soaking Pits / Gutters	1.5	3	To construct Bund & Water to Agriculture	3.5	6
27	Moi	Construction of Soaking Pits	1.35	3	To construct Bund & Water to Agriculture	3.5	6
28	Ku-Ruli	Construction	1.0	3	To construct	6	6

Sr. No.	Name of Cities/Villages	Immediate Action			Long Term Plan		
		Particulars	Expected Expenses (Rs. In (Lakhs)	Expected Time (Mths)	Particulars	Expected Expenses (Rs. In Lakhs)	Expected Time (Mths)
		of Soaking Pits			Bund & Water to Agriculture		
29	Chimbali	Construction of Soaking Pits	1.25	3	To construct Bund & Water to Agriculture	4	6
30	Kelgaon	Construction of Soaking Pits	1.35	3	To construct Bund & Water to Agriculture	4.5	6
31	Charoli-Khu	Construction of Soaking Pits	2.75	5	To construct Bund & Water to Agriculture	4.5	6
32	Dhanore	Construction of Soaking Pits	0.77	3	Construction of Soaking Pits	2	2
33	Solu	Construction of Soaking Pits	2.65	5	To construct Bund & Water to Agriculture	4	6
34	Golegaon	Construction of Soaking Pits	0.75	3	Construction of Soaking Pits	2	2
35	Markal	Construction of Soaking Pits	2.35	5	To construct Bund & Water to Agriculture	4	6
Shirur							
1	Koregaon Bhima	Construction of Soaking Pits	1.00	3	To construct Bund & Water to Agriculture	4.00	6
2	Vitthalwadi	Construction of Soaking Pits	0.50	3	Construction of Soaking Pits	1.35	2
3	Aalegaon Paga	Construction of Soaking Pits	0.53	3	Construction of Soaking Pits	1.50	2
4	Nangargaon	Construction of Soaking Pits	0.46	3	Construction of Soaking Pits	1.30	2
5	Wadgaon Rasai	Construction of Soaking Pits	1.50	3	To construct Bund & Water to Agriculture	5.50	6
6	Ganegaon Dumala	Construction of Soaking Pits	1.20	3	To construct Bund & Water to Agriculture	3.00	6
7	Mandavpharata	Construction of Soaking Pits	0.71	3	Construction of Soaking Pits	2.00	2
8	Tandli	Construction of Soaking Pits	0.50	3	Construction of Soaking Pits	1.40	2
9	Zamgaon	Construction of Soaking Pits	0.80	2	To construct Bund & Water to Agriculture	4.50	6
10	Darekarwadi	Construction of Soaking Pits	0.40	3	Construction of Soaking Pits	1.10	2
11	Shikrapur	Construction of Soaking Pits	0.80	2	To construct Bund & Water to Agriculture	10.00	6
Maval							
1	Kale	Construction	0.41	3	Construction	1.10	2

Sr. No.	Name of Cities/Villages	Immediate Action			Long Term Plan		
		Particulars	Expected Expenses (Rs. In (Lakhs)	Expected Time (Mths)	Particulars	Expected Expenses (Rs. In Lakhs)	Expected Time (Mths)
		of Soaking Pits			of Soaking Pits		
2	Yelse	Construction of Soaking Pits	0.43	3	Construction of Soaking Pits	1.20	2
3	Mahagaon	Construction of Soaking Pits	0.49	3	Construction of Soaking Pits	1.30	2
4	Kadade	Construction of Soaking Pits	0.38	3	Construction of Soaking Pits	1.00	2
5	Warunj	Construction of Soaking Pits	0.50	2	To construct Bund & Water to Agriculture	4.00	6
6	Chikalse-Ahirwade	Construction of Soaking Pits	0.60	3	Construction of Soaking Pits	1.70	2
7	Bahur	Construction of Soaking Pits	0.63	3	Construction of Soaking Pits	1.80	2
8	Aade	Construction of Soaking Pits	0.26	3	Construction of Soaking Pits	0.80	1
9	Ozarde	Construction of Soaking Pits	0.34	3	Construction of Soaking Pits	1.00	2
10	Urse	Construction of Soaking Pits	0.70	2	To construct Bund & Water to Agriculture	5.50	6
11	Parandwadi	To Create Sewage Water Project	0.00	3	Construction of Soaking Pits	1.30	2
12	Somatne	Construction of Soaking Pits	0.40	2	To construct Bund & Water to Agriculture	5.00	6
13	Shirgaon	Construction of Soaking Pits	0.50	2	To construct Bund & Water to Agriculture	5.00	6
14	Gahunje	Construction of Soaking Pits	0.45	2	To construct Bund & Water to Agriculture	3.50	6
15	Waru	Construction of Soaking Pits	0.26	3	Construction of Soaking Pits	0.80	1
16	Bhramanoli	Construction of Soaking Pits	0.19	3		0.70	1
17	Koturne	Construction of Soaking Pits	0.35	3	Construction of Soaking Pits	1.10	2
18	Chichwadi (Koturne)	Construction of Soaking Pits	0.44	3	Construction of Soaking Pits	1.10	2
19	Shivli	Construction of Soaking Pits	0.49	3	Construction of Soaking Pits	1.30	2
20	Yelghol	Construction of Soaking Pits	0.21	3	Construction of Soaking Pits	0.70	1

Sr. No.	Name of Cities/Villages	Immediate Action			Long Term Plan		
		Particulars	Expected Expenses (Rs. In (Lakhs)	Expected Time (Mths)	Particulars	Expected Expenses (Rs. In Lakhs)	Expected Time (Mths)
21	Dhagavhan	Construction of Soaking Pits	0.14	3	Construction of Soaking Pits	0.50	1
22	Bhadavli	Construction of Soaking Pits	0.13	3	Construction of Soaking Pits	0.50	1
23	Thugaon	Construction of Soaking Pits	0.21	3	Construction of Soaking Pits	0.70	1
24	Aardav	Construction of Soaking Pits	0.12	3	Construction of Soaking Pits	0.40	1
25	Malwandi Dhore	Construction of Soaking Pits	0.00	3	Construction of Soaking Pits	0.80	1
26	Shivane	Construction of Soaking Pits	0.50	2	To construct Bund & Water to Agriculture	3.00	6
27	Sadavli	Construction of Soaking Pits	0.50	2	Construction of Soaking Pits	0.80	1
28	Bebad-Ovhol	Construction of Soaking Pits	0.50	2	To construct Bund & Water to Agriculture	2.75	6
29	Pimplekhute	To Create Sewage Water Project	0.28	3	Construction of Soaking Pits	0.90	1
30	(Chandkhed) Chandanwadi	Construction of Soaking Pits	0.18	3	Construction of Soaking Pits	0.50	1
31	Sate	Construction of Soaking Pits	0.50	2	To construct Bund & Water to Agriculture	5.00	6
32	Done	Construction of Soaking Pits	0.29	3	Construction of Soaking Pits	0.80	1
33	Dhamne	Construction of Soaking Pits	0.44	3	Construction of Soaking Pits	1.10	2
34	Godumbre	Construction of Soaking Pits	0.40	3	Construction of Soaking Pits	1.00	2
35	Salumbre	Construction of Soaking Pits	0.37	3	Construction of Soaking Pits	1.00	2
36	Darumbre	Construction of Soaking Pits	0.45	3	Construction of Soaking Pits	1.20	2
37	Sangavde	Construction of Soaking Pits	0.40	3	Construction of Soaking Pits	1.00	2
38	Takve-Khu	Construction of Soaking Pits	0.40	3	Construction of Soaking Pits	1.00	2
39	Khadkale (Kamshet)	Construction of Soaking Pits	0.50	2	To construct Bund & Water to Agriculture	10.00	6
40	Taje	Construction of Soaking	0.30	3	Construction of Soaking	0.90	1

Sr. No.	Name of Cities/Villages	Immediate Action			Long Term Plan		
		Particulars	Expected Expenses (Rs. In (Lakhs)	Expected Time (Mths)	Particulars	Expected Expenses (Rs. In Lakhs)	Expected Time (Mths)
		Pits			Pits		
41	Pimploli	Construction of Soaking Pits	0.00	3	Construction of Soaking Pits	0.90	1
42	Pathargaon	Construction of Soaking Pits	0.00	3	Construction of Soaking Pits	0.40	1
43	Nane	Construction of Soaking Pits	0.40	2	To construct Bund & Water to Agriculture	5.00	6
44	Kahe	Construction of Soaking Pits	0.50	2	To construct Bund & Water to Agriculture	5.00	6
45	Naigaon	Construction of Soaking Pits	0.37	3	Construction of Soaking Pits	1.00	2
46	Sai	Construction of Soaking Pits	0.20	3	Construction of Soaking Pits	0.50	1
47	Nanoni	Construction of Soaking Pits	0.15	3	Construction of Soaking Pits	0.50	1
48	Parwadi	Construction of Soaking Pits	0.12	3	Construction of Soaking Pits	0.40	1
49	Ghonshet	Construction of Soaking Pits	0.60	3	Construction of Soaking Pits	1.70	2
50	Wadgaon	Construction of Soaking Pits	0.45	2	To construct Bund & Water to Agriculture	10.00	6
51	Katvi	Construction of Soaking Pits	0.50	3	Construction of Soaking Pits	0.60	1
52	Rajpuri	Construction of Soaking Pits	0.25	3	Construction of Soaking Pits	0.80	1
53	Warale	Construction of Soaking Pits	0.50	2	To construct Bund & Water to Agriculture	5.00	6
54	Shiv Shankar Colony BhimaShankar Colony	Construction of Soaking Pits	0.15	2	Construction of Soaking Pits	1.70	2
55	Aambi	Construction of Soaking Pits	0.37	3	Construction of Soaking Pits	1.00	2
56	Mangrul	Construction of Soaking Pits	0.25	3	Construction of Soaking Pits	0.90	1
57	Malwadi	Construction of Soaking Pits	0.40	2	To construct Bund & Water to Agriculture	5.00	6
58	Indori	Construction of Soaking Pits	0.50	2	To construct Bund & Water to Agriculture	7.00	6
59	Mundawre	Construction of Soaking Pits	0.15	3	Construction of Soaking Pits	0.30	1

Sr. No.	Name of Cities/Villages	Immediate Action			Long Term Plan		
		Particulars	Expected Expenses (Rs. In (Lakhs)	Expected Time (Mths)	Particulars	Expected Expenses (Rs. In Lakhs)	Expected Time (Mths)
60	Jambul	Construction of Soaking Pits	0.50	2	To construct Bund & Water to Agriculture	5.00	6
61	Aamble	Construction of Soaking Pits	0.39	3	Construction of Soaking Pits	1.00	2
62	Warangwadi	Construction of Soaking Pits	0.36	3	Construction of Soaking Pits	1.00	2
63	Waksai	Construction of Soaking Pits	0.45	2	To construct Bund & Water to Agriculture	4.00	6

Source: Data collected by Maharashtra Pollution Board, Pune

Long term remedial measures:

Municipal Corporations, Municipal Councils, Containment Boards are the main cause of sewage water. Urban local self government must study the pattern of water supply and sewage disposal and zero percent water should be add in the river without purification and treatment. The country like Singapore recycle the sewage water which is used for construction, gardening and industrial purpose. The construction of sewage treatment plant with state of art technology is the basic solution for the water technology. The sewage water from the small villages is not very grievance problem but the point of concern there is no system for the sewage water management and entire sewage water is added in the river. Though quantity of sewage water is less but the treatment of the sewage water is also not adequate. Soak pits are the best low cost, low maintenance and eco-friendly system.

Trunk sewage Line: Pimpri-Chinchwad and Pune Municipal Corporation is having maximum speed of urbanization. Now, the visible effects of untreated sewage water in the jurisdiction of Pune & Pimpri-Chinchwad are visible. If the trunks sewage line is constructed along with the river banks in the jurisdiction of Pune and Pimpri-Chinchwad Municipal Corporation which will prevent untreated sewage water allowed to go in river flow. This trunks sewage line will definitely help prevention of water pollution.

In Dehu Cantonment Board: the sewage water flew through three nala's. It is added in the river Pauna and Indrayani. The Bund shall be constructed immediately on this three nala's and water can be diverted after preliminary treatment for agriculture irrigation purpose. There must be construction of sewage treatment plant

at the middle of nala's which will process sewage water and ultimately will make prevention of water pollution.

Removal of Slit from Ujani Water Reserver:

Irrigation Department/Water Conservation Department shall make action plans for removal of slit from Ujani Water Reserve. This will enhance water storing area and also confined the growth of aquatic plants.

Sand Dragging:

Excess dragging of sand from Bhima & its tributaries in few places water flew become stagnant and geo-marc logical structure change of river bed. Dragging shall be controlled by strict rules and regulations and in context of environment protection.

Continuous water flow in the river Bed:

Irrigation/Water Consumption department shall have symbolic pollution control line in the river beds and below that line there must be unobstructed continuous water flow. Continuous water flow reduces BOD. For this mission irrigation department must have blue-print for continuous water flow.

Solid Waste Management:

Every Municipal Corporation, Municipal Council, Cantonment Board must have solid waste disposal and treatment units and it shall not be added as a pollutant in the river. The state of art solid waste management project shall be operated.

Industrial Effluents:

Untreated Industrial effluents which are situated on the banks of river and its tributaries the Maharashtra Pollution Control Board and directorate of Industrial Safety and health shall enforce strict rule for each industrial units that there must be 100% sewage treatment.

Role of local self government:

When there are upcoming mega project educational hub, big industries without having sewage treatment plant no completion certificate shall be allotted. Before giving completion certificate every project must have following facility;

Sewage Treatment Plant

Solid Waste Management System

Water Recycling Units

Pollution Control of Sewage

CHAPTER-VIII

WATER POLLUTION OF BHIMA RIVER AND REMEDIAL PROCEDURES AND ACTION

Bhima basin is one of the Prominant basins in Pune district covering Indrayani, Pauna, Mula, Mutha, Mina, Kukadi & Ghod rivers are main tributaries of Bhima river. These rivers are having courses adjoining to Pimpri-Chinchwad & Pune Municipal Corporation. Pune Dehu Road and Khadki Contonment board, Lonawala, Talegaon, Aalandi, Junner, Shirur, Daund, Indapur, and municipal council. Above mention municipal corporations, contonment boards and municipal councils, small villages and Maharashtra industrial development corporation hubs and also agro-based industries produce lot of sewage water and the same water is added in Bhima and its tributaries. The quantity of untreated sewage is considerably high that is totally having potentiality to pollute drinking water source of the settlements which are habitat of the banks of Bhima river and its tributaries.

The Ujani river bank is build on Bhima river and water pollution quotioned of Ujani reserver is also alma-meter of gravity of the water pollution. Maharashtra Pollution Control Board has conducted many surveys to determine the magnitude of water pollutants in Bhima river and put their inferences for the case study. Industrial development of Pune district is of geometrical mean and especially the basins of Pauna, Mula, Mutha, Indrayani are the potential basins for urban settlements and industrial development, urbanisation and industrial development of Pune district has given negative impact on the flora and fauna of Bhima river and its tributaries.

Sewage Water Treatment processing and disposal is major challenge for the preservation of eco-system. At the same time providing pure drinking water to the cities and villages is also become almost important objective. Zilla Parishad Pune, Maharashtra Jeevan Pradikaran, Municipal Corporation, Municipal councils, Village Panchayat should play an important role for safe drinking water supply. Maharashtra Pollution control board has conducted samples survey of Bhima river and its tributaries for 196 villages, outcome of survey notified that 70/196 villages are affected with polluted drinking water supplies. It is important that sewage treatment and disposal shall be taken on top priority and at the same time there must be

remedial measures of long term and short term measures which can control water pollution of Bhima river and its tributaries. The main cause of water pollution for Bhima river is untreated domestic sewage water.

The pressure on Bhima river is due to domestic sewage water. When we study upper Bhima river basin the total flow of sewage water was about 1725.19 MLD. Municipal Corporation and Local governments are having sewage water processing plants. But positive results are still not achieved. Disposal of sewage water produces from domestic and industrial uses are still major concerns and challenge for the eco-systems. About 697.71 MLD sewage water is processed and treated and re-added to Bhima river. The study indicated that every day around 541.92 MLD sewage water which is produced due to domestic and Industrial processes is added in Bhima river. Bio-logical oxygen demand of the water of Bhima river is also tested and at many places Bio-logical oxygen demand in percentage was about 200-250 mg/l. this is absolutely serious threat for the flora and fauna of Bhima basin. If the percentage of BOD is 250 mg/l then, organic load of the Bhima river per day calculated as 1.35 lac.kg/day means 135.48 tons organic solid sewage is added in Bhima river and its tributaries.

As per statistics treated and processed sewage water about 600 MLD which is having bio-logical oxygen demand less than 30 is added in Bhima and its tributaries. If we have to match the BOD by supplying artificial oxygen then it is a necessary to dissolve 145.48 tons of oxygen daily in Bhima river and its tributaries. The percentage of oxygen is 20 % every year so every day we have to add 7.4-7.6 ton per year in Bhima and its tributaries to match and overcome the BOD of the system. Bio-logical oxygen demand itself is detonation of environmental water source and purity of the water source. The major reason for increasing the BOD is domestic and industrial sewage water, adding sleek, industrial solid waste, excessive use of fertilizers, which results in eutrofication on the dragging of sacks from river, water plants which reduces the mobility of water.

The Sewage water treatment plants are playing major role to prevent water pollution. Domestic sewage and industrial sewage shall be treated in sewage water treatment plant and after estimating BOD of that treated water shall be added in river flow or used for agriculture and garden purposes.

Rules of MPCB in controlling pollution :

Maharashtra Pollution control board is a regulatory authority to check the pollutants which are added in a river flow. MPCB monitors source of pollutant nature of pollutants and what are the parameters of Industrial sewage and waster which directly or indirectly affect eco-systems. MPCB has permitted few industries to add their sewages in the Bhima river and its tributaries after proper process and treating water plant. But majority of industrial units release hazardous chemicals added in river flow is a major concern for the water pollution. Following are the industries which are permitted to add their treated sewage water in the river.

Table 8.1 : List of units permitted by MPCB to add process water iny Bhima river

Sr. No.	Name of Industries	Water Supply (Domestic)	Water Supply (Industrial)	Sewage Water (Domestic)	Sewage Water (Industrial)
1.	Tata Motors LTD., Pimpri	4500 cubic Mtr/day	8500 cubic Mtr/day	3810 cubic Mtr/day	601500 cubic Mtr/day
2.	Tata Motors Passenger Car, Chikli, Tahsil-Haveli	1300 cubic Mtr/day	4900 cubic Mtr/day	720 cubic Mtr/day	4230 cubic Mtr/day
3.	Padmaji Pulp and Paper Mill, Thelgaon Chinchwad, Pune	250 cubic Mtr/day	58580 cubic Mtr/day	200 cubic Mtr/day	5500 cubic Mtr/day
4.	Rama-Krishi Rasayan, Lonekalbhor, Tal-Haveli	18.3 cubic Mtr/day	376.7 cubic Mtr/day	7.00 cubic Mtr/day	130.00 cubic Mtr/day

Table 8.2 : List of units adding Processed Water in Bhima river

Sr. No.	Name of Industries	Water Supply (Domestic)	Water Supply (Industrial)	Sewage Water (Domestic)	Sewage Water (Industrial)
1	Ordonance factory Deo road, Pune	1500 Cubic mtr/day	1300 Cubic mtr/day	1100 Cubic mtr/day	550 Cubic mtr/day
2	High explosice factory, Khadki, Pune	378 Cubic mtr/day	3784 Cubic mtr/day	350 Cubic mtr/day	3500 Cubic mtr/day
3	Ammunition Factory, Khadki, Pune	670 Cubic mtr/day	1668 Cubic mtr/day	603.00 Cubic mtr/day	1501.25 Cubic mtr/day

Source: Data collected by Maharashtra Pollution Board, Regional Office Pune.

Eminent Remidial Action Plan:

Prevention of Pollution at the level of Origin of Sewage Water. This is an ideal situation when there is a source of pollution. In the initial stage small units of sewage disposal and treatment plants can be constructed and these plants can serve the purpose in a larger interest of the environment. The decentralization of sewage treatment and processing units is the ideal alternative for prevention of water pollution of the rivers. These alternatives are much more technical and economically more suitable and very easy to enforcement.

Disposal of sewage:

In process of pollution control methods the most usable is planning and co-ordination of sewage treatment plant. These plants may be of small scale nature or major scale nature. Sewage treatment plants can be useful for domestic sewage. Hence, consist of mainly for household and domestic sewage. The water treated may be composed of faces, urine, paper, bath water, soap used, fibres and may also receive drainage from villagers and many place. It contains dust & oily particles. Sewage water treatment palants requires different strategy & financial backups. These are long term plans for Municipal Councils & Zilla Parishad. Following systems/technology are used for sewage treatment.

a. Activated slidge technology, b. SBR, c. Muvable bed biop-reactor (MBBR) and d. Up flow un-aerobic slidge baknket (UASB)

These are state of art technology for sewage treatment. Technical manpower, technological setup, non-disturb electric supplies and maintenance of the plants are required. These technologies are used for domestic sewage disposal.

Table 10.3 Percentage of chemical water

Sr. No.	Place	Date	Percentage of Chemical water							
			P.H.	B.O.D	C.O.D	Suspended Solid	Oil & Grease	T.D.S	Sulphate	Chlorides
1	Sanghvi (Capacity-15 Lacs Ltrs/Day)	15/3/10	8.1	26.35	76	11	NIL	398	40.58	329.9
		20/2/10	7.4	18	64	30	NIL	420	29.97	115
		12/1/10	8.02	21.5	68	12	NIL	184	1.368	62.5
2	Kasarwadi Phase-1 (Capacity-40 Lacs Ltrs/Day)	15/3/10	8	26	80	52	NIL	258	41.95	56
		20/2/10	7.5	19	64	33	NIL	380	34.76	95
		12/1/10	7.38	17.2	56	14	NIL	552	51.75	57.5
3	Kasarwadi Phase-2 (Capacity-40 Lacs Ltrs/Day)	15/3/10	7.9	6	20	52	NIL	402	43.31	125
		20/2/10	7.5	9	28	8	NIL	410	68.62	105
		12/1/10	6.97	6	20	12	NIL	147	38.53	125
4	Chikli 1 (Capacity-16 Lacs Ltrs/Day)	15/3/10	8.2	6	16	9	NIL	212	37.38	40
		20/2/10	8	8.8	28	12	NIL	340	37.38	80
		12/1/10	8.2	6.2	24	15	NIL	267	15.61	65
5	Chikli 2 (Capacity-16 Lacs Ltrs/Day)	15/3/10	8	25	104	22	NIL	318	73.18	30
		20/2/10	7.5	219	480	14	NIL	386	24.39	110
		12/1/10	7.84	19.4	64	8	NIL	148	7.295	57.5
6	Pimple Nilakh (Capacity-20 Lacs Ltrs/Day)	15/3/10	8	18	60	15	NIL	442	51.75	100
		20/2/10	8.6	30	128	24	NIL	710	43.66	174.9
		12/1/10	7.71	11.4	40	7	NIL	302	21.43	87.5
7	Chichwad Phase-1 (Capacity-30 Lacs Ltrs/Day)	15/3/10	8.4	15	48	33	NIL	304	48.79	65
		20/2/10	7.6	10	36	20	NIL	510	17.55	135
		12/1/10	7.86	17.6	54	11	NIL	663	4.901	65
8	Chinchwad Phase-2 (Capacity-30 Lacs Ltrs/Day)	15/3/10	8.5	6	24	10	NIL	I..	31.69	80
		20/2/10	8	7	24	7	NIL	640	27.81	179.9
		12/1/10	7.87	6	24	5	NIL	187	1.368	70

Source: Data collected by Maharashtra Pollution Board, Regional Office Pune.

Biological Prevention of Water Pollution:

Few species of plants are also used for controlling water pollution and sewage treatment. This is the easiest method but rarely used. This system should be used as this is a very eco friendly system. Plants like *Pyrites astrolists, Phalarist ardilanci, Gleciria mexia* and small grasses like *Thypha & Scrippers.* These are useful for the prevention of Water Pollution.

Treated sewage water can be used for irrigation:

The sewage water after preliminary treatment can be used for irrigation purpose in agriculture. But before supplying there shall be treatment like filteration and by dissolving oxygen by churning method. If oxygen is dissolved in by

mechanical charning method it will reduce BOD and after this preliminary treatment on sewage this can be used for the purpose of agriculture. This type of system is implemented in Karnataka and Israel is also using this system very effectively. By these methods of irrigation Israel has captured entire vegetable and fruit market. This system is most useful in India, as India always suffers with draught & famine conditions. This method is preventing further pollution of the river flow as at various geographical locations and this can be used as decentralization manner.

Implementation of water pollution measures in primary flows and its tributaries:

This system is also tried and tested in various corner of the world. When small tributaries, small springs, confluence with big river and makes volumes flow to treatment is not economically, mechanically and logistically physical. When small tributaries are confluence with the main river the assessment of pollutant shall be estimated at the tributaries or small springs and the efforts shall be made to water pollution in initial phase of the water flow. The river tributaries and springs they are also equally important to increase the magnitude of water pollution of the main river.

Phyto-remediation:

It is technique where phyto-technology for filtration is used. It is also used in natural marshy land. In this technique plant roots are used. These roots absorb most of the pollutants in sewage water and provide purified water to various crops. It also plays an important role of protection in environment. This is low cost, eco-friendly, low maintenance system.

De-Silting :

It is very simple and easily available alternative for prevention of water pollution. De silting can be done by mechanically or manually. This alternative is used indigenously all over the world. This alternative provides very good flow for the water and flowing water gets more surface area for dissolveerment of the oxygen. In Pune, Mithi river & Mula river this system was used for preverntion of water pollution. At the time of removing silt acquatic plants are also removed which also enhance, absorption of oxygen and reducing Biological Oxygen Demand. This is eco-friendly symbol of without maintenance system. In many place of Mula, Mutha, Indrayani & Pauna de-silting is required as this rivers are badly approach with aquatic plant which are obstruction for natural flow of rivers. Stagnation of water also

increases the threats of water pollution. This system view immediate results. While de-silting the process of charming is also there, so it is also accelerate the process of disseverment of Oxygen.

Mechanical Churning/Mechanical Agitation:

It is a not so important system used for sewage treatment. In Bhima river to reduce the BOD it will approximately require 67.4 ton/year to need the BOD or to neutralize the BOD. Especially, Mula, Mutha, Pauna & Indrayani require such type of mechanical churning. In this system air is dissolved in river water with high pressure. After dissolving the air in water the BOD of the aquatic system get reduces.

Biological Re-Genuvation:

It is a process to reconstruct balance of eco-system by the natural mean, which is disturb by human encroachments. Biological re-genuvatoin is very simple but time consuming and of permanent nature. Plants animals, aquatic animals, and algae pythons & bacteria constituent the process of biological re-genuvation. It is a system based on principle of commensalism which is beneficial ach and every factor of the eco-system. Benefits of this process are one of the most eco-friendly sewage treatment systems, not so costly and easy to maintenance. In this system ecological balance is calculated by the system gold Mine and basic foundation of promotion, protection & prevention, natural eco-system of that particular environment.

Removal of Phytoplankton and Aquatic plants:

In major portion of Mula, Mutha, Indrayani, Pauna river at many places there is a growth of aquatic plants and unwanted plant like *Jalparni*. Due to these plants the oxygen dissolved in water is consumed by plants and BOD of the water increases so removal of these plants decreases proportionally biological oxygen demand. Secondly, due to presence of water plants in the flow of river it stagnant the flow of river and stagnation of water gives more chances of water pollution. Even these plants gets decomposed in the water and decomposition requires and the process of detain also disturb purity of water and increases the water pollution. Even these aquatic plants disturb the eco-system and serious threats for flora and fauna.

Minimum Maintenance of flowing water flow of the river:

It is very important that the flow of water shall be in motion with kinetics of water. Flowing water is much importance for the eco-system of the river. Stagnant water is a high BOD and even process of decomposition of plants and animals get

accelerated and change the bio-chemistry of the water. Due to decaying of plants and animals gases like Methane, Hydrogen sulphide Carbon-dioxide is released in air which also increases the BOD. Nonstop continuous water flow is the best way of promotion preservation & protection eco-system of the Bhima river.

Table 8.4 Water bourne deceases in different villages and persons affected

Sr. No.	Disease No.	Disease Name	Taluka		Village Accused	Population	Total		Date of Disease Commenced	Reason	Action Taken
							Accused	Died			
1	1	Gastro	Daund	Kedgaon	Nathachiwadi, Aavhalwadi, Holewadi	240	16	0	15/04/07	Tap Overflow	
2	2	Typhoid	Purander	Jejuri	Ekhatpur	1052	38	0	02/05/07	Well	
3	3	Jaundice	Haveli	Dehu	Malwadi	3731	15	0	16/04/07	Tap Flow &	
4	4	Gastro	Haveli	Phursungi	Bhekrainagar	17814	198	0	03/06/07	Well Water	
5	5	Diaherria	Aambegaon	Dimba	Aambedara	293	48	0	04/06/07	Well Water	
6	6	Gastro	Junner	Nimgaon Sawa	Sakori	3192	108	0	19/06/07	Tap Flow	
7	7	Gastro/ Coleria	Khed	Chakan	Deshmukhwadi	359	19 Gastro 5 Coleria	0	22/06/07	Unlimited Water Purification	
8	8	Gastro/ Coleria	Khed	Waafgaon	Gulani	1819	9 Gastro 1 Coleria	0	24/06/07	Hand Pump Water	
9	9	Gastro	Velha	Velha	Dapasre Rede khind, Dhangarwadi	24	7	2	21/06/07		
10	10	Gastro	Haveli	Khanapur	Aambi	1065	12	1	11/07/07	Unpurified Water	
11	11	Gastro/ Coleria	Shirur	Kendur	Pabhal	8000	72 Gastro 1 Coleria	0	16/07/07		

Source: Data collected from Primary health Centres, Taluka Hospitals of Pune district

1) Coleria-7 2) Gastro-441 3) Jaundice-15 4) Typhoid-48 5) Diaheria-38

Total Patients – 549

Total Died – 03

Table 8.5 : Water bourne deceases in different villages and persons affected

Sr. No.	Disease Sr. No.	Disease Name	Tal	P.H.C.	Accused Villages	Population	Total		Date Of Disease Commenced	Date of Disease Cured											Reason For Disease	Action Taken
											Months		Months		Months		Months		Water Samples Tested			
							Accused	Died			Check	Affected	Check	Affected	Check	Affected	Check	Affected				
1	1	Gastro	Bhor	Bhor	Bholawade	3075	72	0	19/04/08	21/04/08	2	1	2	0	2	0	4	1	20	2		
2	2	Gastro	Daund	Nangaon	Pargaon	7500	65	0	20/06/08	26/06/08	3	0	3	0	3	0	6	1	15	1		
3	3	Diaheria	Junner	Sawargaon	Gunjalwadi	2727	61	0	10/07/08	13/07/08	2	0	2	0	2	0	8	1	14	1		
4	4	Gastro/ Coleria	Junner	Junner Nagar	Junner Nagar	27987	121 Gastro 5 Coleria	0	21/09/08	28/09/08	0	0	10	0	0	0	5	0	15	0		
5	5	Tokso Plasmosis	Indapur	Nirwangi	Walchand Nagar	8500	239 240	0	29/01/09	28/02/09	2	0	2	0	2	0	9	0	15	0		
6	6	Gastro	Mulshi	Mutha	Daswe (Lavasa)	12896	566	0	28/02/09	07/03/09	1	0	1	0	1	0	5	0	8	0		

Source: Data Collected from primary health centres, Taluka Hospitals of Pune district

1) Coleria-5 2) Gastro-824 3) Jaundice-0 4) Typhoid-0 5) Diaheria-61 6) Toxsoplosmosis-239

Total Patients- 1129 Died - NIL

Table 8.6 : Water bourne deceases in different villages and persons affected

Sr. No.	Disease Sr. No.	Disease Name	Tal	P.H.C.	Accused Villages	Population	Total		Date Of Disease Commenced	Date of Disease Cured	Months		Months		Months		Months		Water Samples Tested		Reason For Disease	Action Taken
							Accused	Died			Check	Affected	Check	Affected	Check	Affected	Check	Affected				
1	1	Diaheria	Haveli	Kunjirwadi	Naigaon	2300	186	0	27/05/09	02/06/09	2	1	2	1	2	1	27	12	33	15		
2	2	Gastro	Khed	Wada	Shetewadi	259	27	0	16/07/09	20/07/09	1	0	1	0	1	0	4	0	7	0		
3	3	Gastro	Khed	Point	Chorgewadi	164	9	1	06/08/09	10/08/09	1	0	1	0	1	0	1	0	1	1		
4	4	Jaundice	Haveli	Khed Shivapur	Shivapur (Shivaji Nagar)	882	55	0	03/12/09	24/05/10	2	2	2	2	2	2	12	6	18	12		
5	5	Gastro	Bhor	Nasrapur	Hatwey Bru	997	47	0	09/12/09	17/12/09	2	0	2	0	2	0	8	8	14	8		
6	6	Diaheria	Aambegaon	Dimbha	Shinoli	4382	144	0	05/03/10	24/03/10	2	0	2	0	2	0	10	1	16	1		

Total Disease 6		
1	Gastro	3
2	Diaheria	2
3	Jaundice	1
Total		6

Sr. No.	Disease Name	Accused	Died
1	Gastro	83	1
2	Diaheria	330	0
3	Jaundice	55	0
Total		468	1

Total Patients – 468

Total Died – 1

Table 8.7 : Water bourne deceases in different villages and persons affected

Sr. No.	Taluka		P.H.C.	Villages	Year	Coleria			Gastro			Diaheria			Typhoid			Jaundice			Other Disease			
1	Aambegaon	-	-	-	2008-09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	2009-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		1	Dimbha	Gangapur	2010-11	-	-	-	-	-	-	-	-	-	1	106	0	-	-	-	-	-	-	2
		2	Dimbha	Kanse		-	-	-	-	-	-	1	130	0	-	-	-	-	-	-	-	-	-	
		-	-	-	2011-12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
2	Baramati	-	-	-	2008-09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	2009-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	2010-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	2011-12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	Bhor	1	Bhor	Bholawade	2008-09	-	-	-	1	72	0	-	-	-	-	-	-	-	-	-	-	-	-	1
		1	Aambewade	Karnawad	2009-10	-	-	-	1	28	1	-	-	-	-	-	-	-	-	-	-	-	-	2
		2	Nasrapur	Hathwey Bru		-	-	-	1	47	0	-	-	-	-	-	-	-	-	-	-	-	-	
		1	Bhogwali	Saroli	2010-11	-	-	-	-	-	-	-	-	-	-	-	-	1	22	0	-	-	-	1
		-	-	-	2011-12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	Daund	1	Nangaon	Pargaon	2008-09	-	-	-	1	65	0	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	2009-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	2010-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	2011-12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	Haveli	-	-	-	2008-09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		1	Kunjirwadi	Naigaon	2009-10	-	-	-	-	-	-	1	186	0	-	-	-	-	-	-	-	-	-	2
		2	Khed Shivapur	Shivapur		-	-	-	-	-	-	-	-	-	-	-	-	1	55	0	-	-	-	
		1	Khed Shivapur	Aarvi	2010-11	1	4	0	1	5	0	-	-	-	-	-	-	-	-	-	-	-	-	3
		2	Kunjirwadi	Theur		1	2	0	1	115	0	-	-	-	-	-	-	-	-	-	-	-	-	
		3	Khanapur	Khanapur		-	-	-	-	-	-	-	-	-	-	-	-	1	20	0	-	-	-	
		-	-	-	2011-12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	Indapur	-	Bijwadi	Walchand Nagar	2008-09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	240	0	1
		-	-	-	2009-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	2010-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	2011-12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	Junner	1	Sawargaon	Gunjalwadi	2008-09	-	-	-	-	-	-	1	61	0	-	-	-	-	-	-	-	-	-	2

Sr. No.	Taluka		P.H.C.	Villages	Year	Coleria			Gastro			Diaheria			Typhoid			Jaundice			Other Disease			
		2	Junnergaon	Junner		1	5	0	1	121	0	-	-	-	-	-	-	-	-	-	-	-	-	
		1	Aaptale	Chavand (Khadakwadi)	2009-10	-	-	-	1	21	1	-	-	-	-	-	-	-	-	-	-	-	-	1
		-	-	-	2010-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	2011-12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	Khed	-	-	-	2008-09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		1	Wada	Shetewadi	2009-10	-	-	-	1	27	0	-	-	-	-	-	-	-	-	-	-	-	-	2
		2	Point	Chorgewadi		-	-	-	1	9	1	-	-	-	-	-	-	-	-	-	-	-	-	
		-	-	-	2010-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	2011-12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	Mawal	-	-	-	2008-09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		1	Yelse	Kale	2009-10	-	-	-	1	52	0	-	-	-	-	-	-	-	-	-	-	-	-	1
		-	-	-	2010-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	2011-12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	Mulshi	1	Mutha	Daswe (Lavasa)	2008-09	-	-	-	1	156	0	-	-	-	-	-	-	-	-	-	-	-	-	1
		-	-	-	2009-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	2010-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	2011-12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	Purander	-	-	-	2008-09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		1	Malshiras	Voravkemal	2009-10	-	-	-	1	58	0	-	-	-	-	-	-	-	-	-	-	-	-	1
		-	-	-	2010-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	2011-12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	Shirur	-	-	-	2008-09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	2009-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		1	Kawte	Munjalwadi	2010-11	-	-	-	-	-	-	-	-	-	-	-	-	1	15	0	-	-	-	1
		-	-	-	2011-12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	Welha	-	-	-	2008-09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	2009-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		1	Welhe	Khodad	2010-11	-	-	-	1	27	1	-	-	-	-	-	-	-	-	-	-	-	-	2
		2	Welhe	Wanjle		-	-	-	1	93	0	-	-	-	-	-	-	-	-	-	-	-	-	
		-	-	-	2011-12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	**2008-09**	**1**	**5**	**0**	**4**	**827**	**0**	**1**	**61**	**0**	-	-	-	-	-	-	**1**	**240**	**0**	-	
	-	-	-	**2009-10**	-	-	-	**7**	**242**	**3**	**1**	**186**	-	-	-	-	**1**	**155**	**0**	-	-	-	-	
	-	-	-	**2010-11**	**2**	**6**	**0**	**4**	**240**	**1**	**1**	**130**	**0**	**1**	**106**	**0**	**3**	**57**	**0**	-	-	-	-	

Sr. No.	Taluka		P.H.C.	Villages	Year	Coleria			Gastro			Diaheria			Typhoid			Jaundice			Other Disease			
	-	-	-	2011-12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Source: Data collected from Primary Health Centres, Taluka Hospitals of Pune district

Sugar factory Effluents and river pollution:

Despite repeated circulars and review meetings by sugar commissioner, air and water pollution by the sugar factories continue to remain unchecked in Pune division. In fact, as compared to 2011, the number of factories penalised by the Maharashtra Pollution Control Board (MPCB) doubled in 2012.

As per MPCB data, bank guarantee worth Rs 38,50,000 of eight sugar factories in the Pune division had been seized for failing to adhere to the standards laid by the board in terms of discharge of effluents between January and December 2012. The board had seized bank guarantees of Rs 15 lakh of four factories between January and December 2011 in Pune division.

Of the eight sugar factories, one was in Pune district, while five were in Solapur and two were in Satara district. There are 56 sugar factories in Pune division, with a majority being run by various cooperative societies. MPCB officials noted that other than discharge of untreated effluent directly into water bodies, air pollution is also a major concern with the factories.

Concerned with the level of pollution generated by the sugar factories, the then MPCB member secretary had written a letter to the sugar commissioner in 2011, asking him to look into the matter. In the letter, he had mentioned that the board had been complaining, about the nature of discharge of untreated effluent into Panchganaga, Krishna, Warna and other rivers. The letter had also stated that sugar factories should issue a sou motto report for non- compliance of the any of the environmental guidelines and would cease production in case of such breach. The board had increased inspection of the sugar factories to ensure the discharge is within limits.

According to independent MP and farmers' leader Raju Shetty, the action taken by the board was just the tip of the iceberg. Shetty said a majority of the factories in Pune, Satara and Kolhapur districts, which are run by political bigwigs, are let go scot-free for fear of political reprisal. "Every year in Satara, lakhs of fish die in the Krishna river due to direct discharge of effluents from cooperative sugar factories. As the factories are run by the ruling alliance, the board officials turn a blind eye towards them". Officials added that the recent outbreak of jaundice in Ichalkaranji was also due to the discharge of untreated effluents into the river from sugar factories. "In most parts of these districts, the ground water is highly polluted

and incidents of cancer and other diseases are on rise. Sugar Commissioner Maharashtra Government also noted that problem of pollution was grave. The office has set strict guidelines for the factories and regular reviews are taken in every meeting,"

Effect of pollution on human health

Water pollution can pose health dangers to humans who come into contact with it, either directly or indirectly.

Water pollution has been documented as a contributor to a wide range of health problems and disorders in humans. It has also been shown to have drastically negative impacts on wild animals and the environment as a whole. There are quite a few different effects of water pollution that are of significant importance to humans.

Contaminated Drinking Water

The risks of your health being negatively impacted by polluted drinking water in a developed country is small in comparison with developing countries. However, it is possible to become ill from contaminated water. When you are out hiking, you can acquire giardiasis that can lead to the presentation of acute symptoms like vomiting and intense nausea. This infection is caused by drinking water that has been fouled by animal wastes in untreated waterways. In anthropogenic environments like cities and towns, the potential toxins are far more numerous.

Mercury Level Risks

Health risks from pollution vary from area to area. One of the most pervasive non-localized water pollution issues facing the world today is the level of mercury in the oceans. Inorganic mercury is a common byproduct of a number of industrial processes. The level of mercury in fish is mostly dangerous for small children and women who might become pregnant, are pregnant or are nursing. Mercury has been found to interfere with the development of the central nervous system in fetuses and young children, which could potentially lead to a large amount of long-term side effects.

In Louisiana, water quality can be so bad in many waterways that fish advisories are often posted to warn people against eating fish out of contaminated waterways. This is largely due to industrial runoff from localized sources and the accumulative effects of runoff and dumping from states that lie along the Mississippi river. When the river empties into Louisiana, it brings those accumulated toxins with

it. This is believed to lead to higher rates of cancer in areas surrounding the Mississippi delta in an area that is colloquially referred to as "cancer alley." Phosphorous runoff from industry can get into waterways and create toxic algal blooms. These blooms have been linked to higher occurrences of paralytic shellfish poisoning in humans, which can lead to death.

Glyphosate is an herbicide that is often used on crops throughout the United States. In areas where GM crops resistant to glyphosate are planted, the pesticide is often overused and laid out using a cascade spray. This can get into water and cause reproductive issues and kidney failure.

Overall Ecological Risks

Water pollution also causes negative effects within the environment to animals and their habitats.

Ecological Deadzone

The entrance of pollutants into waterways can have a wide range of impacts. It is possible for the pollutants to raise the temperature of the water enough to force fish out in search of cooler waters. This can itself create an ecological deadzone.

Increase in Algal Blooms

Water pollution can also significantly increase the rate of algal blooms. These blooms create massive fish die-offs as the oxygen in the water gets depleted and the fish suffocate. Fish can also be killed when excessive algae get caught in their gills.

Oil Spill Ramifications

Oil spills are a common occurrence throughout the world; however major spills like the Exxon Valdez and the BP Deepwater Horizon disaster have shown what water pollution can do on a very large scale. It was found that dolphins have been dying in record numbers near the site of the BP Deepwater Horizon disaster. It has also been found that the oil from the BP disaster has gotten into wetlands, which are considered the nursery for nearly every creature that lives in the area.

Water Pollution Impacts Everyone

The effects of water pollution are not always immediate. They are not always seen at the point of contamination. They are sometimes never known by the person responsible for the pollution. However, water pollution has a huge impact on the lives of all people. With knowledge, consideration and preparation, water pollution can be decreased. It doesn't take much effort -- just a little thought.

Effect of fresh water pollution of Pune urban area on fish population

The huge collection of fishes made by Fraser (1942) from Pune area was investigated by Hora and Misra (1942) recording 54 fish species. Suter (1944) added 17 species to Pune list. Tonapi and Mulherkar (1963) recorded 60 fish species from Pune, 25 being new local records. Yazdani and Mahabal (1978) recorded 34 fish species from Indrayani river. To assess the urbanization impact, Ghate and Wagh (unpubl.) resurveyed Mula and Mutha rivers between 1992 and 1995, to list 64 fish species, 14 of which were fresh local records. All this literature records 110 fish species from Pune urban area. This re-survey reports about species extinction, population changes and introductions in relation to each other and various human influences.

Fig 8.1 : Dead Fish on the Banks of Mula-Mutha (Bhima river)

About 66 species from 38 genera and 18 families, taking the records for the area to 114 species from 47 genera and 22 families, depicted in the annex along with ecological parameters. The 48 species recorded earlier of which 18 fish species appear locally extinct form folk perceptions and habitat quality. Remaining 30 species are too rare, besides possibly escaping detection due to seasonal variations and sampling limitations. Population of 6 species appears declining. Seven fish species have been introduced here recently. The common and widespread species include *Notopterus notopterus, Salmostoma boopis, Rasbora daniconius, Garra mullya, Mystus bleekeri, Oreochromis mossambica, Channa marulis* etc. Five species are rare while another 7 are only occasionally encountered. About 25 species are

recorded from a one or two localities each. Aundh and Yerwada are most important localities hosting about a dozen such localised species each.

The 18 species that have most possibly become locally are primarily large size fishes belonging to genera such as Anguilla, Tor, Bagarius, Silonia etc. having high consumption value and subject to heavy harvesting. Siltation due to catchment erosion or waste dumping makes the water column shallow, depriving the larger fishes their habitat. Human harvests affect 19 species including 6 that have shown significant decline, given their high food value and demand. Pollution has also driven significant population decline or loss. A locally extinct fish Ompak pabo was recorded here by Fraser in 1942. Of late, it has been recorded only in the far upstream of Mula river (Kharat et al, unpubl.). The two major rivers of Pune City, Mula and Mutha, are highly polluted owing to organic and inorganic waste. Mula river flows through an industrial zone and hence inorganic salts and heavy metals from the industrial wastes contaminate the water. This has probably resulted in absence of all fish species except Oreochromis mossambica near Khadki. Organic pollution has triggered spread of water hyacinth plants covering water surface in many places. While Katraj upper lake is polluted mainly by domestic sewage, Pashan lake is polluted also by industrial effluents. While this has affected most fish negatively, populations of few species such as Heteropneustus fossilis that can withstand organic pollution due to its breathing ability are even increasing. The introduction of commercially important fish such as Cyprinus carpio communis, Oreochromis mossambica have probably driven such as Labeo fimbriatus. Population decline of Aplocheilus liniatus feeding on larvae may be attributed to resource competition with introduced exotic larvivorus fishes of the family Poecillidae.

We doubt, based on circumstantial evidence, earlier of records a dozen fish species such as Notopterus chitala here. Neoissochilus wynnaadensis, a cyprinid fish recorded by Tonapi and Mulherkar (1963) is actually species endemic to Kerala (Shaji and Easa, 1998). Singh and Yazdani (1992) had likewise doubted the occurrence of Osteobrama cotio cunma from Mula-Mutha river. We report four species for the first time from the area. Cirrhinus cirrhosus, the cavery white carp, is a common fish in the Deccan (Nagulu et. al., 2000) and one specimen was collected from our study area. However, despite these four new geographical records, we conclude our findings on the sad not of decline of over third of the recorded species,

another sixth having become locally extinct. Impending fish erosion cannot be minimised without halting siltation and promote optimal, rather than maximal harvests; and exploring checks on growth of exotic species.

ANNEXURE: Distribution pattern of fresh-water fishes of Pune city

Records doubtful. Localities are indicated only for species found at one or two sites Abd (abundance): a-abundant, c-common, o-occassional, r- rare Chg (change): d-decreasing, f-first record, in-increasing, it-introduced, n-presently unrecorded, x-extinct DF (Driving Forces):h-harvest, ie-introduced sp. effect, p-pollution

Table 8.8 : Distribution pattern of fresh-water fishes of Pune city

FISH SPECIES	BD	CHG	DF	LOCALITY
Family: Notopteridae				
Notopterus chitala (Hamilton-Buchanan)*		n		
N. notopterus (Pallas)	a			
Family: Anguillidae				
Anguilla bengalensis bengalensis (Grey)		x	h	
Family: Cyprinidae				
Subfamily: Cyprininae				
Catla catla (Hamilton-Buchanan)	c			
Cirrhinus cirrhosus (Bloch)	o	f		Aundh
C. fulungee (Sykes)	a			
C. mrigala mrigala (Hamilton-Buchanan)	c			Yerwada
C. reba (Hamilton-Buchanan)	c			
Cyprinus carpio coomunis Linnaeus	o	t		
Gonoproktopterus kolus (Sykes)	a			
G. thomassi (Day)		n		
Labeo ariza (Hamilton-Buchanan)	r	d	h	Yerwada
L. boggut (Sykes)	r	d	h	Yerwada
L. calbasu (Hamilton-Buchanan)	a			
L. fimbriatus (Bloch.)		x	, ie	
L. kawrus (Sykes)		x	, ie	
L. porcellus (Heckel)	c			
L.potail (Sykes)		x	h	
L. rohita (Hamilton-Buchanan)	a			
L. sindensis (Day)		x	h	
Neolissochilus wynaadensis (Day)*		n		
Osteobrama cotio cunma (Day)*		n		
O. cotio peninsularis Silas	c			
O. neilli (Day)	c			Aundh
O. vigorsii (Sykes)	a			
Osteocheilus (Osteochilichthys) godavarinsis (Rao)	c	f		Vishrantwadi
O. (Osteochilichthys) nashii (Day)	a			Warje, Aundh
O. (Osteochilichthys) thomassi (Day)*		n		
Puntius amphibius (Valenciennes)	a			Aundh, Yerwada
P. arenatus (Day)		n		
P. chola (Hamilton-Buchanan)	a			
P. conchonius (Hamilton-Buchanan)	o			Warje, Aundh
P. dorsalis (Jerdon)		n		
P. jerdoni (Day)	c			Aundh

FISH SPECIES	BD	CHG	DF	LOCALITY
P. melanostigma (Day)		n		
P. sarana sarana (Hamilton-Buchanan)	r	d	h	Yerwada
P. sarana subnasutus (Valenciennes)	a			
P. sophore (Hamilton-Buchanan)	c			
P. ticto (Hamilton-Buchanan)	a			
Rohetee ogilbii (Sykes)	c			Aundh
Schismatirhyncus (Nukta) nukta (Sykes)		x	h	
Tor khudree (Sykes)		x	h	
T. mussulah (Sykes)		n		
Subfamily: Cultrinae				
Chela cachius (Hamilton-Buchanan)		n		
C. laubuca (Hamilton)		n		
Salmostoma acinaces (Valenciennes)		n		
S. boopis (Day)	c			
S. clupoides (Bloch)		n		
S. novacula (Valenciennes)	c			
S. phulo (Hamilton)		n		
Subfamily: Rasborinae				
Amblypharyngodon mola (Hamilton-Buchanan)	c			Aundh
Barilius barna (Hamilton-Buchanan)		x	h	
B. bendelisis (Hamilton-Buchanan)	c			
B. gatensis (Valenciennes)		x	h	
Danio aequipinnatus (Mc-Clelland)	a			
D. devario (Hamilton- Buchnan)*		n		
D. malabaricus (Jerdon)	c			Aundh
Rasbora daniconious (Hamilton-Buchanan)	a			
R. labiosa (Mukerji)	o	f		
Subfamily: Garrinae				
Crossocheilus latius latius (Hamilton- Buchanan)		x	p	
Gara gotyla gotyla (Gray)	c			Aundh
G. mullya (Sykes)	a			
Family: Parapsilorhynchidae				
Parapsilorhynchus tentaculatus (Annandale)		x	p	
Family: Balitoridae Subfamily: Nemacheilinae				
Nemacheilus anguilla Annandale	c			Warje
N. denisoni dayi Hora		n		
N. denisoni denisoni Day	a			
N. evezardi Day	a			
N. moreh (Sykes)	a			
N. rueppelli (Sykes)	c			Aundh, Yerwada
N. savona (Hamilton-Buchanan)		n		
N. striatus Day *		n		
N. sps. (resembling N. cincticouda(Blith)) *		n		
N. sps. (resembling N. multifasciatusDay)*		n		
N. sps. (resembling N. savonaHamilton)*		n		
Family: Cobitidae				

FISH SPECIES	BD	CHG	DF	LOCALITY
Subfamily: Cobitinae				
Lepidocephalus guntea (Hamilton-Buchanan)	c			
L. thermalis (Valenciennes)		n		
Family: Bagridae				
Aorichthys seenghala (Sykes)	c			
Mystus bleekeri (Day)	c			
M. cavasius (Hamilton-Buchanan)	a			
M. gulio (Hamilton-Buchanan)		x		
M. malabaricus (Jerdon)	c			Aundh, Yerwada
Rita kuturnee (Sykes)	o			Aundh
R. pavimentata (Valenciennes)		x	h	
R. rita (Hamilton- Buchanan)*		n		
Family: Siluridae				
Ompok bimaculatus (Bloch)	a			
O. pabo (Hamilton)		x	, p	
Wallago attu (Schneider)	r	d	h	
Family: Schibeidae Subfamily: Schibeinae				
Proeutropiichthys taakree taakree (Sykes)	r	d	h, p	Yerwada
Silonia childreni (Sykes)		x	h	
Family: Sisoridae				
Bagarius bagarius (Hamilton-Buchanan)		x	h	
B. yarrelli Sykes		n		
Glyptothorax conirostre poonensis Hora		x		
G. lonah (Sykes)		x	h	
G. madraspatanum (Day)	o			Yerwada
Nangra itchkeea (Sykes)		n		
Family: Heteropneustidae				
Heteropneustes fossilis (Bloch)	c	t, in	p	Yerwada
Family: Belonidae				
Xeneotodon cancila (Hamilton-Buchanan)	c			Yerwada
Family: Aplocheilidae				
Aplocheilus lineatus (Valenciennes)	o	d		Vittalwadi,K'wasla
A. panchax (Hamilton - Buchanan)*		n	e	
Family: Poeciliidae				
Gambusia affinis (Baird & Girard)	a	t		
Poecilia (Labistes) reticulata Peters	a	t		
Xiphophorus hellerii Heckel	c	t		Warje,Vitthalwadi
Family: Ambassidae				
Chanda nama Hamilton-Buchanan	c			Warje
Pseudambassis ranga (Hamilton-Buchanan)	c			
Family: Mugilidae				
Rhinomugil corsula (Hamilton-Buchanan)	c	t, in	p	Yerwada
Family: Cichlidae				
Oreochromis mossambica (Peters)	a	t, in	p	
Family: Gobiidae				
Subfamily: Gobiinae				

FISH SPECIES	BD	CHG	DF	LOCALITY
Glossogobius giuris (Hamilton-Buchanan)	c			
Family : Belontiidae				
Macropodus cupanus (Valenciennes)		n		
Family: Channidae				
Channa marulius (Hamilton-Buchanan)	c			
C. orientalis Bloch & Schneider		n		
C. punctatus (Bloch)	a			
C. striatus (Bloch) *		n		
C. sps.		n		
Family: Mastacembelidae				
Mastacembelus armatus (Lacepede)	c			

CHAPTER-IX

SUMMARY AND CONCLUSION

The overall primary as well as secondary data and reports as well as records from different MPCB, WHO, NGO's etc. compiled and reviewed in the present study had clearly identical that the most auspicious and holy river Bhima as well as its all tributaries are fully polluted due to urbanization, industrialization and municipal sewage.

All the villages in the Bhima basin are in great trouble. The human population is suffering from series of water borne deceases and many are dying every year. The domestic animals are also the great sufferer of polluted water. The life of aquatic plants biota, algae and mostly the fishes are in great danger. Their species are either threatened becoming rare to becoming extinct.

This is a great loss to our biodiversity and hence it is a great concern for country like India. For the population of environment especially river water pollution. Apart from the rules and regulations acts and laws are made by the central and state government but these are not executed properly. Inspite of all these legislation not only for Bhima river and its tributaries but all most all the rivers have become dumping place of garbage, sewage, plastics and all other waste.

The action taking bodies like municipal corporations, municipal councils, Zilla parishad, Panchayat Samiti, NGO's have become paralyzed, deaf and dumb.

Effective / remedial measures are there, technologies are available for treatment of waste water polluting rivers, lakes and other water bodies but not effective implementation.

In this situation who will save and protect our holy rivers. Today everybody is dreaming of "Smart Cities". How we can transfer this dream into reality without the protection of our environment? "Green and clean environment" is the main pillar in this activity. To protect ourselves we have to protect our environment and should be aware of the theme "Jal hai to Kal hai".

In many opinion the best solution for this is to have the pressure groups of common people Pune citizens and NGO's to stop all this nonsense and negligence. People should not tolerate the useless behavior corporate bodies and industries. Self

discipline, self awareness and self responsibility in society may bring some change in this movement. Strong motivation and action on war footing is necessary to protect the river Bhima and its tributaries from pollution.

ABBREVIATIONS

A.S.P.	Activated sludge process
B.O.D.	Biochemical oxygen demand
BMPs	Best Management Practices
C.W.L.T.	Constructed wet land technology
COD	Chemical oxygen demand
D.O.	Dissolve oxygen
DNAPLs	Dense nonaquaus phase liquids
EC	Electrical conductivity
Ec	Electriconducctivity
EPA	
l	Liter
lbs	Pounds
M.B.B.R.	Muvable bed bio reactor
M.I.D.C.	Maharashtra industrial Development corporation
M.L.D.	Million litres per day
mg	miligram
ml	mililiter
NPS	Non paint services
oF	Degree Fahrenheit
PCBs	Poly chlorinated biphenyls
pH	Hydrogen ion concentration
R.O.	Reserve osmosis
S.B.R.	Sequacial batch reactor
T.D.S.	Total dissolve solid

TDS	Total dissolved solids
TpH	Total petroleum hydrocarbons
TSS	Total suspended solids
U.A.S.B.	Up-flow an aerobic sludge blanket
VOCs	Volatile organic compounds
WHO	World health organisation

BIBLIOGRAPHY

- Alam, Undala, "Water Rationality: Mediating the Indus Waters Treaty," unpublished PH.D. dissertation, University of Durham (1998)
- Bhima Report on Bhima Nadi Pradhushan Niyantran Kruti Aarakhada, Zilha Pune (Bhima river Pollution Control Action Plan, District Pune). By Maharashtra Pollution Control Board.
- Boxer, Baruch, China's Water Problems in the Context of U.S.-China Relations, China Env't Series 2, 20 (Summer 1998)
- Browder, Greg & Ortolano, L., The Evolution of an International Water Resource Management Regime in the Mekong river basin, 40 Nat. Resources J. 499 (2000)
- Caponera, D.A., The Legal Aspects of Mekong river Projects, 16 Indian J. Power & river Valley Devel. 35 (1966)
- Cottage Hospitals from Bhima basin in Pune district.
- Davidson, J., Resolution of Tran boundary Pollution Disputes: The Great Lakes Experience 3 Asia Pac. J. Envt'l L. 233 (1998)
- Day, F. 1878. Fishes of India (Vol. I and II). William Dawson and Sons Ltd., London.
- Frazer, A. G. L. 1942. Fish of Pune- Part 1. Jr. B.N.H.S. 43: 79-91.
- Frazer, A. G. L. 1942. Fish of Pune- Part 3. Jr. B.N.H.S 43: 452-454.
- Ghate, H. V. and Wagh, G. K., (unpublished).
- Hora, S. L. and Misra, K. S. 1942. Fish of Pune- Part 2. Jr. B.N.H.S 43: 218-228.
- Jayaram, K. C. 1991. Revision of genus Puntius (Hamilton) from Indian

region (Pisces: Cypriniformes: Cyprinidae: Cyprininae). Records of Zoological Survey of India (ZSI) Occasional Paper No. 135. ZSI, Culcutta.

- Kharat, S. S., Dahanukar, N., Raut, R., and Mahabaleshwarkar, M. (unpublished) Changing fish fauna of Mula Mutha rivers.
- Menon, A. G. K. 1987. Fauna of India and adjacent countries (Pisces) Vol 4 (Part 1), Homalopteridae. ZSI, Calcutta.
- Nagulu V., Rao V. V. and Shriniwasulu C. 2000. Wildlife Heritage of the Deccan: Deccan Heritage. University Press, Hyderabad.
- Shaji, C. P. and Easa, P. S. 1994. Status and distribution of endemic fresh water fishes in Kerala, Western Ghats of India. Tiger paper 25:21-24.
- Singh, D. F. and Yazdani, G. M. 1991. Osteobrama bhimensis: a new Cyprinid fish from Bhima river, Pune District, Maharashtra. Jr. B.N.H.S 89:96-99.
- Suter, M. J. 1944. New records of fish from Pune. Jr. B.N.H.S 44: 408-414.
- Talwar, P. K. and Jhingran K. C. 1992. Inland fishes (Vol. I and II), Oxford and IBH, New Delhi.
- Tilak, R. and Tiwari, D. N., (1976), On the fish fauna of Pune District (Maharashtra), News Letter Zoological Survey of India, 2 (5): 193-199.
- Tonapi, G. T. and Mulherkar, L.,(1963), Notes on the freshwater fauna of Pune, Part:1, Fishes, Proc. Ind. Acad. Sci., 58:187-197.
- Yazdani and Mahabal (1978), Fishes of Indrayani river, Biovigyanam (Pune) 2: 119-121.
- Dellapenna, Joseph W., The Philippines Territorial Water Claim in International Law, 5 G.W. J.L. & Econ. Dev. 45-61 (1970)
- Desai, B., Sharing of International Water Resources: The Ganga and

Mahalaki river Treaties, 3 Asia Pac. J. Envt'l Law 172 (1998)

- Dobbert, J.P., *Water Pollution and International river Law*, 35 Y.B. of the A.A.A. 60 (1965)
- Fisher, W.F., ed., Towards Sustainable Development: Struggling Over India's Narmada river(Vedams 1997)
- Frazer, A. G. L. 1942. Fish of Pune- Part 3. Jr. B.N.H.S 43: 452-454.
- Gardner, A., et. al., *Water Resources Law (Australia)*, (LexisNexis Butterworths 2009)
- Ghate, H. V. and Wagh, G. K., (unpublished).
- Graph from Bhima river Water Pollution Control Action Plan. Pune district.
- Hills, P.R., et. al., Transboundary Pollution Between Guandong Provinbce and Hong Kong: Threats to Water Quality in the Pearl river Estuary and their Implications for Environmental Policy and Planning, 41 J. Env't Plan & Mgmt. 355 (1998)
- Information from District Veternary and Animal Husbandary Departments.
- Information from Municipal Councils from the top of Bhima basins.
- Information from public health centres units from Bhima basin.
- Institute for the Development of Indian Law, Indian Water Rights (1984)
- Jayaram, K. C. 1991. Revision of genus Puntius (Hamilton) from Indian region (Pisces: Cypriniformes: Cyprinidae: Cyprininae). Records of Zoological Survey of India (ZSI) Occasional Paper No. 135. ZSI, Culcutta.
- Khalid, Abu Raihan M, The Interlinking of rivers Project in India and International Water Law: An Overview Source, 3 Chinese J. of Int'l Law 553 (2004)
- Knauth, "The Indus river System," 54 Am. Soc. Int'l L. Proceedings 134

(1960)

- Kulz, Helmut R., *Further Water Disputes between India and Pakistan*, 18 Int'l & Comp. 734 (1969)

- Kummu, M, Keskinen, M., & Varis, O. (Eds.), Modern Myths of the Mekong - A Critical Review of Water and Development Concepts, Principles and Policies (Water & Development Publications - Helsinki University of Technology. Finland 2008)

- Laylin, *Principles of Law Governing the Uses of International rivers: Contributions from the Indus basin*, 51 Am. Soc. Int'l L. Proceedings 20 (1957)

- Lecaros, *International rivers: The Lauca Case*, 3 Indian J. Int'l L. 133 (1963)

- Menon, A. G. K. 1987. Fauna of India and adjacent countries (Pisces) Vol 4 (Part 1), Homalopteridae. ZSI, Calcutta.

- Molle, Francois et.al. (Eds), *Contested Waterscapes in the Mekong Region: Hydropower, Livelihoods and Governance* (2009)

- Nollkaemper, Andre, The Legal Regime for Transboundary Water Pollution: Between Discretion and Constraint (Dordrecht: Martinus Nijhoff / Graham & Trotman, 1993)

- Pichyakorn, Bantita, Sustainable Development and International Watercourse Agreements: The Mekong and the Rhine, International Union for the Conservation of Nature (Draft 30 June 2002)

- Pune District, Gazeeteers.

- Shaji, C. P. and Easa, P. S. 1994. Status and distribution of endemic fresh water fishes in Kerala, Western Ghats of India. Tiger paper 25:21-24.

- Souce report from District Fisheries officers, Pune

- Source from Maharashtra Industrial development corporation.
- Source information from Collector, Pune.
- Source Information from water source department, district Pune.
- Source report from Cantonment Boards Dehu, Khadki and Pune.
- Source report from Chief executive officer, Zilla Parishad, Pune.
- Source report from Divisional Forest officers, Pune division, Bhor division.
- Source report from Maharashtra Industrial safety and health.
- Source report from Maharashtra Pollution Control Board, Regional office, Pune.
- Source report from Pune Municipal Corporation and Pimpri-Chinchwad Municipal Corporation.
- Source report from Sassoon Hospital, Pune.
- Source report on Supretendent of agriculture, district Pune.
- Source reports from Maharashtra Jeevan Pradhikaran.
- Source reports from Sub-divisional officers, Pune district.
- Suter, M. J. 1944. New records of fish from Pune. Jr. B.N.H.S 44: 408-414.
- Tilak, R. and Tiwari, D. N., (1976), On the fish fauna of Pune District (Maharashtra), News Letter Zoological Survey of India, 2 (5): 193-199.
- Tonapi, G. T. and Mulherkar, L.,(1963), Notes on the freshwater fauna of Pune, Part:1, Fishes, Proc. Ind. Acad. Sci., 58:187-197.
- van Dunne, Jan M., ed., Non-Point Source river Pollution - The Case of the river Meuse: Technical, Legal, Economics and Political Aspects (Kluwer Law Int'l 1997)

- Yazdani and Mahabal (1978), Fishes of Indrayani river, Biovigyanam (Pune) 2: 119-121.

WEBLIOGRAPHY

- answers.yourdictionary.com/science/why-is-water-important.html
- oceanservice.noaa.gov/education/kits/pollution/03pointsource.html
- oceanservice.noaa.gov/education/kits/pollution/04nonpointsource.html
- pdf.usaid.gov/pdf_docs/PNADL375.pdf
- pdf.usaid.gov/pdf_docs/PNADL375.pdf
- phoenix.gov/WATER/drinkhow.html
- serc.carleton.edu/woburn/Case_summary.html
- water.epa.gov/lawsregs/rulesregs/sdwa/radionuclides/basicinformation.cfm#one
- water.epa.gov/learn/kids/drinkingwater/watertreatmentplant_index.cfm
- water.org/learn-about-the-water-crisis/facts/
- www.ehow.com/about_5251373_water-renewable-resource-.html
- www.enotes.com/science-fact-finder/environment/what-eutrophication
- www.google.com
- www.nrdc.org/water/pollution/gsteps.asp
- www.pacinst.org/reports/water_related_deaths/water_related_deaths_report.pdf
- www.rpi.edu/dept/chem-eng/Biotech-Environ/Environmental/THERMAL/tte1.html

- www.searo.who.int/LinkFiles/SDE_Chemical-contamination.pdf
- www.survivaltopics.com/survival/the-best-way-to-make-water-safe-to-drink
- www.voanews.com/engligh/news/africa/Kenya-Provides-Funds-to-Combat-Drought.Famine
- www.who.int/household_water/advocacy/combating_disease.pdf
- www.wilsoncenter.org/waterstories/Household_Water_Treatment.pdf
- www.worldvision.org/content.nsf/pages/horn-of Africa-famine-2011
- www.bettermedicine.com/kwashiorkor
- www.newsweek.com/2010/12/13/how-to-stop-cholera-in-haiti.html
- crofsblogs.typepad.com/h5n1/2011/05/the-uns-report-on-origins-of-cholera-in-haiti.html
- dyinginhaiti.blogspot.com/2011/03/cholera-in-haiti-march-2011.html
- www.merlinusa.org/2011/07/update-on-merlin%e2%80%99s-east-africa-emergency-response/
- blogs.vonews.com/breaking-news.com/breaking-news/2011/08/us-team-in-kenya-t0-assess-and-address-drought
- edition.cnn.com/2011/World/Africa/08/05/Kenya.camel.milk/
- www.grinningplanet.com/2005/07-26/water-pollution-facts-article.html
- www.who.int/water_sanitation_health/dwq/WSH02.07.pdf