Comprehensive Study Report on Koyna River

(Koyna dam to confluence with Krishna River, Karad)

Submitted by

MITRA

(Mass Initiative for Truth Research & Action)

2014

Acknowledgement

Maharashtra Pollution Control Board had assigned the project of Comprehensive Study on Koyna River – Koyna Dam to confluence with Krishna River, Karad as per guide lines of CPCB Dated 25th June 2013 to MITRA. The period of survey June 2014 to Nov 2014 was limited to complete a detailed study however actual observations, site visits, water quality analysis was carried out. Secondary data was procured from MPCB as well as statistical analysis was also used for completion of the report.

There were limitations to observations during the rainy season as the sugar industries and distilleries do not work during this period and as such the report is not holistic. Shortcomings in the report if any can be brought to the notice and can be changed.

The following people have given their valuable help during the completion of the report and hence it is essential to acknowledge them. Hon'ble Mr Suryakant Doke, Regional Officer, MPCB Kolhapur Division; Hon'ble Mr Anil Mohekar, Regional Officer, Pune region; sub-regional officers namely Mr. Barbole - satara; Mr Vijay Patil, Executive Engineer of Kolhapur Irrigation Department. Commissioner, CEO Zilha Parishad, CO of Municipal Corporations, Officers of various Gram Panchayats, social activists in Satara district, journalists all have contributed to making this report possible by making a vast data of information available to us.

Friends and well-wishers of MITRA, Anil Chaugule, Advt. Kedar Munishwar, Kunal Desai, Sangram Chavan, Sanjay Salpe, Mahesh Shivpuji , Viresh Shivpuji, Kalyani Pednakar, Aishwarya Patil have given inputs for the completion of the report. We are thankful to the trustees of MITRA Nilisha Desai, Anuradha Gaikwad; our advisors Prof. Dr. Jay Samant, Prof. Dr. Madhukar Bachulkar, Prof. Dr. Anilraj Jagdale and Dr. Suhas Khambe for their support while giving final form to the report.

With hope and wishes that the suggestions given in the report would be implemented and it would help in making Krishna a pollution free river!!!

Uday Gaikwad
Mass Initiative for Truth,
Research and Action(MITRA)

CONTENTS

CHAPTER – I

Introduction

Background –

The earth has an unique combination of atmosphere, hydrosphere and lithosphere. This unique combination helps it to support and sustain life. Water is essential for formation of life on earth. In fact life originated in water and in the process of evolution organisms became terrestrial with respect to their habitat. In the process of civilisation human beings formed their settlements near water bodies. All early human settlements are found to have been established and flourished on river banks. However in course of time with advances in science and technology human settlements spread over a wider area on earth. Transition from hunter-gatherer to agrarian lifestyle and then today's modern industrial lifestyle was not without impacts on environment.

The industrial era emerged in the late eighteenth century. This brought about a drastic change in the relationship of man with his environment. The exploitative, interventionist technology developed as a result of advances in science has led to growth of issues like pollution of natural resources, ozone depletion, global warming, etc. Pollution of natural resources has become a major concern threatening life on earth. According to World Health Organisation (WHO) almost 1 billion people lack access to safe drinking water; about 2 million annual diarrhoeal deaths are attributed due to unsafe drinking water, sanitation and hygiene. This has also been an issue of concern and has been deliberated upon in variety of environmental conferences such as Stockholm Conference 1972, Earth Summit of 1992, Rio +10 at Johannesburg in 2002; Rio + 20 at Rio in 2012 and other international discussions.

Rivers have always been an integral part of human life; and have played an important and life-sustaining role in human societies for thousands of years, and that is why many of the world's great cities, are found on the bank of great rivers. Rivers have been used as a source of water, for food, for transport, as a defensive barrier, as a source of hydropower to drive machinery and as a means of disposing of waste. Industrialisation has caused most of the rivers in the world to become polluted. It is estimated that 80 % of water resources have been polluted to some extent. The US based Blacksmith Institute and Switzerland based Green Cross organisation enlisted the top ten polluted rivers in the world. Two Indian rivers namely Ganga and Yamuna are the part of these top ten polluted rivers.

Rivers in India -

India as a country falls in Southern Asia and is the seventh-largest country by area, the second-most populous country with over 1.2 billion people, and the most populous democracy in the world. It is bounded by the Indian Ocean on the south, the Arabian Sea on the south-west, and the Bay of Bengal on the south-east. Towards the north lie the Himalayan ranges. India lies in the northern hemisphere between 6° 44' and 35° 30' north latitude and 68° 7' and 97° 25' east longitude. The country is rich in a variety of landforms and water bodies. Rivers of India play an important role in the lives of the Indian people. People are associated with the rivers socio- culturally and economically. The river systems make life possible by providing water for irrigation, domestic use, industries, cheap transportation, electricity generation and the source of livelihood for a large number of people all over the country. Apart from this rivers also play an important role in various religious rituals in the country.

In India there are four major geographical regions namely – the Himalayan Range, the Indo Gangetic Plain, the Dessert region and the Deccan plateau and the Peninsula. The Himalayan regions are intermingled with wide plateaus and valleys like Kashmir and Kulu. About one-sixth area of India is covered by this mountain region. This area stretches from one end of India to the other end in the northernmost part of the country and comprises almost parallel ranges between which are found large plateau and fertile valleys. They extend over a distance of around 2,400 Km. The Indo-Gangetic Plains, among the greatest stretches of the flat alluvium in the world, are formed by the basins of three rivers-the Sind, the Ganga and the Brahmaputra. This extends across Northern India for about 2,400 Km with a width varying from 260 to 350 Km. The Desert regions are the 'Great desert' extending from the edge of Rann of Kutch beyond the Luni river northward, embracing the whole of Rajasthan-Sind frontier, and the "Little Desert" extending from the Luni river between Jaisalmer and Jodhpur up to the north. The Deccan Plateau and Peninsula, extending south of the Vindhyas is geologically the oldest portion of the Indian land. The Aravalli, Vindhya, Maikala and Ajanta mountain ranges separate this Plateau from the Gangetic plain. This Plateau is flanked by the Eastern and the Western Ghats.

A number of minor and major rivers originate from these geographical areas. Seven major rivers along with their numerous tributaries make up the river system of India. Most of the rivers pour their waters into the Bay of Bengal; however, some of the rivers whose courses take them through the western part of the country empty into the Arabian Sea. Thus rivers in India can be classified as westward flowing rivers and eastwards flowing rivers. The major rivers of India flowing into the Bay of Bengal are Brahmaputra, Ganges (with its tributaries) Meghna, Mahanadi, Godavari, Krishna, Kaveri (and its main tributaries) and flowing into the Arabian Sea are Indus, Narmada, Tapi (and their main tributaries)

All major rivers of India originate from one of the three main watersheds:

1. The Himalaya and the Karakoram ranges
2. Vindhya and Satpura ranges and Chota Nagpur plateau in central India
3. Western Ghats in western India

Western Ghats

The Western Ghats are hill ranges that run across the 1600 km north to south parallel to the west coast of India, between the river Tapi in Gujarat and Kanyakumari in Tamilnadu covering an area approximately 160,000 sq km of the area. They are amongst the 34 biodiversity hot-spots identified in the world. It is a UNESCO World Heritage Site and is one of the eight "hottest hotspots" of biological diversity in the world. In the east, they form the western boundary of the Indian plateau and they slope gently towards the Deccan Plateau. The average height of these ranges is 1200 m. Climatic conditions in the Western Ghats vary with the altitude and physical proximity to the Arabian Sea. The Western Ghats experience a tropical climate - being warm and humid during most of the year with mean the temperature ranging from 20^o C in the south to 24^o C in the north. The rainfall ranges as high as 9000 mm to as low as 1000 mm with average rainfall around 2500 mm. The Western Ghats supports a variety of flora and fauna. There is great variety of vegetation all along the ghats which contains scrub jungles, grassland along the lower altitude, dry and moist deciduous forests; semi-evergreen and evergreen forests sustaining rich and endemic biodiversity.

The Western Ghats stand as a major water divide of the South Indian plateau. It forms the catchment area for complex riverine drainage systems that drain almost 40% of India. The important river basins of Godavari, Krishna and Kaveri arise in the Western Ghats. The Godavari is the largest river on the Indian plateau and has its source in the Sahyadris near Trimbakeshwar. It flows nearly around 1,465 km before falling to Bay of Bengal. The Parvara, the Purna, the Manjra, the Penganga, the Wardha, the Wainganga, the Indravati and the Kolab are the major tributaries of the river. Godavari Basin extends over an area of 3,12,812 km^2 in five states, which is nearly 9.5% of the total geographical area of the country. The Krishna River rises from at a height of 1337m north of Mahabaleshwar. Koyna forms one of the important sub-tributaries of the Krishna river. The Koyna dam across the river is life line of Maharashtra providing the state with water for domestic use, irrigation and industrial use.

Koyna River -

The Koyna River is a tributary of the Krishna River which originates in Mahabaleshwar, Satara district, Western Maharashtra, India. It rises near Mahabaleshwar, a famous hill station in the Western Ghats. Unlike most of the other rivers in Maharashtra which flow East-West direction, the Koyna River flows in North-South direction.

The Koyna River Basin generally trends North – South and covers an area of 2,036 km^2 in the Deccan terrain of the district of Satara in the state of Maharashtra. With an elevation range of 550 – 1,460 m above msl it typically represents a physiographic setup characterized of the Deccan plateau in the Western Ghats region. The Koyna River Basin stretches between 17^o 54" to 17^o.16" N and 73^o 42" to 74^o 06" E. The uniqueness of the Koyna River is that it flows north – south for a distance of about 65 km. Before it takes an eastward turn to join the river Krishna in the east, it is dammed by the Koyna Dam at Koynanagar forming the Shivsagar reservoir.

The Koyna River basin has a subtropical monsoon type of climate. The catchment of the River Course up to Helwak, has an average rainfall of above 5000 mm. upto Koyna Dam, the catchment area is 891.78 sq km. the average annual yield with 75% dependability ie120 TMC.

Salient Features of Koyna Basin	
Basin Extent Longitude Latitude	17^{o} 54" to 17^{o}.16" N 73^{o} 42" to 74^{o} 06" E
Length of Koyna River (Km)	65
Catchment Area (Sq.km.)	891.78
Live Storage Capacity of Completed Projects (MCM)	2836
Total Live Storage Capacity of Projects (MCM)	2950.05

Koyna Tributaries

Koyna River is supported by four tributaries. They are namely Kera, Wang, Morna and Mahind. Among these rivers Kera, Wang and Morna are dammed. All the tributaries originate in the Western Ghats. The details of the rivers is mentioned in the table no 1.1

Table no. 1.1 Details of rivers and dams in Koyna River Basin

Sr. No.	River	Origin	Length (km)		Dams	Irrigated Area (ha)	Power Generation (MW/Yr)
			A 1	A 2	Major		
1	Koyna	Mahabaleshwar	80.39	148.5	Koyna nagar		147.844
2	Kera	Mandure	7.09	10.11	Mandure		
3	Wang	Nigde	6.21	30.82	Dhebewadi	73.34	
4	Morna	Gotne	15.31	28.47	Morgiri	17.55	
5	Mahind	NA	NA	NA	NA	NA	NA

NA – Not Available

Koyna Hydrological project

The Koyna Dam built on Koyna River is a measure source of water for the state of Maharashtra. It is a rubble concrete dam 103.02 m high above the deepest foundation level, and 85.35m high above river bed. It has a total length of 807.22 m. The Dam is founded on Basalt rock, is one of the major Hydro Electric Projects in the country. The Dam impounds 2980.34 MCM water to generate 1960 MW power.

The work on Koyna dam initiated in 1951 and the reservoir was filled up in 1961 and the first turbine started working in1962. At present the stage V of Koyna Hydroelectric Power Project is under construction.

Sahyadri Tiger Reserve -

Koyna Wildlife Sanctuary covering an area of around 423.55 km^2 was notified in 1985. On May 21, 2007 Koyna Wildlife Sanctuary along with Chandoli National Park was declared as a part of Sahyadri Tiger Reserve declared by The National Tiger Conservation Authority. Chandoli Park is notable as the southern portion of the Sahyadri Tiger Reserve, with Koyna Wildlife Sanctuary forming the northern part of the reserve. Tiger reserve covers 741.22 sq. km area which is a habitat for variety of endemic flora and fauna.

CHAPTER – II
Methodology for Survey

2.1 Background –

Considering the ever increasing problem of river water pollution, as per letter dated 25th June 2013, the Central Control Pollution Control Board (CPCB) had decided to carry out a comprehensive study on Polluted Stretch of four rivers in India namely Tapi – Madhya Pradesh border to Bhusaval, river Girna from Malegaon to Jalgaon, river Krishna from Dhom dam to Kolhapur and river Ulhas downstream to Mohane. Hence accordingly directions were given to MPCB to carry out such comprehensive study for the prescribed river stretches. Koyna is an important tributary of river Krishna and therefore it was essential to study it. Hence the stretch identified for study is Koyna River from Koyna dam D/S upto confluence with Krishna River at Karad. The comprehensive study of Koyna River was supposed to assess polluting sources, estimation of pollution load reaching to river, detailing of polluting sources, requirement of environmental flow, etc. Hence to complete this study following objectives were determined.

2.2 Objectives –

- To assess the polluting sources.
- To estimate the pollution load reaching to river.
- To carry out detailing of pollution sources viz large, medium and small scale industries.
- To assess the CETPs operating / required along with their affected quality.
- To quantify the domestic pollution .
- To procure the information on river water quality .
- To assess the environmental flow.
- To study the existing STP's.
- To suggest requirement of STPs and Treatment technology required for abatement of pollution.

2.3 Methodology –

In order to achieve the objectives mentioned above following appropriate techniques was used.

Study Area

The methodology adopted for the study included initial pilot field survey of the study area to finalise the scope of the study and to identify representative sites for infield study. The study included field investigations, water analysis for studying various anthropogenic impacts on river environment. The field study was carried out periodically from May 2014 to October 2014

Geographical location of each sampling point was located using GPS. The collection, preservation and analysis of the samples were done as per methods given in the manual of American Public Health Association (APHA, 2001). From each water sample 14 physico-chemical and one microbiological parameters were analysed to check the water quality. Old river water quality analysis results were procured and used from MPCB.

The parameters selected and methods used for water parameter analysis are as follows:

Table no 2.1 Water Parameters and used analysis method

Sr. no.	**Name of the parameter**	**Units**	**Method used**
1	pH	-	APHA 4500 H-B
2	Electrical Conductivity	µmhos/cm	APHA 2510
3	Temperature	°C	APHA 2550
4	Total Dissolved Solids	mg/l	APHA 2540-B
5	Total Solids	mg/l	APHA 2540-B
6	Turbidity	NTU	APHA2130-B
7	Dissolved Oxygen	mg/l	APHA 4500-O
8	BOD 5 at 20°C	mg/l	APHA 5150-B
9	COD	mg/l	APHA 5220-B
10	Hardness	mg/l	APHA 2340-B
11	Nitrates	mg/l	APHA 4500-NO_3
12	Phosphates	mg/l	APHA 4500-P
13	Fluorides	mg/l	APHA 4500-F
14	Oil and Grease	mg/l	APHA 5520-B
15	Most Probable Number	100/ml	APHA 9221

Secondary data was collected from the departments such as Maharashtra Pollution Control Board (MPCB), Maharashtra Industrial Development Corporation (MIDC), Director of Sugar Industry, Irrigation Department, Agriculture Department, etc. of Satara Districts in the form of census, reports, maps, resolutions of various government departments.

To define the water quality of river Koyna sampling of river water was carried out. Sampling stations were identified on the basis of earlier river water analysis results for various sampling stations and a pilot field survey of river stretch. The following table shows the details of sampling sites.

Table no 2.2 Details of Sampling Sites

Sr. No.	Station No.	Name
1	1	Koy-1 Dam Downstream- Bridge at Karad to Chiplun Road
2	2	Koy-2 Vittalwadi (Patan Upstream)
3	3	Koy-3. Patan Downstream
4	4	Koy-4. Navarasta To Gavhanwadi
5	5	Koy-5. Nisre To Sonaichiwadi
6	6	Koy-6. Old Sakurdi To Tambave
7	7	Koy-7. NH4 Bridge (Karad Upstream)
8	8	Koy-8. Karad - Vita Bridge

2.4 Statistical Analysis -

To understand the general status of rivers earlier data was procured from MPCB. The GEMS Minar data of three years (2011 to 2013) of 22 river sampling sites from three districts namely Satara, Sangli, Kolhapur was obtained. 26 parameters were considered for analysis which include pH, BOD, Nitrates, COD, Conductivity, Ammonia, Total coliforms, Fecal coliforms, TKN, TDS, Total fixed solids, TSS, Turbidity, Hardness, Flurides, Boron, Chlorides, Sulphates, Total alkalinity, P- alkalinity, Sodium, Potassium, Calcium, Magnesium, Phosphate and Dissolved oxygen. The data was grouped into three seasons namely winter, summer and rainy to see the seasonal variation. The data was also statistically processed by using standard deviation with the help of Microsoft excel and MINITAB software.

The standard deviation (SD) (σ) measures the amount of variation or dispersion from the average. A low standard deviation indicates that the data points tend to be very close to the mean or average; a high standard deviation indicates that the data points are spread out over a large range of values. Standard Deviation is calculated by following formula –

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2}$$

2.5 Limitation –

The Pollution load determines the total amounts or loads of various pollutants that move past a monitoring station during a particular period of time, often one year. Calculation of pollutant loading requires stream flow data (volume/time), pollutant Concentration data (amount/volume) and time data (time). Although loads can be calculated for any time period, it is conventional to report loadings on an annual basis. By reporting loads on an annual basis, seasonal patterns of runoff can be taken into account.

The period of present study was restricted to six months. All the rivers are dammed by Kolhapur type weirs which confine the flow of river and them a chain of pools. Hence the restricted flow of rivers and short time period of study were major constraints in calculating the Pollution load. An extensive study of river is needed to calculate the pollution load.

Chapter – III
Study Area

3.1 Introduction

As per the directions of CPCB and letter of MPCB for the comprehensive study of Koyna River stretch involves area from Koyna Dam to Krishna Koyna confluence at Karad. The Koyna River is a tributary of the Krishna River which originates in Mahableshwar, Satara district, Western Maharashtra, India. It rises near Mahabaleshwar, a famous hill station in the Western Ghats. The Koyna River Basin generally trends North – South and covers an area of 2,036 km^2 in the Deccan terrain of the district of Satara in the state of Maharashtra. With an elevation range of 550 – 1,460 m above msl it typically represents a physiographic setup characterized of the Deccan plateau in the Western Ghats region. The uniqueness of the Koyna River is that it flows north – south for a distance of about 65 km, while all other rivers originating from the Western Ghats flow east-west or west-east. Before it takes an eastward turn to join the river Krishna in the east, it is dammed by the Koyna Dam at Koynanagar forming the Shivsagar reservoir.

3.2 Geographical details of Koyna river basin

The Koyna River Basin stretches between 17^o $54^"$ to 17^o.16” N and 73^o $42^"$ to 74^o $06^"$ E. Koyna river flows in a north - south direction almost parallel to the continental divide for a distance of 65 Kms. from Mahabaleshwar to village Helwak, skirting King Shivaji's fort Pratapgadh. At village Helwak, it turns sharply eastwards, travels for about 56 Kms and joins River Krishna at Karad. It’s a peculiar confluence where both the rivers meet head on. This confluence is aptly named as Preeti Sangam. The river flows through the talukas of Patan and Karad. The catchment of the River Course is up till Helwak and has an average rainfall of above 5000m. The catchment area of the river up to Koyna Dam is 891.78 sq. km.

The major tributaries of Koyna River are Kera, Wang, Morna and Mahind.

3.3 Geological details of Koyna River Basin -

Geologically, the Koyna River basin consists of basaltic lava flows that erupted through fissures during the late Cretaceous to lower Eocene epoch. Some of the basaltic flows are locally lateritized at their tops, especially under wetter conditions. Laterites often form flat plateaus and tablelands at elevations ranging from 975–1,400 m at msl. These lateritic profiles have a thickness of about 12–30 m in the eastern and northern parts, and about 2–5 m in the southern parts. Alluvium of the Koyna River is localized in the valley sections. Groundwater generally occurs under unconfined conditions in shallow aquifers, while in deeper aquifers it occurs under semi-confined to confined conditions and is associated only with basalts. Each basaltic flow consists of two main trap units: (1) a lower massive unit, and (2) an upper vesicular unit. The massive unit constitutes the main trap unit and forms 60–85% of the basaltic flows. It is mostly fine grained, dense, compact, and greenish to dark gray in color. The massive unit possesses negligible primary porosity and permeability, and generally acts as an impermeable bed.

However, the process of weathering and the occurrence of joints and fractures at places make it moderately permeable.

.

3.4 Hydrology of Koyna River

There are four sub-tributaries of the Koyna River. They are Kera, Wang, Morna and Mahind respectively. The dam on Koyna at Koyna nagar is used for electricity generation. This water is used for various purposes such as for irrigation 2521.28 Mm^3, for domestic purpose 637.32 Mm^3 and for industrial reasons 76.114 Mm^3. There are dams on the rivers Wang and Morna respectively at Dhebewadi and Morgiri. The details of the river are mentioned in the following table no 3.1

Table no 3.1 Koyna River's Tributaries, their Length, Irrigated area and Power Generation Capacity

Sr. no.	River	Origin	Dams	Length (km)	A1 Length (Km)	A2 Length (Km)	Area Under Irrigation (Ha)	Power Generation (MW/Yr)	Confluence With	Confluence At
1	Koyna	Mahabaleshwar	Ky Nagar **	228.89	80.39	148.5		147.844	Krishna	Karad
2	Kera	Mndure		17.20	7.09	10.11			Koyna	Patan
3	Vangna	Nigde	Dhebewadi *	37.03	6.21	30.82	540		Koyna	Chchegav
4	Morna	Atoli	Morgiri *	43.50	15.31	28.47	100		Koyna	Sangvd
5	Mahind+									

+ Data not available, Major dams are indicated as **, Medium dams are indicated as *

3.5 Hydro-power generation details

There is a major dam on the Koyna River. Koyna dam is a rubble concrete dam 103.02 m high above the deepest foundation level and 85.35 m high above the river bed. It has a total length of 807.22 m. the dam is located near village Deshmukhwadi in Patan Talukha in Satara District. The dam impounds 2980.34 MCum water. The total Installed capacity of the project is 1,960 MW.

The project consists of 4 stages of power generation. All the generators are located in the underground Powerhouses excavated deep inside the surrounding mountains of the Western Ghats. A dam foot powerhouse also contributes to the electricity generation. The project is composed of four dams with major contributors Koyna Dam and Kolkewadi Dam. The water from Shivasagar reservoir formed by Koyna dam is used for electricity generation in 1st, 2nd and 4th stages. This water is drawn from head race tunnels situated underground below the reservoir. Then it travels through vertical pressure shafts to the Underground Powerhouses. The discharged water from these stages is collected and stored in Kolkewadi Dam situated near village Alore at a lower level than Koyna dam. The water is drawn from penstocks of Kolkewadi dam to an underground power station in the 3rd stage and then discharged to the Arabian Sea.

The electricity generated in all the stages is delivered to the main electrical grid. The project is run by Maharashtra State Electricity Board.

3.6 Sahyadri Tiger Reserve –

The catchment of the Koyna River is enriched with pristine forest area. Earlier the area was protected as Koyna Sanctury. Koyna wildlife sanctuary notified in 1985 includes Eastern and Western catchments of Koyna dam. Chandoli National Park is a 317.67 km2 (122.65 sq mi) area in Sangli District Maharashtra state, India, established in May 2004. The 741.22 sq. km (286.19 sq mi) Sahyadri Tiger Reserve, including all of Chandoli National Park and Koyna Wildlife Sanctuary was declared by The National Tiger Conservation Authority as a Project Tiger reserve on May 21, 2007. The Sahyadri Tiger Reserve was then estimated to have nine tigers and 66 leopards. Chandoli Park is notable as the southern portion of the Sahyadri Tiger Reserve, with Koyna Wildlife Sanctuary forming the northern part of the reserve. The mixed forest cover is observed in the area include ever green and moist deciduous types of vegetation. There are variety of endemic flora and fauna.

3.7 Demography of the Koyna river basin

The Koyna River Basin is part of two talukas Patan and Karad in the district of Satara. The population of these two talukas is 2,99,505 and 5,84,085 respectively. There are 336 and 219 villages in the two talukas respectively. It includes the major settlements of Koynanagar, Debewadi, Malharpeth, Patan, Navarasta, Marali, Malkapur and Karad Corporation. The following table gives the details of Population in Koyna river basin.

Table no 3.2 Population in Koyna River Basin

District	Taluka	No. of Town/ Village	Population
Satara	Karad	219	543424
	Patan	336	298095
	Total	**555**	**841519**

Source: District statistical reports of Satara (2012)

3.8 Land use in Koyna River basin -

The land use pattern can be broadly categorized into forest land, non-agricultural land and cultivable land. From the two talukas Patan and Karad of Satara district 280671 ha land is covered in the Koyna River basin. Out of this 38322 ha is under forest, 21804 ha is used for non-agricultural purposes and 220545 ha is cultivable land. The Taluka wise details of land use against total area of district are reported in the table given below:

Table No 3. 3 Details of Land Use Pattern (all figures in Ha)

Taluka	Forest land	Non-agricultural land	Cultivable land	Total
Patan	27,720	15,835	1,19,026	**1,62,581**
Karad	10,602	5,969	1,01,519	**1,18,090**
Total	**38,322**	**21,804**	**2,20,545**	**2,80,671**

Source: District statistical reports of Satara (2012)

3.9 Cropping pattern -

Large area from Satara, Sangli and Kolhapur is under cultivation. The major crops in this district are paddy, wheat, bajari, corn, wari, nachani, raala, sava, harbhara, tur, mug, udid, kulith, mataki, vaal, vatana, sugarcane, chili, garlic, other spices etc. Fruits such as mango, grapes, citrus fruits, banana, etc are also cultivated. The vegetables such as potato, onion, brinjals, tomatoes, other vegetables; oil seeds such as ground nuts, cotton, sunflower, soya, etc; other medicinal plants like turmeric and other crops are cultivated in the Krishna river basin area. For cultivation number of chemical fertilisers and pesticides are used widely in the basin.

3.10 Cattle –

Cattle growing and animal husbandry is a supportive business of agriculture. There are number of cattle in the basin. This area has number of small and two large dairies producing milk and other milk products. For variety of agricultural works cattle are used in this region. According to animal census of 2007 total number of cattle in Patan and Karad is 211207. Among that in 20538 are foreign hybrid cattle, 48236 are Indian hybrid cattle, 142433 are buffaloes. The other animals such as sheep/ lamb, goats, horses as well as poultry and other small birds are also grown in the region.

Table no 3.4 Number of Cattle in the Koyna River Basin

	Foreign Hybrid Cows and oxen	**Indian Hybrid Cows and oxen**	**Buffalos**	**Total**
Patan	3334	28597	54545	**86476**
Karad	17204	19639	87888	**124731**
Total	**20538**	**48236**	**142433**	**211207**

Source: District statistical reports of Satara (2012)

3.11 Industries –

Apart from agriculture in the basin variety of industries have been established in the Koyna river basin within all the two talukas. Depending upon the type of production these industries are categorised as red, orange and green. There are a total of 29 industries; among them 3, 17 and 9 industries are from red, orange and green categories respectively. There is only one sugar industry at Marali. There are two dairies and one agro products processing unit and fruit juice, jam, and pulp industry. The other category of industries constitutes of non-polluting assembling units.

3.12 Other developmental activities –

No major mining activity is observed in the Koyna river basin. Minor minerals are mined in the area. Minor minerals such as stones, fertile soil are excavated widely in the Koyna River basin. Installation of wind mills, construction of roads and other developmental activities are rapidly changing the land use and also creating direct as well as indirect impacts on Koyna River and its tributaries.

Chapter – IV
Observations

The water from river Koyna and its tributaries is used for various anthropogenic activities. Water from Koyna River and its tributaries is is used for drinking, domestic, agriculture, electricity generation and industries, etc. The various activities such as fishing; washing of cloths and animals; religious activities like idol and nirmalya (Pooja Offerings) immersion and crematorium ash immersion; excavation of fertile soil from the river banks for brick making; etc. are reported on the banks of rivers. After the field visit the potential sites were identified for sampling purpose.

4.1 Observations –

The major causes of pollution of the river included disposal of untreated or partially treated sewage, industrial effluent, agricultural runoff, and religious waste, improper disposal of solid waste such as municipal solid waste, biomedical waste, and hazardous waste. Activities like brick making, stone mining were also reported during the study which contributed to the pollution of the river.

The quality of river water and location of the industries and other related aspects are prescribed in the river restriction zone 2009. Environment Department, Government of Maharashtra, vide Govt. Resolution No. MMV-2009/325/58/TB-3 dated 15th July 2009 has notified the industrial location policy from environmental angle in the river catchments. Accordingly, the river catchments have been categorised in 4 categories i.e. A-I, A-II, A-III and A-IV based on the river water quality. Accordingly, from origin upto the first dam the river shall have desired water quality A-I. From first dam upto the area designated as A-II, the river quality shall be as prescribed in A-II, While in A-III classified area; the river quality shall be suitable for fisheries and wildlife. In A-IV zone, the river quality should be suitable for agricultural and Industrial usages. The Restriction is applicable to industrial areas to be developed by MIDC also. However, for an existing MIDC industrial area where land has been acquired and developed, but the plot allotment has not been done, in such case the restrictions for developing industries shall be applicable upto 500 m from HFL of the river on both sides in A-II class area. The criteria for setting up industry is as follows

Classes	No Development zone for any type of industries	Only Green category of industries with pollution control devices.	Only Orange category of industries with pollution control devices.	Any type of industries (Red, Orange, Green) with pollution control devices
A -I	3 Km on the either side of river	From 3 Km to 8 Km from river (H.F.L.) on either side	From 3 Km to 8 Km from river (H.F.L.) on either side	Beyond 8 Km from river (H.F.L.) on either side.
A -II	1/2 Km on the either side of river.	From 1/2 Km to 1 Km from (H.F.L.) on either side	From 1 Km to 2 Km from (H.F.L.) on either side	Beyond 2 Km from river (H.F.L.) on either side.
A -III	1/2 Km on the either side of river	From 1/2 Km to 1 Km from river (H.F.L.) on either side	From 1/2 Km to 1 Km from river (H.F.L.) on either side	Beyond 1 Km from river (H.F.L.) on either side.
A -IV	1/2 Km on the either side of river	From 1/2 to 1 Km from river (H.F.L.) on either side	From 1/2 to 1 Km from river (H.F.L.) on either side	Beyond 1 Km from river (HFL.) High Flood Line on either side.
IDC with CETP	1/2 Km on the either side of river	From 1/2 Km to 3/4 Km from river (H.F.L.) on either side	From 1/2 Km to 3/4 Km from river (H.F.L.) on either side	Beyond 3/4 from river (H.F.L.) on either side.

4.3 General Observations of Koyna River Basin –

The major causes of river pollution are discussed bellow:

4.3.1 Domestic Sewage –

The zone upto 3 km from high flood line on both the river banks is considered as A-II zone where Red Category industries are completely restricted. Hence in the entire Koyna River stretch the villages, towns, municipal corporations which are within the 3 Kms area from the river were identified for study. The total population of about 156283 lives in this expanse. On the left side of the river bank there were 19 villages and towns with population of 31148 and on the right side of the river there were 31 villages and towns with a population of 125135. These settlements released untreated or partially treated domestic sewage directly disposed into the river. The details of population and the villages is shown in the following table

Table no 4.1 List of places and population upto 3 kms to left and right side of Koyna River

Left side	Population	Right side	Population
Rasti	1540	Koyna nagar	
Goshatwadi	1001	Helwak	734
Vanzoli	358	Govare	366
Karte	838	Kadoli	529
Patan		Taliye	635
Maloshi	531	Maneri	729
Yerphale	1614	Lendhori	707
Navraswadi	995	Zakade	406
Malharpeth	4106	Gunjali	584
Abdarwadi	850	Killemorgiri	716
Nisare	1104	Manyachiwadi	538
Navdi	1028	Nerale	706
Vihe	3449	Jyotibachiwadi	670
Mhopre	2042	Kavarwadi	743
Beldari	1290	Mulgaon	882
Vasantgad	1953	Tripudi	1085
Vanzole	358	Chopadi	1621
Gote	3747	Gavhanwadi	531
Munde	4344	Chopdarwadi	781
		Sangwad	1160
		Choughulewadi	1208
		Paparde Kh.	732
		Marul Haveli	3183
		Sonichiwadi	1787
		Vitthalwadi	279
		Surul	911
		Tambave	4838
		Kirpe	1318
		Chachegaon	3040

		Malkapur	22392
		Karad	71324
Total	**31148**	**Total**	**125135**
Total		**156283**	

Source: Provisional Census 2011

4.2.2 Industrial effluent –

A variety of industries have been established in the Koyna river basin within all the two talukas. Depending upon the type of production these industries are categorised as red, orange and green.

There are total of 29 industries among them respectively 3, 17 and 9 industries are from red, orange and green categories. Their details of water consumption and effluent generation are mentioned in table no 4.2. There is only one MIDC area in Patan Taluka. The non – MIDC area of Koyna bsin contains only 10 industries. These industries consume water for both domestic and industrial purpose. The total water consumption is 1624.8 m^3 out of which 452.8 m^3 of water is consumed for industrial purpose while 1162 m^3 water is consumed for domestic use in industries respectively. The total effluent generated in these industries is 337.8 m^3 out of which 60.77 % is industrial effluent and 39.23 % is domestic effluent. The breakup of effluent generated is shown in table no 4.2.

Table no 4.2 Category wise water accounts of Industries from the Koyna River Basin

Taluka	**Name of MIDC**	**Category**			**Total Con. (CMD)**	**Ind. Con. (CMD)**	**Ind. Eff. (CMD)**	**Dom. Con. (CMD)**	**Dom. Eff. (CMD)**
		Red	**Orange**	**Green**					
Patan	Patan MIDC	1	9	9	476.5	0	1.5	476.5	0.9
	Non MIDC	2	8	-	1138.3	452.8	203.8	685.5	131.58
	Total	**3**	**17**	**9**	**1614.8**	**452.8**	**205.3**	**1162**	**132.48**

4.2.3 Sugar Industry –

In the entire river basin there is only one sugar industry which is located at Marali in Patan Taluka. The effluent generated in the industry is many times released into the river water without or with partial treatment. The effluent stored into the lagoons many times gets leaked out and through nallas enter into the river. The sudden release of effluent from sugar industry creates sudden shock in the river patch leading to odour to river water.

Sugar industry use large amount of water, generating large amount of effluent. The effluent generated in the industry is many times released into the river water without or with partial treatment. The effluent is openly released through nallas enter into the river. The sudden release of effluent from sugar industry creates sudden shock in the river patch leading to odour to river water and sometimes fish kill in the river.

Though sugar industries were closed in the study period some facts were noted and mentioned bellow. Some of the facts major issues related to sugar industries and distilleries include; there is difference in sanctioned and actual crushing capacity of the industries. Many times industries exceed the sanctioned crushing capacity. The crushing days are also not fixed. Sugar industries do not take prior No Objection Certificate (NOC) from MPCB. Existing machinery in the industries is very old and is not working with it's best efficiency. There is difference in crushing capacity and effluent treatment capacity. Generally crushing is carried out beyond the treatment capacity of ETP. Industrial effluent is stored in kaccha lagoons in the vicinity before, during and after the treatment. Many sugar industries dispose off their untreated or partially treated effluent directly into nearby stream or river. Many times effluent is mixed with river water. After dilution it is used for irrigation purpose. Due to a misconception that such effluent could make land soft and suitable of cultivation; effluent from distilleries is filled in the tankers and disposed on the barren or rocky land piece. Such unscientific and illegal disposal of effluent may lead to pollution problems in near future. Waste material from industries such as bagasse, ash, sludge and other solid waste is stored on the area which is without any lining. This has led to formation of leachate in the neighbourhood area. Majority of the sugar industries lye in flood-line within 3 km from river.

4.2.4 Agricultural Runoff -

Runoff is water from rain which is not absorbed and held by the soil, but runs over the ground and through loose soil. Agricultural runoff is water leaving farm fields because of rain or irrigation. Agricultural runoff can include pollution from soil erosion, feeding operations, grazing, and ploughing, animal waste, application of pesticides, irrigation water, and fertilizer. Pollutants from farming include soil particles, pesticides, herbicides, heavy metals, salts, and nutrients such as nitrogen and phosphorus. High levels of nitrates from fertilizers in runoff can contaminate drinking water. Polluted agricultural runoff is the leading source of water enrichment in rivers. It can also trigger algae blooms and eutrophication. The pesticides in runoff can accumulate in fish, which can expose people who eat the fish to high levels of these chemicals.

The river basin being a predominantly agricultural area has an extensive use of both fertilisers as well as pesticides. In the river basin region there is 163486 Ha area is under cultivation and 76931 MT of the chemical fertilisers are sold. From the land under cultivation and fertiliser sale it can be seen that in the river basin area average 2.9 MT of fertilisers are used per Ha. The excess fertiliser is washed off with the excess water used for irrigation in the form of agricultural runoff. Through agricultural runoff excessive fertilisers and pesticides enter into the river water. The details of cultivation land and sell of chemical fertilisers is mentioned in the table no 4.3.

Table no 4.3 Total Cultivated Area and Sale of Chemical Fertilisers in the Koyna River Basin

Taluka	Land under cultivation (ha)	Sale of Fertilisers MT	Per hectare use MT
Patan	82556	18658	4.42
Karad	80930	58273	**1.38**
Total	**196486**	**76931**	**2.90**

Source: District statistical reports of Satara (2012)

4.2.4 Waste from animal Husbandry –

Cattle growing and animal husbandry is a supportive business of agriculture. There are number of small and large, private and cooperative dairies. Many individuals do milking which is a source of income for them. There are number of individuals and dairies who have own cattle stables. The number of cattle is mentioned in table no 3.4. The other animals such as sheep/ lamb, goats, horses as well as poultry and other small birds are also grown in the region. These waste generated from the cattle and animal husbandry did not have any treatment system. Hence this waste through nallas enters into the river water.

4.2.5 Religious wastes -

All the places of the river confluence have religious importance. At such places various rituals take place. Religious rites and rituals like release of ash after cremation of dead bodies, immersion of puja idols (Ganapati and Durga puja) and nirmalya (puja offerings in the form of dried/used flowers) add to pollution of the river. The pigments used for colouring these idols, calcium sulphate used for making these idols leads to increasing the hardness of the river water. That means a sizable amount of religious wastes do reach the river and add to its pollutants.

4.2.6 Solid waste management –

The waste created in Koyna River Basin contains domestic waste, building dabarage, plastic, slaughter-house waste, bio-medical waste, waste from commercial establishments, e-waste etc. it is essential to dispose of this waste properly and scientifically so as to avoid pollution. All this waste has to be disposed of as per Municipal solid Waste management and handling rules 2000. The e waste has to be treated as per E- waste Management and Handling rules 2011, while the bio medical waste has to be treated as per Bio-medical waste Management and Handling rules 1998. It has been observed that many a times this waste is directly dumped in the water bodies including river.

The quantification of solid waste from villages, towns and municipal corporation is not done properly. As per available data the in Karad and Malkapur Municipal corporations 43 tons of municipal solid waste is generated. Most of this waste is not properly treated and disposed off. Thus this adds to the pollution of the river. The biomedical liquid waste from hospital was treated at the STP of hospital however it was constructed below 10 feet of ground level in the flood prone area.

4.2.7 K. T. Weir –

A distinctive feature of the irrigation system of the rivers in the districts is the presence of Kolhapur Type Weirs constructed exclusively for the purpose of irrigation. It is built in the riverbed for purpose of impounding water for irrigation. The maximum height of the weir is in level with the riverbank. While building the weirs further factors are considered –the riverbed should have a stable rock base and the weir should be approachable from both the banks of the river; the velocity of water is another factor considered before constructing the weirs. K. T. weirs are seen in an area where the river flows with a relatively gentle velocity. They assist in irrigation and act as bridges joining two sides of the riverbank facilitating transport through and fro. The usual practice with respect to weirs is to allow passage of water through the weirs at periodic intervals. Stakeholders for purpose of irrigation then use this water. However during the months of summer when the volume of water in the river is low and rate of evaporation very high, the weirs prove to be obstacles to flow of water. The water between two consecutive weirs remains stagnant for a specific time interval while sewage and industrial effluents continuously enters the river and thereby increases the intensity of pollution. There are only 4 K. T. weirs on the Koyna river and her tributaries, two each on Koyna and Wang River.

4.2.8 Brick Making –

The natural vegetation on the banks of the river has been destroyed in the process of soil removal for brick making. The use of fertile soil for making bricks is responsible for degradation of land. The fertile top soil is excavated leaving the surface below exposed and this too hastens the erosion and thus degradation of land. Use of this soil for brick making is causing irreversible loss to the river bank.

Various studies show that there are adverse effects of brick industries on soil, water, air, vegetation and human health. In the process of brick making coal and rice husk is used extensively as fuel in kilns which gives rise to air pollution and generation of ash. This ash is disposed into the river.

Koyna river stretch is not recorded for sand mining or saline soil. However excessive use of water in the area for irrigation may cause problem of soil salinity in near future.

4.2.9 Flow of river water –

After the discharge from the dam river is not flowing continuously. The K. T. weirs, ducts produced due to excavation of sand, sand deposits in the river bed after removal soil causing disturbing the river bank, bridge in the rivers, water discharge system run by irrigation department without considering the ecology, environment, pollution and biodiversity are affecting the natural flow of river. All together this is affecting the pollution intensity in various parts of the river. This issue is needed to be discussed and studied in detail.

4.3 Visit Observations:

For the purpose of study field visits were carried out in all three districts i.e., Satara, Sangli and Kolhapur. The actual visual observations at various places are mentioned below:-

The following observations are from the villages on the left and right bank of Koyna River falling within a distance of 3km from the river bank. Washing of clothes and bathing of animals and human beings, washing of vehicles was observed at many places on the river bank. At many places religious rituals were conducted on the river bank and at the confluence of rivers. Also the river banks are used for disposal of solid wastes. From many places nala's carrying industrial as well as domestic effluents lead directly to the river body.

At Sahyadri Hospital the water consumption is 60,000 l/d consumption. The Hospital is 100 m away from Koyna River. The STP was functional but it was constructed 10 feet below the ground level in the flood prone area. Hence there is a possibility that the effluent might be mixing with flood runoff. The treated effluent is used for irrigation of agricultural on the bank of the river. There is a threat of agricultural runoff carrying the traces of the hospital effluent meeting the river during the monsoons. Further the operator was not qualified for handling the STP.

In the sugar industry lagoons with wooden gate whose flow was towards the nala. Press mud had been spread on the open ground. The ETP consisted of following treatment facilities; Oil separator, equalization tank, clarifiers with surface aeration, sludge sump well and a washing tank. Lagoons were used for composting and the compost is sold. It was further reported that effluent from industry was crossing the road and flowing towards river.

Chapter – V
River Water analysis

5.1 River Water Analysis by MPCB –

Under the National Water Monitoring Program (NWMP) CPCB in collaboration with concerned SPCBs/PCCs established a nationwide network of water quality monitoring comprising 2500 stations in 28 States and 6 Union Territories. The monitoring is done on monthly or quarterly basis in surface waters and on half yearly basis in case of ground water. The monitoring network covers 445 Rivers, 154 Lakes, 12 Tanks, 78 Ponds, 41 Creeks/Seawater, 25 Canals, 45 Drains, 10 Water Treatment Plant (Raw Water) and 807 Wells. Among the 2500 stations, 1275 are on rivers, 190 on lakes, 45 on drains, 41 on canals, 12 on tanks, 41 on creeks/seawater, 79 on ponds, 10 Water Treatment Plant (Raw Water) and 807 are groundwater stations. There are 22 river sampling stations from the districts of study area. In Satara district there is one sampling stations on Koyna River At-Karad, Tal-Karad, Dist-Satara.

The GEMS Minar data of sampling site from 2011 to 2013 was procured from the MPCB. The data was also statistically processed by using standard deviation with the help of Microsoft excel and MINITAB software to understand the general status of the rivers as well as the seasonal status of the river. 26 parameters were considered for analysis which include pH, BOD, nitrates, COD, Conductivity, Ammonia, Total coliforms, Fecal coliforms, TKN, TDS, total fixed solids, TSS, Turbidity, Hardness, Flurides, Boron, Chlorides, Sulphates, total alkalinity, P-alkalinity, sodium, potassium, calcium, magnesium, phosphate and dissolved oxygen. The average parameter reading and its standard deviation are reported in bellow table -

Table no. 5.1 Koyna River Water Analysis from Satara District At- Karad, Tal-Karad (2011 – 2013) with Standard Deviation

	Parameter	A-II River std	Winter Season	Summer Season	Rainy Season	Average
1	**pH**	6.5 to 9.0	8.01 ± 0.38	8.14 ± 0.23	7.98 ± 0.31	8.05 ± 0.31
2	**Conductivity**	-	203.55 ± 48.02	157.51 ± 52.49	200.73 ± 99.43	187.27 ± 71.79
3	**BOD**	5.0 Mg/l	5.31 ± 1.36	6.01 ± 1.31	5.25 ± 1.34	5.52 ± 1.35
4	**Nitrate (N)**	45 mg/l	0.35 ± 0.24	0.75 ± 1.08	0.42 ± 0.30	0.51 ± 0.67
5	**Ammonia**	1.5 mg/l	0.28 ± 0.18	0.72 ± 0.48	0.50 ± 1.23	0.50 ± 0.72
6	**Total Coliform**		1062.50 ± 650.60	1122.72 ± 494.73	1313.88 ± 707.63	1184.38 ± 682.02
7	**Faecal Coliform 100 ml**		236.25 ± 120.19	152.50 ± 95.41	245.42 ± 76.59	211.39 ± 105.08
8	**C.O.D.**	-	16.67 ± 5.35	18.67 ± 3.55	15.00 ± 3.46	16.78 ± 4.36
9	**TKN**		1.99 ± 0.36	2.53 ± 0.69	2.51 ± 1.40	2.34 ± 0.93
10	**TDS**	-	151.58 ± 41.21	111.00 ± 40.55	138.83 ± 69.37	133.81 ± 53.46
11	**Total Fixed Solids**	-	125.25 ± 31.35	91.83 ± 31.51	115.33 ± 60.43	110.81 ± 44.39
12	**T.S.S.**	-	11.83 ± 3.51	11.83 ± 4.13	16.83 ± 4.63	13.50 ± 4.66
13	**Turbidity**	-	2.59	0.91	9.97	4.49

			+ 4.30	+ 0.36	+ 19.55	+ 11.91
14	**Hardness**	500 mg/l	58.50 + 21.76	38.50 + 17.77	70.17 + 70.43	55.72 + 44.53
15	**Fluoride**	1.5 mg/l	1.08 + 0.56	0.66 + 0.31	0.81 + 0.19	0.85 + 0.41
16	**Boron**	-	0.43 + 0.09	0.42 + 0.16	0.33 + 0.13	0.39 + 0.14
17	**Chloride**	600 mg/l	28.50 + 11.82	38.92 + 16.05	26.50 + 19.65	31.31 + 16.64
18	**Sulphate**	400 mg/l	6.47 + 2.83	4.39 + 2.70	5.64 + 3.98	5.50 + 3.25
19	**Total Alkalinity**	-	44.83 + 17.59	29.17 + 14.92	50.17 + 48.02	41.39 + 31.20
20	**P-alkalinity**	-	6.00 + 1.73	NIL	2.00 + 0.58	4.00 + 1.05
21	**Sodium**	-	13.00 + 5.74	9.37 + 3.20	13.27 + 9.83	11.86 + 6.86
22	**Potassium**	-	2.00 + 1.43	1.21 + 0.51	2.08 + 1.94	1.76 + 1.76
23	**Calcium**	-	22.67 + 13.08	16.17 + 14.18	31.83 + 40.52	23.56 + 25.99
24	**Magnesium**	-	35.83 + 13.00	22.33 + 7.48	26.00 + 14.49	28.18 + 12.94
25	**Phosphate**	-	0.68 + 0.43	0.29 + 0.27	0.35 + 0.33	0.44 + 0.38
26	**D. oxygen**	4.0 mg/l	5.47 + 1.89	5.57 + 0.33	5.67 + 0.24	5.57 + 0.27

Data Source – Maharashtra Pollution Control Board, + indicates Standard Deviation from mean

The river water analysis is carried out to show the general status of the river. Majority of the water parameters are within the prescribed standards of A-II River. pH of all the sample ranges in neutral as well as there is very minute deviation in its range. There is slight variation in the pH of all the three seasons. The parameters such as dissolved oxygen, fluorides, boron are within the limits and also show small deviation from its average reading. These parameters do not show much deviation during seasonal change. The electrical conductivity shows variation during summer and other two seasons i.e. winter and rainy season The B.O.D. level of sample is slightly exceeded than the limits. There is a small variation in the number of total coliforms in three seasons however large variation is visible between number of total coliforms and fecal coliform number in all the three seasons. The presence of coliforms indicates the fecal contamination in the river water. The levels of C.O.D., TKN, T.S.S., turbidity, potassium, ammonia and nitrates show variation from the average parameters readings. The parameters such as conductivity, total fixed solids, TDS, hardness, chlorides, sulphates, total alkalinity, sodium, calcium and magnesium show higher variation from their average reading. These parameters are dependent on the ions in the water. As per the season the discharge of pollutants in the water also varies which give rise to higher deviation from average reading.

5.2 Koyna River Water Analysis -

All the components mentioned in chapter IV were responsible for changing the river water quality. To define the water quality of river Koyna sampling of river water was carried out. Sampling stations were identified on the basis of earlier river water analysis results for various sampling stations and a pilot field survey of river stretch. Total of 8 sampling sites were identified. During the May 2014 from all the sites river water samples were collected. 15 parameters of water were tested. For the second round of sampling among the 8 samples 4 sampling sites were identified for sample collection. In the month of October 2014 from 4 identified sites samples were collected for analysis.

The following table show the details of sampling sites.

Table no 5.2   Details of Sampling Sites

Sr. No.	Station No.	Name
1	1	Koy-1 Dam Downstream- Bridge at Karad to Chiplun Road
2	2	Koy-2 Vittalwadi (Patan Upstream)
3	3	Koy-3. Patan Downstream
4	4	Koy-4. Navarasta To Gavhanwadi
5	5	Koy-5. Nisre To Sonaichiwadi
6	6	Koy-6. Old Sakurdi To Tambave
7	7	Koy-7. NH4 Bridge (Karad Upstream)
8	8	Koy-8. Karad Vita Bridge

Table no 5.3 Koyana River Water analysis (May 2014)

		Sample Site No.								
Sr. No.	**Parameters**	**Units**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	pH	-	6.83	7.05	7.09	7.16	6.96	7.28	7.1	7.05
2	Electrical Conductivitiy	µmhos/cm	64.3	74.8	73.8	81.4	89.7	87.6	270	270
3	Temperature	°C	26	25	27	29	28	29	29	30
4	Total Dissolved Solids	mg/l	45.65	53.11	52	57	60	62.2	193	185
5	Total Solids	mg/l	47.55	55.51	53.4	58.8	64.4	67.1	199.1	199.2
6	Turbidity	NTU	4.1	5	2.9	2.9	11.1	11	15.6	33
7	Dissolved Oxygen	mg/l	7.5	7.6	6.6	7.22	7	6.6	Nil	48
8	BOD 5 at 20°C	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	1.2
9	COD	mg/l	3.2	Nil	Nil	Nil	1.6	Nil	Nil	3.2
10	Hardness	mg/l	30	32	36	40	36	36	108	124
11	Nitrates	mg/l	0.02	0.04	0.04	0.09	0.54	0.11	1.26	1.37
12	Phosphates	mg/l	0.23	0.092	0.23	0.018	0.22	0.1	0.23	0.12
13	Fluorides	mg/l	1.345	0.77	1.373	1.108	1.756	1.064	1.49	1.079
14	Oil and Grease	mg/l	Nil	Nil	-	Nil	Nil	Nil	Nil	Nil
15	Most Probable Number	100/ml	40	40	-	25	20	14	40	225

Table no 5.3 River Water analysis (October 2014)

		Sample Site No.				
Sr. No.	**Parameters**	**Units**	**1**	**3**	**7**	**8**
1	pH	-	7.44	7.06	7.44	7.35
2	Electrical Conductivitiy	µmhos/cm	70	180	100	190
3	Temperature	°C	25	25	25	25
4	Total Dissolved Solids	mg/l	50	130	70	135
5	Total Solids	mg/l	52	132	72	140
6	Turbidity	NTU	1.5	0.9	1.9	4.6
7	Dissolved Oxygen	mg/l	7.8	7.8	7.1	7.2
8	BOD 5 at 20°C	mg/l	Nil	Nil	Nil	Nil
9	COD	mg/l	Nil	Nil	Nil	2.0
10	Hardness	mg/l	76	152	324	260
11	Nitrates	mg/l	1.32	0.40	1.28	0.70
12	Phosphates	mg/l	0.18	2.08	0.21	0.20
13	Fluorides	mg/l	0.53	0.74	0.74	0.71
14	Oil and Grease	mg/l	Nil	Nil	Nil	Nil
15	Most Probable Number	100/ml	12	120	80	250

- Sample site no 1 is Koyna 1 – dam downstream – bridge at Karad to Chiplun road – The sampling site didn't influenced by domestic sewage. The parameters show the water was clear and negligible contamination on the site. However only hardness levels are considerably increased in October 2014 than May 2014 levels. This might be because of high water levels during rain and heavy discharge of water from dam which carry dissolved matter with it.

- Sample Site no 2 is Koyna 2 Vitthalwadi (Patan Upstream) – show similar results to that of earlier site. The water was clear and non-contaminated. During October 2014 sampling this sample did not show any considerable changes in parameters carried out on the site.

- Sample Site no 3 Koyna 3 (Patan downstream) – the water parameters show slightly higher results especially hardness and fluorides during May 2014. Electrical conductivity, TDS and TS levels were increased during October 2014 sampling. This may be because of discharge of domestic sewage from Patan city and the waste from dairy industry enter into the Koyna river.

- Sample Site no 4 Koyna 4 (Navarasta to Gavanwadi) – the sample does not show significant contaminants in the water. Only the electrical conductivity seems to be increased slightly. During October 2014 sampling this sample did not show any considerable changes in parameters carried out on the site.

- Sample Site no 5 Koyna 5 (Nirase to Sonyachiwadi) – the water parameters and field observation interpret that there is very negligible discharge from industries which do not alters the quality of river water. During October 2014 sampling this sample did not show any considerable changes in parameters performed on the site. This might be because of dilution after rainy season.

- Sample Site no 6 Koyna 6 Old Sakurdi to Tambave) - the sample performed in May 2014 did not show significant contaminants in the water. Only the electrical conductivity seems to be increased slightly which is an indicator of presence of ions in the water. The sampling performed in October 2014 also did not show significant contamination in the water.

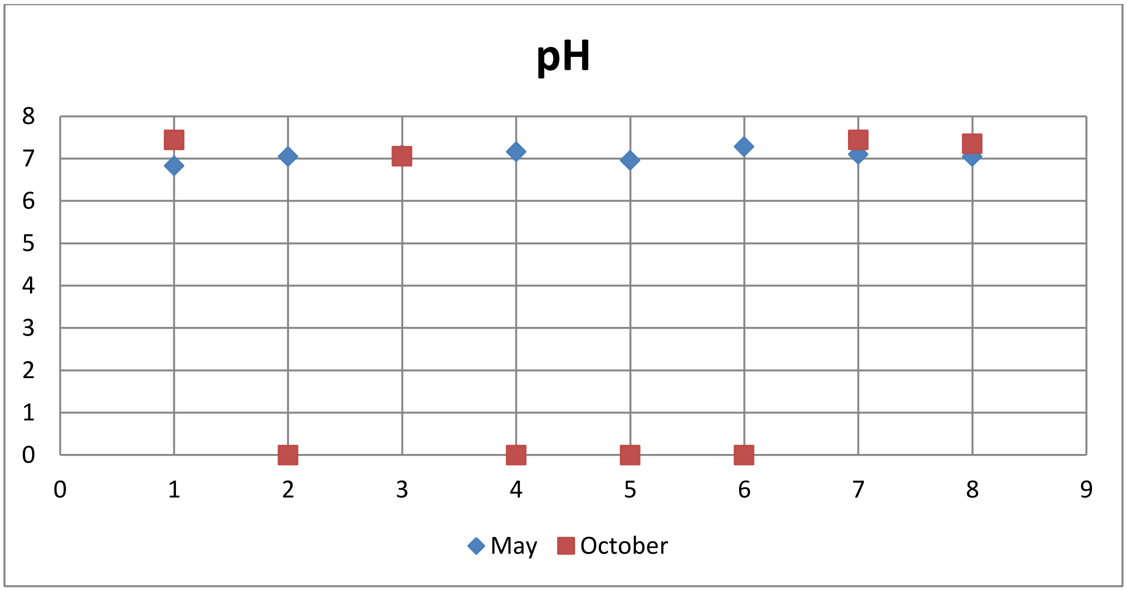
- Sample Site no 7 Koyna 7 NH4 Bridge (Karad Upstram) – the water sample from this site show very poor dissolved oxygen level in May 2014, on the contrary during October 2014 the dissolved oxygen levels are higher. High electrical conductivity levels were recorded during May 2014. During October 2014 electrical conductivity, TS and TDS levels were reduced. These parameters are dependent on the ions in the water; but in the downstream the particulate matter in the water gets settled due to reduced riverbed slope, K. T. weirs and its meandering. There were large chances of hospital waste, domestic sewage and sugar industry's effluent disposal in this stretch.

- Sample Site no 8 Koyna 8 (Karad – Vita bridge) - the water sample from this site show very poor dissolved oxygen level, high electrical conductivity levels during May 2014. The sewage from Karad and Malakapur city enter into the river. There was sugar industry in the stretch. The treatment of Krishna and Sahyadri hospitals were also treated in the area. However the levels of the treatment plants were lower than that of river level which may increase the possibility of contamination of river water with hospital waste. Levels of these parameters were reduced during October 2014. This might be because of high levels of river water after monsoon and low elevation of river bed.

From over all analysis it was evident that the parameters such as electrical conductivity, Total solids, total dissolved solids and hardness were noted to be increased at some of sites in upstream. However, at some of the sites especially in the downstream region these parameters were recorded with slightly decrease in their levels in October 2014 than May 2014. At upstream of the river sudden discharge from dams and higher slope of river bed the chances of siltation are more. As a result the parameters such as electrical conductivity, Total solids, total dissolved solids and hardness are observed more than that of downstream. The decrease in the levels of readings of parameters could have taken place due to higher levels of water in the river due to rain, settling of particulate matter during meandering of river as well as the Kolhapur type of weirs. For better understanding of the pattern of river pollution the graphical presentation of certain parameters is carried out which is as follows:

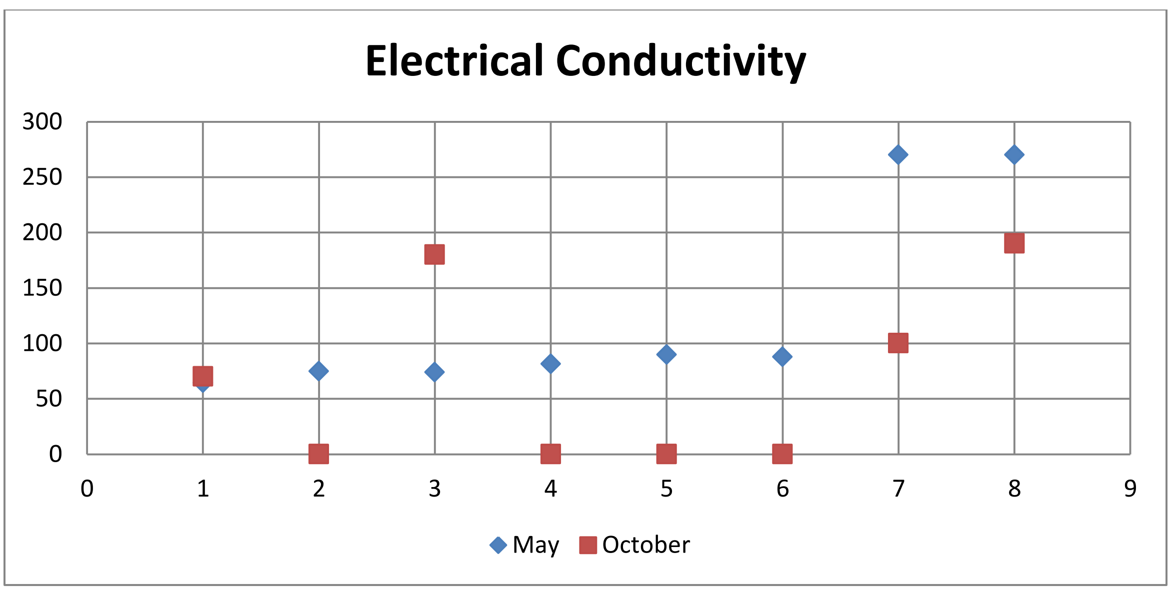
The sudden drops to zero levels in all the graphs during October month are recorded because at these stations further investigations were avoided. On site testing and other observations did not show any considerable pollution levels at these sites.

Fig. 5.1 Water parameter pH



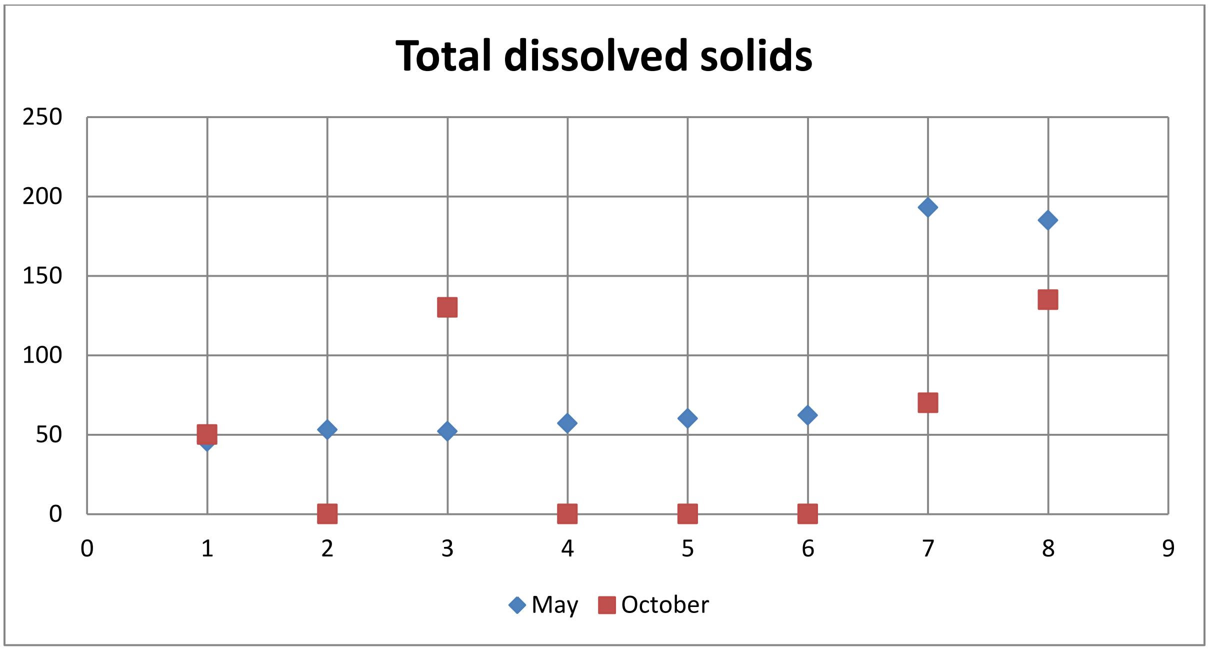
The pH levels of the samples at all the 8 stations lied between the range of 6 to 8 which is a neutral pH range. Slight variation was noted during two sampling periods. For the four sampling stations i.e. 2, 4, 5 and 6 in October 2014 samples were not collected.

Fig. 5.2 Water parameter electrical conductivity



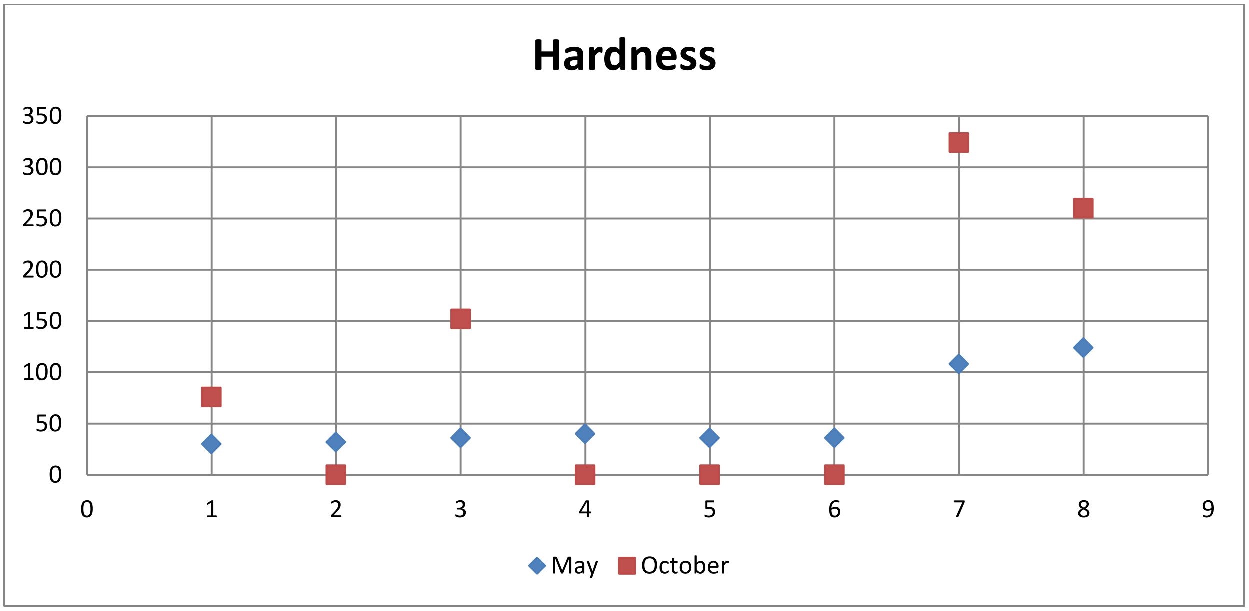
The electrical Conductivity of the water is dependent on the ions in the water. It ranges between 50 µmhos/cm to 300 µmhos/cm. At upstream of the river the electrical conductivity readings were observed increased during October 2014 while at the downstream it was decreased. This decrease in the levels of readings could be due to higher levels of water in the river due to rain, meandering of river, sandy river beds as well as the Kolhapur type of weirs.

Fig. 5.3 Water parameter Total Dissolved Solids



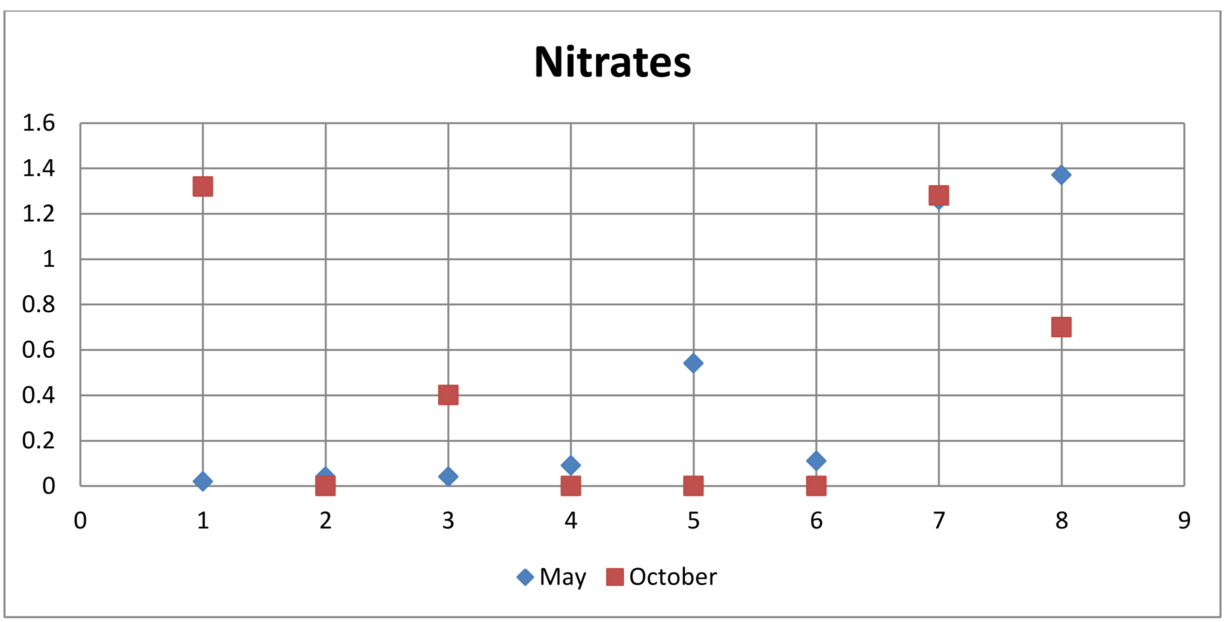
The TDS of the water is dependent on the ions in the water. It ranges between 50 mg/L to 200mg/L. At upstream of the river the TDS readings were observed increased during October 2014 while at the downstream it was decreased. This pattern was similar to that of electrical conductivity as both the parameters are interdependent. This decrease in the levels of readings could be due to higher levels of water in the river due to rain as well as the Kolhapur type of weirs.

Fig. 5.4 Water parameter Hardness



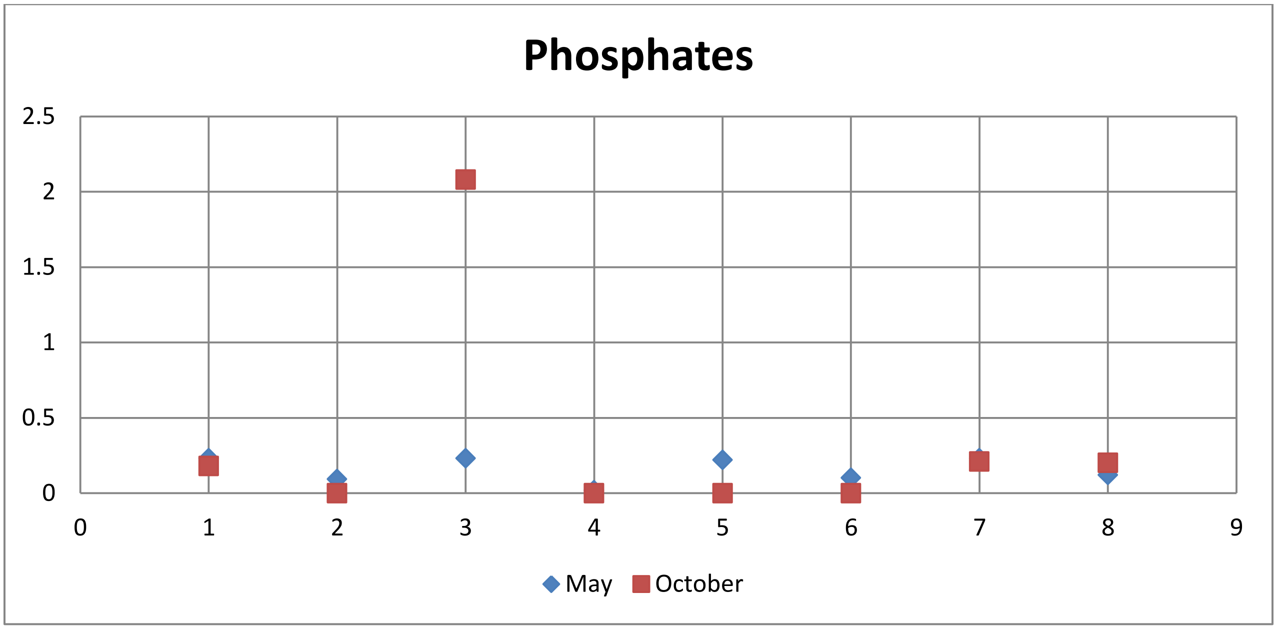
The hardness of the river water lies in the rage of 20 mg/L to 350 mg/L. the levels of hardness are fluctuating in upstream and downstream during May 2014. In May 2014 for first 6 sampling site hardness is more or less similar and for further area it increased. However, the levels of hardness are increasing during October 2014. with this discharge of non-point source pollutant also play important role in this fluctuations.

Fig. 5.5 Water parameter Nitrates



The nitrates levels in the water are less than 1.5 mg/L. The sources of nitrates in the water are domestic sewage, agricultural runoff and animal washing, cloths washing activities. The levels of nitrates are more during May 2014 than October 2014. However in general the average levels of nitrates are low.

Fig. 5.6 Water parameter Phosphates



The phosphate levels in the water are less than 2.50 mg/L. Only at one sampling station in upstream this was recorded higher than other stations. The sources of phosphates in the water are domestic sewage, agricultural runoff and animal washing, cloths washing activities. The levels of phosphates were more or less similar during May 2014 than October 2014. However in general the average levels of phosphates are low.

All the samples except few with lowered dissolved oxygen were within the standards of water prescribed for A –II type of river. There are number of obstacles in the river such as K. T. weirs, bridges, etc. which break the continuous flow of the rivers and convert rivers into chain of pools. The industries, sugar industry, dairy and other red as well as orange category industries are also contributing in river water pollution. The urban and rural centres on the banks of the river release their domestic sewage into the river. Hospital in the river basin and near to river bed are releasing their partially treated or untreated hospital waste into the river water. Religious places on the bank of river including pilgrimage at confluences are adding pollutant load in to the river. Removal of fertile soil from the banks of the rivers for brick making is causing changing the river bank. Animal waste from animal husbandry also causes a considerable amount of pollution which has always remained overlooked. This needs to identify in detail. Moreover the anthropogenic activities such as washing of animals, vehicles, cloths and bathing are also contributing the river water pollution.

Though the analysis of water shows various parameters lie within the A-II limits for river, all these activities are causing pollution of the river. The release of effluent or other waste water into the river causes sudden shock i.e. sudden changes in the water quality at the local area which further leads to fish kills. Hence it is essential to seek for the possible polluting agents along with the river water analysis.

5.3 Biomedical liquid waste nala sample analysis –

Two major hospitals namely Krishna Hospital and Sahyadri Hospital are located on the confluence of river Koyna river and Krishna river. 9 parameters were tested which include pH, total solids, total dissolved solids, total suspended solids, chlorides, sulphates, COD, BOD, oil and grease and heavy metals like FE, Zn, Cr, Hg. Their sampling codes are as follows:

Table no. 5.4 Details of sampling locations

Sr. No.	**Code**	**Name of the Location/ Industry**
23	23	Sahyadri Hospital
24	24	Krishna Hospital

Table no 5.5 Water analysis of samples from industries and domestic sewage nalas

SR.	Sample code	pH	T.S.	TDS	TSS	Cl	SO4	COD	BOD	O&G
1	H 1	6.79	1520	1500	20	220	18	128	40	00
2	H 2	6.79	200	170	30	100	62	18	10	00

Sample no 1 was collected from the outlet of SPT of Sahyadri Hospital. The COD and BOD levels are within the standards. However the TS, TSS and TDS are on higher side. The location of the STP is of major issue. This STP is located just 500 m away from river bed which is in floodline of the river. During the flood times there is strong possibility that this STP can go under the water creating a serious threat to the nearby areas. In case Krishna Hospital untreated sewage from hospital is directly discharged into the river water. Though the parameters show lower levels, direct discharge of the hospital liquid waste into water is creating a serious threat to large population.

Chapter – VI
Recommendations

6.1 River water management –

River water management is a crucial component which plays a key role maintaining river ecosystem and its health.

- Irrigation department, Maharashtra Pollution Control Board, agricultural department, MIDCs, concerned corporations, local bodies and other stake holders should take responsibility of maintaining river flow.
- The existing structures of K. T. weirs are creating problems in terms of flow of the river and siltation in the river bed. The doors of weirs should be opened mechanically from downward direction which will maintain continuous flow of river.
- It is essential to do modifications in the designs and working of K.T. weirs. For such alterations in the design and working of weirs, help can be taken from institutes like Maharashtra Engineering Research Institute, which will maintain the river flow, ecosystem of river including its biodiversity and water quality.

6.2 Domestic sewage

There is no proper treatment facility available for domestic sewage. Domestic sewage generated directly or indirectly enters in to river water through nallas in the villages and cities. This is enriching the river water with nutrients leading towards patchy growth of water weeds and algae. It has also causing frequent outbreak of waterborne diseases in the river basin. It is necessary to treat sewage and avoid its entry into river.

- **For small villages (population less than 1000) –** root zone technology, phyto remediation technique can be used which may be appropriate at locations. Decentralized systems or clusters or collective systems can be developed for sewage treatment. After treatment this water can be reused for irrigation or other purposes.

- **For small villages or municipal councils (Population 1000 to 10000) –** underground drainage system (100%) can be developed. Sewage from such system can be collected together and treated with trickling filter technique or phyto remediation or facultative lagoon techniques or with combination of these techniques. Land should be allocated or kept reserved for treatment plants considering the future growth of village of towns. Considering the geographical features and feasibility cluster of two or more villages or towns can be made and following suggested techniques such as SBR, ASP, UASB and MBBR can be used to treat sewage.
- **For towns and cities (Population more than 10000) –** underground drainage system (100%) can be developed. Separate STP should be developed. Techniques such as Activated sludge process (ASP), Sequential batch Reactor (SBR), Movable Bed Bioreactor (MBBR), Upflow anaerobic sludge blanket (UASB), etc. can be used for treating sewage. Appropriate technique can be used.
- Treated sewage should be reused and should not be allowed to enter into the river.

For detailed management of domestic sewage a comprehensive study should be carried out for every village, towns and cities.

6.3 Solid Wastes

Solid waste disposal is the major issue in the river basin. There is no proper system for segregation, treatment and disposal of municipal solid waste, industrial waste, hazardous waste. Treatment provided to biomedical waste is also insufficient. There is no proper system observed for disposal of waste from slaughter house. This may lead to serious health and hygiene problems in the study area. Hence further recommendations are made:

- Municipal solid waste should be segregated at the time of collection and needs to be properly treated and disposed off. For this appropriate location should be allocated at every village or cluster of villages can also be made, at every town and city. A system should be put in place for collection of wastes. Along with this proper treatment should be given to the waste. Decentralised units can be developed for treating solid waste.

- The places should be identified and allocated where building / construction demolition waste is to be disposed off. Care should be taken to see that this waste does not enter the river or stream.
- The wastes created out of religious rites and rituals coming from temples, organic wastes from gardens should be composted which achieve the dual purpose of disposal and reuse.
- Waste processing centres should be established separately for industries, industrial areas and MIDCs
- There should be compulsion / it should be mandatory to treat hazardous wastes from industries separately.

For this detailed management of solid waste a comprehensive study should be carried out urgently.

6.4 Issues of Industries and sugar Industries

Industries and sugar industries are major polluting agencies in the river basin. Certain changes needs to be carried out to prevent pollution caused due to industries.

- Sugar industries as well as other industries prominently use wood as a fuel. This wood comes from the extremely fragile and ecologically sensitive Western Ghats. The permission given to factory for use of fuel should be changed to diesel, ethanol, gas, kerosene, bagasse, etc. This will prevent tree felling and also eliminate the issue of air pollution and ash.
- All obsolete and outdated technologies should be changed and it should be made mandatory for the industry to follow up to date technologies.
- While setting up new MIDC's care should be taken to maintain its distance from flood line, water resources as well as RRZ should be followed strictly.
- Waste management units treating solid wastes, hazardous wastes should be set up at appropriate location in the MIDC's.

- For treating effluent CETPs should be built at every MIDC. Quantity and quality of total effluent and sewage generated in industrial area needs to be consider and then only appropriate technology should be used for CETP and STP. Continuous monitoring of working of CETP and STP is essential. Treated effluent should be disposed off at HRTS instead of agricultural land or river.
- To treat industrial effluent and domestic sewage together produced within industry or MIDC will not be feasible every time or place. Hence, as per characteristic of effluent and treatment technology both waste water should be treated separately or collectively.
- It should be made mandatory for all industries to fill up annual returns about pollutants being released from its processes and efforts taken for treatment on it.
- A time bound program has to be implemented for zero discharge from industries.
- Sugar industries should not start their season without NOC from MPCB. Over crushing from sugar industries should be avoided.
- Kachha lagoons maintained for storing untreated or partially treated effluent of industries, sugar industries and distilleries. Such lagoons are needed to be demolished.

Appropriate site and techniques for CETP should be identified after detailed study of MIDCs and characters of effluent generated by industrial units.

6.5 Religious and other activities causing pollution

As a part of tradition each house in the village and city celebrates festivals like the Ganapati or the Durga Puja. At the end of the festival idols of the Gods are immersed in water. As result the mud of idols, plaster of paris, synthetic colours used along with decorative pieces end up polluting the water. Along with this the material used for the puja, offerings to the God in form of ‘Navaidya’, nirmalya (flowers used for the puja) add to the pollution load. These practices are commonly found all across the river banks.

- As per the directives given by the Hon high court in case of Panchaganga river pollution, Godavari river Pollution; all Local self-Government Bodies are supposed to build special permanent waterbodies – Visarjan Kund's for the purpose of idol immersion but none of the bodies have carried out their duties.
- It is essential to create awareness, build special kundas' for the idol immersion or come up with other feasible alternatives for this purpose.
- Separate Raksha kund needs to be built for cremation ash disposal. Moreover electric cremation units are need to installed in clusters, cities and people are need to be made aware for its use.

6.6 Agricultural runoff -

Agricultural runoff is another important component leading towards water pollution which carries pesticides, fertilisers and heavy metals. These pollutants have long term harmful impacts on the biodiversity and human population.

- Considering these fact strict regulations are need to be maintained on the use of chemical fertilisers and pesticides. A care should be taken to restrict the entry of banned chemical pesticides in the market.
- Agriculture department and MPCB should take necessary actions to control the use of chemicals in the fields.
- Awareness should be created among the farmers on the use of chemicals in the fields.

6.7 Other recommendations

- River banks are facing problem of outflanking at many places. Plantation on the banks of rivers should be strictly carried out to avoid such incidences and to maintain the river course.
- Activities like soil excavation, brick making on the banks of rivers are altering the river banks. Such activities should be strictly prohibited upto 500 m from high flood line.
- Widely occurring unscientific sand excavation is altering the river bed and having impact on river ecosystem. This should be banned permanently.

- Encroachments, depositions, reclamation, constructions or any kind of development should be strictly prohibited on the banks or in the beds of streams, nallas, rivers up to minimum of 9 m distance from high flood line.
- Lands should be allocated and reserved considering future population growth in city development plans and regional plans for MSW, BMW, sewage and industrial effluent treatment plant, disposal sites, slaughter house, hazardous waste. While allocating such areas geographical and environmental conditions are need to be considered.
- For effective and feasible solutions of these pollution issues a detailed, scientific, site specific study needs to be carried out urgently to avoid further damage to river environment.
- All the above mentioned recommendations can be more effective and implementable if they are executed at the basin and sub-basin level instead of considering administrative boundaries.

Executive Summary

of

Comprehensive Study Report on Koyna River

(Koyna dam to confluence with Krishna River, Karad)

Submitted by

MITRA

(Mass Initiative for Truth Research & Action)

2014

Executive Summary for Koyna

Koyna report was undertaken at the behest of CPCB as a part of its endeveour to study polluted river stretches in India. The extent of study was from Koyna Dam to Krishna Koyna confluence at Karad. The Koyna River is a tributary of the Krishna River which originates in Mahableshwar, Satara district, Western Maharashtra, India. It rises near Mahabaleshwar, a famous hill station in the Western Ghats. The Koyna River Basin generally trends North – South and covers an area of 2,036 km^2 in the Deccan terrain of the district of Satara in the state of Maharashtra, with an elevation range of 550 – 1,460 m above msl.

- Origin of Koyna River – Mahabaleshwar, Satara
- Total extend of Koyna river basin - 258,948 Km^2
- No of tributaries and sub-tributaries of Koyan river in Maharashtra – 4
- **Details of Koyna river, its tributaries and sub-tributaries**
  - No of dams – 3
  - No of K T Weirs - 4
  - Area under irrigation – 640 Ha
  - Total power generation – 147.844 MW/ Yr

(TOR – 1)*

Population of districts and Domestic Sewage generation in Koyna River Basin in Maharashtra

District	**Taluka**	**No. of Town/ Village**	**Population**	**Domestic sewage (Lit/ day)**
01	02	555	841519	84151900

Average sewage generation by a person is 100 Lit per day

(TOR – 3)

Details of Agriculture in the Koyna river Basin in Maharashtra

- **Land use in the Krishna river Basin in Maharashtra**

District	Taluka	Forest land (Ha)	Non-agricultural land (Ha)	Cultivable land (Ha)	Total (Ha)
01	02	**38,322**	**21,804**	**2,20,545**	**2,80,671**

- **Number of Cattle and their water consumption in the Koyna River Basin in Maharashtra**

District	Foreign Hybrid Cows and oxen	Indian Hybrid Cows and oxen	Buffalos	Water consumption
01	20538	48236	142433	7121650

Average sewage generation by an animal is 50 Lit per day

- **Total Cultivated Area and Sale of Chemical Fertilisers in the Koyna River Basin in Maharashtra**

District	Land under cultivation (ha)	Sale of Fertilisers MT	Per hectare use MT
01	1021979	583784	1.75

(TOR – 2)

Details of Industries in the Koyna river Basin in Maharashtra

- **Category wise water consumption and effluent generation from Industries from the Koyna River Basin in Mahararashtra**

Category of Industries	Category	Water Consumption (CMD)	Industrial Effluent (CMD)	Domestic Effluent (CMD)	Total Effluent (CMD)
Red	3	1614.8	205.3	131.58	336.88
Orange	17				
Green	9				
Total	29				

Recommendations

River water management –

The concerened governmental agencies should maintain minimumwater flows in the river.

The design of K T Weirs should be modified to facilitate environmental flows.

Domestic sewage – (TOR – 5)

All domestic sewage should be properly treated and its entry inti river water should be prevented. The treatment can be carried out as follows-

1. **For small villages (population less than 1000) -–** root zone technology, phyto remediation techniques can be used.
2. **For small villages or municipal councils (Population 1000 to 10000) –** underground drainage system (100%) can be developed.
3. **For towns and cities (Population more than 10000) –** underground drainage system (100%) can be developed.

Solid Wastes

Municipal solid waste should be segregated at the time of collection and needs to be properly treated and disposed off. Wastes should be treated and disposed off properly depending on its type – for eg Waste processing centres should be established separately for industries, industrial areas and MIDCs, hazardous wastes from industries separately.

Issues of Industries and sugar Industries

Industries and sugar industries are major polluting agencies in the river basin.

- The permission given to factory for use of fuel should be changed to diesel, ethanol, gas, kerosene, bagasse, etc. This will prevent tree felling and also eliminate the issue of air pollution and ash.
- It should be made mandatory for the industry to follow state of art technologies.
- While setting up new MIDC's care should be taken to maintain its distance from flood line, water resources as well as RRZ should be followed strictly.

- Waste management units treating solid wastes, hazardous wastes should be set up at appropriate location in the MIDC's.
- For treating effluent CETPs should be built at every MIDC which have to be monitored.
- It should be made mandatory for all industries to fill up annual returns about pollutants being released from its processes and efforts taken for treatment on it.
- A time bound program has to be implemented for zero discharge from industries.
- Sugar industries should not start their season without NOC from MPCB. Over crushing from sugar industries should be avoided.
- Kachha lagoons maintained for storing untreated or partially treated effluent of industries, sugar industries and distilleries should be demolished.

Religious and other activities causing pollution

- It is essential to create awareness, build special kundas' for the idol immersion or come up with other feasible alternatives for this purpose.
- Separate Raksha kund needs to be built for cremation ash disposal. Moreover electric cremation units are need to be installed in clusters, cities and people should be made aware of its use.

Agricultural runoff

- Care should be taken to restrict the entry of banned chemical pesticides on the market.
- Agriculture department and MPCB should take necessary actions to control the use of chemicals in the fields.
- Awareness should be created among the farmers on the use of chemicals in the fields.

Other recommendations

- Plantation needs to be undertaken on the banks of rivers to avoid outflanking of banks and to maintain the river course.

- Activities like soil excavation, brick making are altering the river banks and should be strictly prohibited upto 500 m from high flood line.
- Unscientific sand excavation is altering the river bed and has an impact on river ecosystems. This should be banned permanently.
- Encroachments, depositions, reclamation, constructions or any kind of development should be strictly prohibited on the banks or in the beds of streams, nallas, rivers up to minimum of 9 m distance from high flood line.

Note- the details of the data required for TOR is present in the Original report.

TOR 1 In Chapter III

TOR 2 In Chapter V

TOR 3 In Chapter IV & V

TOR 4 In Chapter V

TOR 5 In Chapter VI

Action Plan for Koyna River Basin

Sr. no.	Particulars	Quantity			Short Term Measures	Long Term Measures	Preference
		Actual	Total	%			
1	**Domestic Liquid Waste**						
i	Patan (N A)		15.61		Arrest, Disinfection, reuse for agriculture	STP, Reuse for Agriculture	
ii	Malkapur (22392)	2.23 MLD		14.28			1
iii	Karad (71324)	7.13 MLD		45.67			1
iv	Villages (1000 – 10000 population) (46458)	4.64 MLD		29.72			1
v	Villages (< 1000 population) (16109)	1.61 MLD		10.31			2
2	**Industrial Effluent**						
I	Patan MIDC	2.4 CMD	337.78	0.71	Reduce, Reuse for agriculture	ETP, CETP, Reuse for Agriculture/ HRTS	1
ii	Non MIDC	335.38 CMD		99.29			2
3	**Solid Waste**						
i	Municipal Solid Waste	--			Quantification, DPR Survey	Propoer treatment	1
ii	Biomedical Solid Waste	--					1
iii	Hazardous Waste	--			----	Ranjangaon HW plant	1
4	**Other**						
i	Religious	--			Ban on immersion in natural water sources	Establishment of Visarjan Kund, Raksha Kund	
ii	Ganesh Idol Immerssion	--					1
iii	Brick Making	--			Immediate restrict the activity	Approval after EIA	1
iv	Sand Mining	--			Immediate restrict the activity	Approval after EIA	1

Photo Plate – Activities at River

Photo no 1

Photo no 2

Photo no 3

Photo no 4

Photo no 5

Photo no 6

Photo no 1 & 2 – washing of heavy vehicles in Koyana river

Photo no 3 – Washing of animals in river

Photo no 4 – Washing activities on the river bank

Photo no 5 – Rich biodiversity around Koyana river

Photo no 6 – Koyana river dam

Photo Plate – Status of River

Photo no 1

Photo no 2

Photo no 3

Photo no 4

Photo no 5

Photo no 6

Photo no 1 & 2 – Outflanking of river bank may lead to change in river course

Photo no 3 – Brick kiln on the Kera river bank

Photo no 4 – Growth of water hysinth and algae in Kera river

Photo no 5 & 6 – Dry river bed without water flow in Koyna sub-basin

Photo Plate – Pollution causing Activities near Koyna river

Photo no 1

Photo no 2

Photo no 3

Photo no 4

Photo no 5

Photo no 6

Photo no 1 & 2 – Effluent nalla from Balasaheb Desai Sugar industry, Marali flowing towards river

Photo no 3 – Solid waste dumping on the river bank at Patan

Photo no 4 – Waste segregation units at Koyna Industry, however are not in use

Photo no 5 – Sahyadri Hospital STP located bellow river bed level

Photo no 6 - Improper housekeeping, passing through compound wall sewage directly enters into river