Comprehensive Study Report on Krishna River Stretch

(Dhom dam to Rathare weir, Satara, Rethare wier to Rajaram Bandhara, Shirol, Sangli)

Submitted by

MITRA

(Mass Initiative for Truth Research & Action)

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Acknowledgement

Maharashtra Pollution Control Board had assigned the project of Comprehensive Study on Krishna River Stretch – Rathare weir to Rajaram Bandhara, Shirol, Sangli and Krishna River Stretch – Dhom dam to Rathare weir, Satara 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.

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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)

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Chapter I

Introduction

1.1 Background –

Earth is the only known planet to sustain life. The atmosphere, hydrosphere and lithosphere constitute biosphere and sustain life on earth. In the process of evolution various organisms appeared on the earth. Since the very beginning man was closely associated with environment for his basic needs. Environmental resources were subjected to various values such as utilitarian, cultural, ethical, aesthetic, medicinal, etc. There existed a reciprocal relationship between man and nature since time immemorial. This relationship between humans and environment has changed drastically over the last 10,000 years. As human culture changed from hunter-gatherer to agrarian to urbanization to industrial the impacts on environment became evident.

In the modern society, specifically during the post industrialization and agricultural revolution major changes took place in the environment. These impacts in the form of depletion of natural resources; deforestation; growing industrialisation; pollution of air, water and soil; intensified agricultural practises with excess use of chemical pesticides and fertilisers; growing urbanisation; ozone depletion; growing desertification; global warming; climate change; etc., are a point of concern worldwide. The book 'Silent Spring' authored by Rachel Carson gave a serious thought to environmental problems throughout the world. During the various 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 various environmental concerns were thoroughly deliberated upon. The problem of pollution and deteriorating quality of water resources - both surface and ground water were also a part of these deliberations. According to World Health Organisation (WHO) almost 1 billion people lack access to safe drinking water; about 2 million die annually due to diarrhoeal. These deaths are attributed due to unsafe drinking water, sanitation and hygiene.

Water has always been an inevitable part of human life; and rivers have played an important and life-sustaining role in human societies for thousands of

years. As such many of the world's great cities are found on the bank of a great river. 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. Even in today's modern world they are a major source of water for domestic, agricultural and industrial usage. The biodiversity of the river can be a rich source of food for the population residing on its banks. However most of the rivers of the world are highly polluted. The modern world requires a lot of water for a variety of reasons such as for domestic usage, washing, for processing, for industries, for agriculture, for power generation, etc. Excessive use of water is generating huge amount of effluent and waste water. Most of this waste water is directly or indirectly released into rivers which in turn deteriorates the quality of river water and further leads to serious problem of river pollution. 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 that top ten polluted rivers.

1.2 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 greatest stretches of the flat alluvium in the world the Indo-Gangetic Plains, 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. The Western Ghats that separate the mainland from the Arabian Sea run parallel to the west coast of India. The narrow strip of land formed in between is highly fertile and comprises mostly the state of Kerala.

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 are eastward flowing and pour their waters into the Bay of Bengal; while, some of the rivers have courses that run through the western part of the country empty into the Arabian Sea. The northern parts of India which includes parts of Ladakh, northern parts of the Aravalli range and the arid parts of the Thar Desert have inland drainage. 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

1.3 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. 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. 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. 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 are rich in a variety of flora and fauna. They include 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 that arise in the Western Ghats are of Godavari, Krishna and Kaveri. The Godavari has its source in the Sahyadris near Trimbakeshwar and is the largest river on the Indian plateau. 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. The

Ghataprabha, the Malaprabha, the Bhima, the Tungabhadra and the Musik are the principal tributaries joining Krishna. Number of small rivers, perennial streams also originates in the Western Ghats.

1.4 River Krishna -

Krishna River originates in Mahabaleshwar with the basin extend of over an area of 258,948 square kilometres which is nearly 8% of the total geographical area of the country. This large basin lies in the states of Karnataka (113,271 km^2), Andhra Pradesh (76,252 km^2) and Maharashtra (69,425 km^2). The details of the basin are as under:-

Salient Features of Krishna Basin in India	
Basin Extent Longitude Latitude	 73° 17’ to 81° 9’ E 13° 10’ to 19° 22’ N
Length of Krishna River (Km)	1400
Catchment Area (Sq.km.)	258948
Average Water Resource Potential(MCM)	78120
Utilizable Surface Water Resource (MCM)	58000
Live Storage Capacity of Completed Projects (MCM)	50117.00
Live Storage Capacity of Projects Under Construction (MCM)	4287.00
Total Live Storage Capacity of Projects (MCM)	54404.00

The Krishna River is one of the longest rivers in the India, which flows for about 1300 km and outfalls into the Bay of Bengal. It rises in the Western Ghats, at an elevation of about 1337 m just north of Mahabaleshwar, about 64 km from the Arabian Sea. The principal tributaries joining Krishna are Koyna, Bhima, Mallaprabha, Ghataprabha, Yerla, Warana, Dindi, Musi, Panchaganga, Dudhganga, etc. Table no 1.1 shows the details of some of the major tributaries of river Krishna which includes drainage area, length of the rivers and elevation of river origin area.

Geographically most of this basin comprises of rolling and undulating country, except for the western border, which is formed by an unbroken line of the Western Ghats. The important soil types found in the basin are black soils, red soils, laterite and lateritic soils, alluvium, mixed soils, red and black soils and saline and alkaline soils.

As per calculations an average annual surface water potential of 78.1 km^3 has been assessed in this basin. Out of this, 58.0 km^3 is utilisable water. Cultivable area in the basin is about 203,000 km^2, which is 10.4% of the total cultivable area of the country.

1.5 Status of Rivers in India –

Like the rivers of the world, rivers in India are also suffering from the problem of pollution. In fact a report of the Planning Commission published in 2007 states that only four major river basins out of 23 are perennial while the remaining may go dry during summers leaving no water for dilution of waste water discharged in them. It further states that DO levels in the waters of Ganga, Yamuna, Krishna, Sabarmati, Tapi, Sutlaj however, go as low as 0.3 mg/l. The ground water quality also in many places exceeds limits of nitrates, fluorides and Arsenic. Traces of heavy metals, insecticides and pesticides have also been reported from sites near urban areas and Industrial estates.

The Government of India has taken cognisance of this fact. The Central Pollution Control Board (CPCB) is monitoring the water quality in India under National Water Quality Monitoring programme (NWAMP). This monitoring network comprises of 1429 stations in the country. The monitoring network covers 239 rivers with 810 stations, 94 lakes with 102 stations, 9 tanks, 41 ponds, 15 creeks, 23 canals, 18 drains and 411 wells. The analysis of water quality data from 2002 CPCB has identified 150 polluted river stretches in the country based on Bio-chemical-Demand (BOD)," In these rivers there are 27 rivers from Maharashtra. The most polluted rivers in the states are Bhima, Godavari, Mula & Mutha, Pawana, Panchaganga, Patatlganga, Indrayani, Koyna, Kundalika, Kalu, Kanhan, Kolar, Mithi, Tapi, Gira, Nira, Wainganga, Wardha, Krishna, Purna, Nira, Chandrabhaga, Venna, Ulhas, Rangavali and Bhatsa.

Certain efforts have been initiated by the government for abatement of pollution in identified polluting stretches under the National River Conservation Plan (NRCP) and National Ganga River Basin Authority (NGRBA). The NRCP including NGRBA presently covers 42 rivers in 195 towns spread over 20 states at a sanctioned cost of Rs 9336.87 crores. Only 4 rivers from Maharashtra are incorporated in the NRCP namely the Panchaganga, Tapi, Krishna and Godavari. However the there are numerous small rivers and tributaries which are polluted and need to be considered for cleanup. However mere inclusion of rivers in the NRCP is not enough for abatement of river pollution. The comprehensive studies of point and non-point sources of pollution from the basins of the rivers need to be identified and treated respectively with people's participation.

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. The comprehensive study 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.

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.

2.2 Methodology –

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

2.3 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. For some of the selected samples heavy metals such as iron, zinc, chromium, mercury and pesticides were also analysed to report the severity of pollution and to suggest mitigation measures. 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
16	Heavy Metals		
16.1	Iron	mg/l	APHA 3500-Fe
16.2	Zinc	mg/l	APHA 3500-Zn
16.3	Chromium	mg/l	APHA 3500-Cr
16.4	Mercury	mg/l	APHA 3500-Hg
17	Pesticides		APHA 6630

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 Kolhapur, Sangli and Satara Districts in the form of census, reports, maps, resolutions of various government departments.

To define the water quality of river Krishna and its tributaries 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	9	Kri-1. Dhom Downstream
2	10	Kri-2. Wai upstream near Menawali
3	11	Kri-3. Wai downstream near Songirwadi
4	12	Kri-4. Ozarde Upstream
5	13	Kri-5. Bhuinj Downstream
6	14	Kri-6. Near Limb
7	15	Kri-7. Sangam Mauli
8	16	Kri-8. Kanher Dam Downstream (Near Nele)
9	17	Kri-9. NH4 Bridge

10	18	Kri-10. After MIDC (Near Mahagaon)
11	19	Kri-11. Near Kameri (Rahimatpur)
12	20	Kri-12. NH4 Near Nagthane (River Urmod)
13	21	Kri-13. Near Umbraj (River Tarali)
14	22	Kri-14. Karad Old Bridge (Wooden Bridge)
15	23	Kri-15. Tembhu Downstream
16	24	Kri-16. Rethare Downstream (Kole)
17	25	Kri-13A. Bridge at Umbraj Masur Road
18	26	Kri-17. Takari Bridge
19	27	Kri-18. Near Ankalkhop
20	28	Kri-19. Kasabe Digraj Upstream
21	29	Kri-20. Sangli Upstream
22	30	Kri-21. Haripur Sangli Upstream
23	31	Kri-22. Kolhapur Sangli Road
24	32	Kri-23. Nrusinhawadi
25	33	Kri-24. Terwad (River Panchganga)
26	34	Kri-25. Rajapura well
27	35	Kri-26. Warnanagar Upstreams
28	36	Kri-27. NH4 (River Warana)

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

Introduction -

As per the directions of CPCB and letter of MPCB for the comprehensive study of Krishna River stretch involves area from Dhom dam to Rethare weir, Satara and Rethare weir to Rajapur Bandhara, shirol, Sangli. The Krishna River originates in Mahabaleshwar in the Western Ghats. It is one of the major rivers in Maharashtra. The river basin in Maharashtra extends from lat $18^0$03' N to long $73^0$34' E covering 69,425 Km^2 area which contributes about 26.81% of total area of Krishna River basin. The length of Krishna river in Maharashtra is 342.02 Km. It is one of the major water source, which supports 2536 major cities, towns and villages along with a population of 68,94,862. The Krishna river stretch covers area from 21 talukas of the three districts namely, Satara, Sangli and Kolhapur.

3.1 Geographical Details of the Krishna River Basin area in Maharashtra –

The Krishna river basin stretch of Maharashtra covers area from 21 talukas of the three districts namely, Satara, Sangli and Kolhapur. Satara, Sangli and Kolhapur districts partially fall in Western Ghats which makes this area ecologically fragile and rich in biodiversity. The climate of the area is temperate in plains and cool in Western Ghats. The Eastern region represents dry weather and it experiences hot winds during April and May. The nights over the entire district are generally cool due to the influences of the sea Breezes. This area is a known origin of number of rivers.

In Satara district has 93 Km length of Sahyadri ranges which constitutes western border of district. Mahabaleshwar and Koyana basin is covered with thick vegetation while rest of the area is dominated with scrubby vegetation. This area has undulating landforms. The average temperature range is 11.6^0C to 37.5^0C. This western part of the district receives rainfall upto 5000 mm while the northern part of the district receives rainfall lower than 500 mm. Number of rivers originate from the western mountain ranges of the district. Krishna is a one of the major rivers. Other rivers such as Koyana, Venna, Kudali, Urmodi, Vasana, Tarali are the tributaries of Krishna. The length of Krishna river in Satara district is about 160 Km.

Sangli district is adjacent to Satara district from its northern side while on its southern side Kolhapur district is there. Western part of district is dominated with mountain ranges which receive high rain fall while eastern part of district has draught prone dry region. Krishna, Warana and Yerala are the major rivers in the region. The average temperature ranges from 14^0C to 42^0C and the average rainfall of the district is 650 mm. Krishna River from Satara district flows into Sangli district. The length of Krishna river in Sangli district is 130 Km. The Warana river flows 173 Km in the district from its south- eastern side. While the length of other rivers in the districts such as Yerala, Agrani, Maan and Bor is 85 Km, 85Km, 35 Km and 64 Km respectively.

Kolhapur district has Sahyadri ranges on its western side. The climate of the district is temperate in plains and cool in Western Ghats. The Western Ghats receive the heavy rainfall and Gaganbavada which receives an average rainfall 5000 mm. Shirol and Hatkanangle talukas record poor rainfall around 500 mm. Krishna, Warana, Panchaganga, Dudhganga, Vedganga, Hiranyakeshi, Ghatprabha are the major rivers in the district. Warana River flows on the border of Kolhapur and Sangli. The Panchaganga River system is formed by the tributaries namely the Bhogavati, the Kasari, the Kumbi, the Tulsi and the Dhamani. The total length of Panchaganga river systemalong with its tributaries is 338 Km.

Krishna and her tributaries are the life lines of the entire area which flourish this region.

3.2 Hydrology of Krishna River Basin in Maharashtra –

There are total of 11 major tributaries and 13 sub tributaries of Krishna River which originate in the Western Ghats and pour water into Krishna River. The main tributaries of Krishna are Venna, Urmodi, Tarali, Uttar mand, Koyana, Dakshin Mand, Warana, Panchganga, Dudhganga and Yerala. The sub-tributaries of Krishna River that have a confluence with the major rivers are: Vasna – Vangna; Koyana –Kera, Vang, Morna, Mahind; Warana – Morna, Kadvi; Panchganga – Bhogavati, Kumbhi, Kasari, Tulashi, DHamani; Dudhganga – Vedganga.

Venna River originates in Mahabaleshwar similar to Krishna River. The length of river is 58.36 Km and the major dam on river is Kanher, its confluence with Krishna River is at Sangam mauli. Urmodi River originates at Kaas meets to Krishna after 50.52 Km at Kashil, Rahir is a major dam on the river. Tarali river and Uttar mand river originates respectively at Jagminwadi and Padolshi. The respective lengths of the rivers are 46.25 Km and 27.66 Km which further have a confluence with Krishna at Umbraj. There is medium sized dam on each of the river. Dakshin Mand originates at Gotewadi, has a medium dam on it at Shelkewadi. River Yerala originates at Mol from eastern side. There is medium dam on the river. This river meets Krishna river after travelling 139.45 Km at Bramhanal.

The Vasana River after the confluence with river Vangana meets river Krishna at Kathapur. There is no dam on both the rivers. Koyana River originates in Mahabaleshwar. It has a major dam with electricity generation plant on it. There are four tributaries of the Koyana namely Kera, Vang, Morna, Mahind. Of these two tributaries Vang and Morna have medium dams on them. Warana is another important river which flows in between Sangli and Kolhapur district and originates in Patharpunji. There is major dam on the river Chandoli near Chandoli national park. Morna and Kadvi are the tributaries of the river. Warana has a confluence with the Krishna at Haripur Sangli after travelling 159.44 Km. The Panchaganga River also originates from the Western Ghats in the state of Maharashtra. The Panchaganga River Basin lies between the river basins of Warna and Dudhganga. The total length of the Panchaganga River System is 338 Km. Average Rainfall in this region is 2501.9mm (2005). The confluence of the five rivers Kumbhi, Kasari, Dhamni, Tulshi and Bhogavati at Prayag forms the River Panchaganga. The River Panchaganga meets the River Krishna at Nrusinhwadi near Kurundwad. Dudhganga River originates at Bambavade with one major tributary Vedganga. This river travels about 127.09 Km of the area and meets river Krishna at Kardge.

The river wise details of the length, A1 and A2 length of rivers, irrigated land, dams on the river and their power generation capacity Along with confluence places of rivers is shown in the table no. 3.1.

Table no 3.1 Krishna 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	Krishna	Mahabaleshwar	Dhom **	342.02	19.24	322.78		10.59		
2	Venna	Mahabaleshwar	Kanher **	97.94	39.58	58.36	102585	16.25	Krishna	Sangam Mauli
3	Vasna	Solashi		62.98	6.92	56.06			Krishna	Kthapur
4	Vangana	Bhadle		40.66	8.66	32			Vasna	Koregav
5	Urmodi	Kaas	Rahir **	64.23	13.71	50.52	4781		Krishna	Kashil
6	Tarali	Jagminwadi	Mrud *	60.95	14.70	46.25	6871		Krishna	Umbraj
7	Uttar Mand	Padolshi	Chafal *	38.96	11.30	27.66	4800		Krishna	Umbraj/Shivde
8	Koyna	Mahabaleshwar	Ky Nagar **	228.89	80.39	148.5		147.844	Krishna	Karad
9	Kera	Mndure		17.20	7.09	10.11			Koyna	Patan
10	Vangna	Nigde	Dhebewadi *	37.03	6.21	30.82	540		Koyna	Chchegav
11	Morna	Atoli	Morgiri *	43.50	15.31	28.47	100		Koyna	Sangvd
12	Dakshin Mand (Yevti Masoli)	Gotewadi	Shelkewadi *	37.06	7.53	29.53	1927		Krishna	Vathar /Rethre
13	Yerala	Mol	Yeralwadi *	143.71	4.26	139.45	4037		Krishna	Brmhnal
14	Warna	Patharpunji	Chandoli **	143.71	30.34	159.44	66305		Krishna	Hripur/Sangli
15	Morna	Vakurde	Padli *	189.78	10.79	28.19	2566		Warna	Kande
16	Kadvi	Udgir	Kadvi *	38.98	5.14	44.53	4889		Warna	Thergav
17	Kasari	Gajapurwadi	Gelawde *	49.67	7.18	79.81	8609		Panchganga	Pryag Chkhli
18	Kumbhi	Tliye	Lakhmapur *	86.99	10.09	61.76	8007		Bhogavti	Bhireshvr
19	Dhamni	Kalksaandre		57.07	11.79	44.28				
20	Tulashi	Talgaon	Dhamod **	52.84	11.03	41.81	5710		Bhogavti	Bid
21	Bhogawati	Asane	Radhanagri **	196.19	19.69	176.5	26560	8.00	Panchganga	Pryag Chkhli
22	Panchganga	Asani		77.62		77.62			Krishna	Nrusinh Wadi
23	Dudhganga	Bambade	Kalammawadi **	143.59	16.50	127.09	38920		Krishna	Kardge
24	Vedganga	Tambyachwadi	Pathgaon *	126.62	8.40	118.22	9516	3.66	Krishna	Kardge
Total			**19**	**2378.19**	**365.85**	**1939.76**	**314367**	**186.344**		

Major dams are indicated as **, Medium dams are indicated as *

The entire basin is covered with number of dams built across the Krishna River and its tributaries at various places. A total of 19 dams are constructed on the Krishna River and its tributaries; among which 8 are major and 11 minor. The total length of A1 rivers stretch is 365.85 Km and A2 river stretch is 1939.76 Km. The total level length of Krishna and other 23 tributaries is 2378.19 Km. On the five rivers power generation takes place. Major power generation takes place at Koyna and its capacity is 147.844 MW/yr. At the five power generation plants 186.344 MW/yr electricity is generated.

Table no 3.2 discusses irrigated area, water storage and water usage of Krishna River and its 23 tributaries. The mass storage capacity of 19 major and minor dams 6122.7 Mm^3 and live storage capacity is 6157.88 Mm^3. The dam on Koyana at Koyana nagar dam possesses highest storage capacity among all the tributaries of the Krishna i.e. 2980.15 Mm^3 which is followed by Chandoli dam and Kalammavadi dam with storage capacity 974.19 Mm^3 and 719.12 Mm^3 respectively. 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. A total of 314367 ha land has been brought under irrigation as a result of these dams.

Table no 3.2 Irrigated area, water storage and water usage of Krishna River and its tributaries

Sr. no.	River	Origin	Dams	Length (km)	MJ/ Gross Storage (Mm^3)	Live Storage (Mm^3)	For Irrigation (Mm^3)	For Domestic (Mm^3)	For Industries (Mm^3)	Area Under Irrigation (Ha)	Confluence With	Confluence At
1	Krishna	Mahabaleshwar	Dhom **	342.02	382.25	331	498.077	137.08	11.84	102585	Krishna	Sangam Mauli
2	Venna	Mahabaleshwar	Kanher **	97.94	285.98	272						
3	Vasna	Solashi		62.98							Krishna	Kthapur
4	Vangana	Bhadle		40.66							Vasna	Koregav
5	Urmodi	Kaas	Rahir **	64.23	282.14	273.27	255.25	20	4	4781	Krishna	Kashil
6	Tarali	Jagminwadi	Mrud *	60.95	165.71	165.46	177.43	51.253		6871	Krishna	Umbraj
7	Uttar Mand	Padolshi	Chafal *	38.96		24.59	26.42	1.1	0.61	4800	Krishna	Umbraj/Shivde
8	Koyna	Mahabaleshwar	Ky Nagar **	228.89	2980.15	2836					Krishna	Karad
9	Kera	Mndure		17.20							Koyna	Patan
10	Vang	Nigde	Dhebewadi *	37.03		77.06	73.34	7.08	1.42	540	Koyna	Chchegav
11	Morna	Atoli	Morgiri *	43.50		36.99	17.55	28.32	3.11	100	Koyna	Sangvd
12	Dakshin Mand (Yevti Masoli)	Gotewadi	Shelkewadi *	37.06		6.88	4.42	0.009	0.137	1927	Krishna	Vathar /Rethre
13	Yerala	Mol	Yeralwadi *	143.71		19.59	14.15	3.037		4037	Krishna	Bramhnal
14	Warna	Patharpunji	Chandoli **	189.78	974.19	779.34	707.7	270.37	35.96	66305	Krishna	Hripur/Sangli
15	Morna	Vakurde	Padli *	38.98		15.16	15.16			2566	Warna	Kande
16	Kadvi	Udgir	Kadvi *	49.67		70.56	16.17	0.434		4889	Warna	Thergav
17	Kasari	Gajapurwadi	Gelawde *	36.99		77.96	71.94	69.4	7.68	8609	Panchganga	Pryag Chkhli

18	Kumbhi	Tliye	Lakhmapur *	71.85		76.49	61.67	0.352	0.163	8007	Bhogavti	Bhireshvr
19	Dhamni	Kalksaandre		56.07								
20	Tulashi	Talgaon	Dhamod **	52.84	96.28	91.92	63.78	0.185		5710	Bhogavti	Bid
21	Bhogawati	Asane	Radhanagri **	196.19	236.79	219.97	182.17	33.93	3.87	26560	Panchganga	Pryag Chkhli
22	Panchganga River System	Asani		77.62							Krishna	Nrusinh Wadi
23	Dudhganga	Bambade	Kalammawadi **	143.59	719.12	679.11	278.81	13.5	7.19	38920	Krishna	Kardge
24	Vedganga	Tambyachwadi	Pathgaon *	126.62		104.8	57.25	1.27	0.134	9516	Krishna	Kardge
				2378.19	**6122.7**	**6157.88**	**2521.287**	**637.32**	**76.114**	**314367**		

Major dams are indicated as **, Medium dams are indicated as *

Krishna river originates in Western Ghat at the elevation of 1267 MSL and the downstream of river it is 519 MSL. There is difference of 748 MSL between origin elevation and downstream elevation. Throughout the length of 342.02 km a gradient of elevation can be seen. Table no 3.3 and Fig. no 3.1 represents the major drops in elevation and the locations. Sudden drop in elevation is seen from origin, dam outlet to Wai. This gradient can have impact on water quality. At the upstream or river origin area the steep gradient area collects lot of silt in the river bed and on the contrary the downstream area with lower elevation gradient settling of silt and particulate matter is visible.

Table no 3.3 Elevations of major places

Sr. No	Location	Elevation (MSL)	Sr. No	Location	Elevation (MSL)
1	Origin	1267	15	U mand confluence	572
2	Dam outlet	741	16	Koyna confluence	554
3	Wai	694	17	Thembhu bridge	549
4	Ozerde	674	18	D mand confluence	549
5	Bhuinj	667	19	Bhe bridge	549
6	Khdki	653	20	Takare bridge	548
7	Limb	645	21	Nagthane	537
8	Vaduth	631	22	Yerla confluence	537
9	Mahuli	621	23	Digrj bridge	532
10	Vasna confluence	607	24	Sangali bridge	527
11	Fdtare bridge	600	25	Warna confluence	527
12	Kameri bridge	595	26	Mahshal bridge	522
13	Urmodi confluence	582	27	Kurundwad	520
14	Tarli confluence	575	28	Rajapur bridge	519

Fig. 3.1 Krishna river gradient

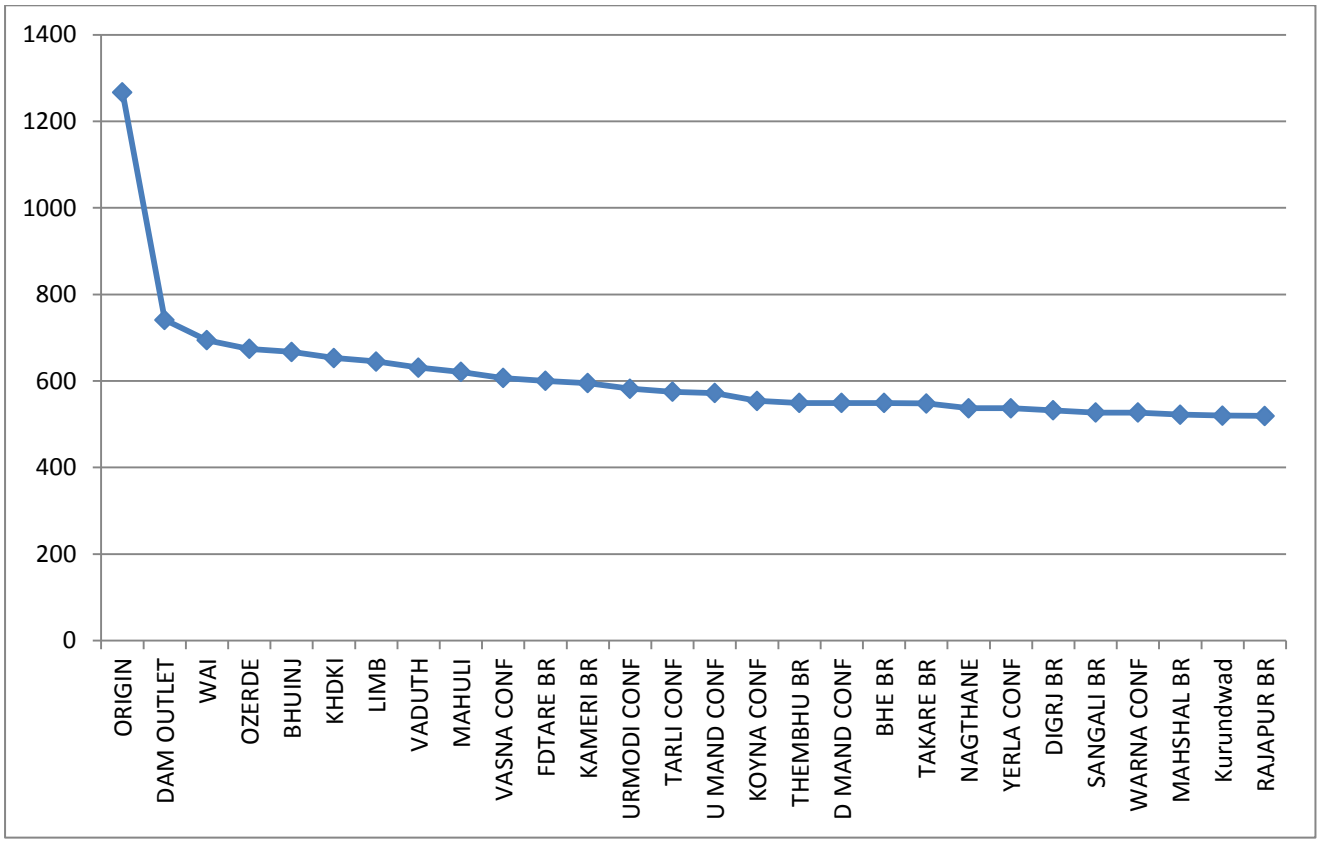
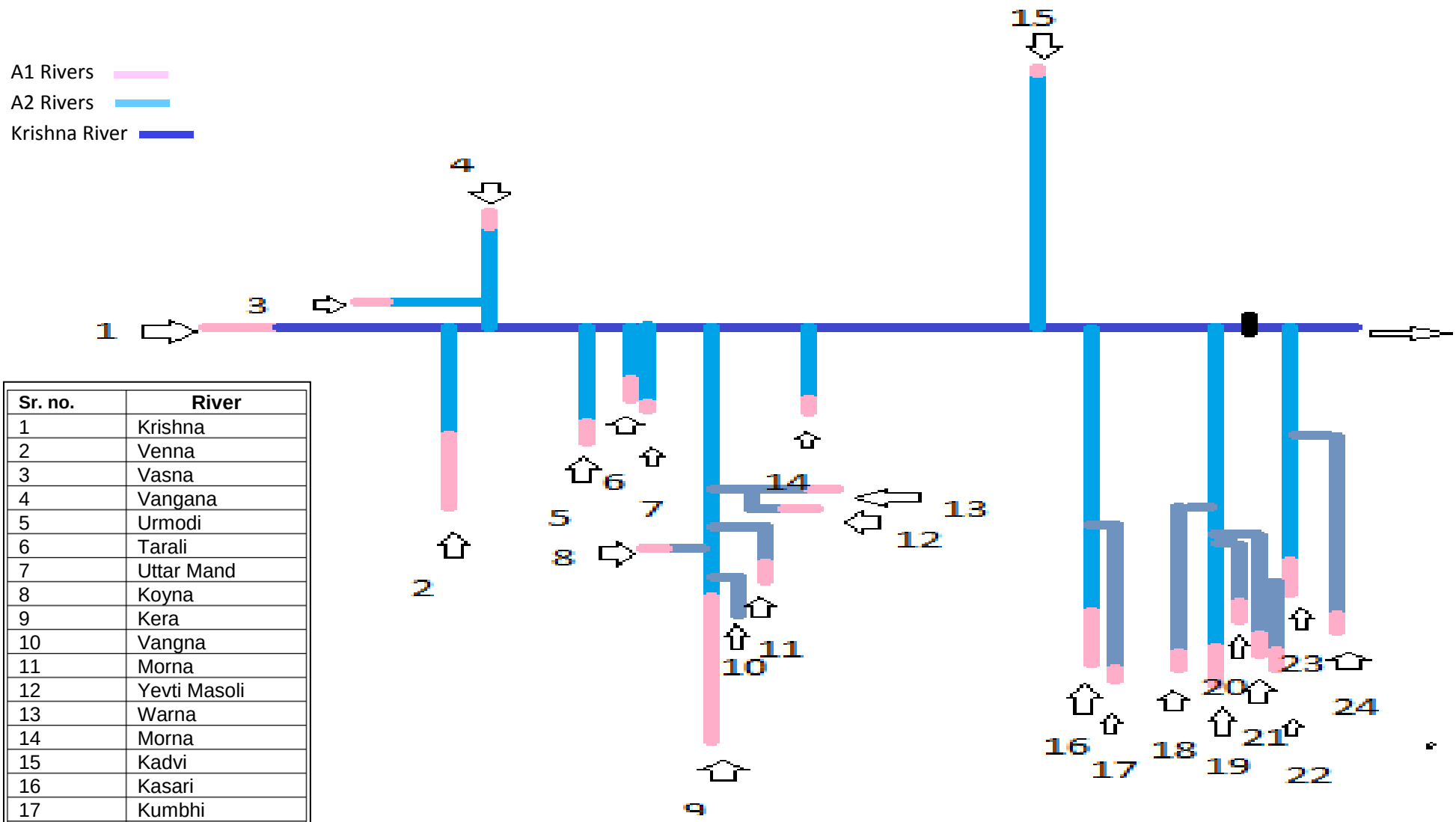


Fig. no 3.2 shows the A1 and A2 stretches of the 23 tributaries and their confluence with the river Krishna is drawn bellow.

Fig. 3.2 Krishna river and its Tributaries along with A1, A2 Area



Sr. no.	River
1	Krishna
2	Venna
3	Vasna
4	Vangana
5	Urmodi
6	Tarali
7	Uttar Mand
8	Koyna
9	Kera
10	Vangna
11	Morna
12	Yevti Masoli
13	Warna
14	Morna
15	Kadvi
16	Kasari
17	Kumbhi
18	Dhamni
19	Tulashi
20	Bhogawati
21	Panchganga
22	Dudhganga
23	Vedganga
24	Yerala

3.4 Demography of the Krishna River basin –

As mentioned earlier the Krishna river basin stretch covers area from 21 talukas of the three districts namely, Satara, Sangli and Kolhapur. Among the 21 Talukas 6 are from Satara district, 6 are from Sangli district and 9 are from Kolhapur district. From Satara district 1207 towns or villages with their population of 18,60,453; Sangli district with 476 towns or villages along with their population of 20,29,715 and Kolhapur district with 853 towns and villages along with population of 30,04,694 are dependent on water from Krishna river basin for various purposes such as domestic, agriculture, industrial and for other purposes. The following table no 3.4 gives details of each district. The detailed population is enclosed in annextures.

Table no 3.4 Population of districts in Krishna River Basin in Maharashtra

District	Taluka	No. of Town/ Village	Population
Satara	Karad	219	543424
	Koregaon	139	253128
	Patan	336	298095
	Satara	208	451870
	Wai	119	189336
	Jaoli	186	124600
Sangli	Khanapur	107	258231
	Miraj	63	756048
	Palus	52	216556
	Shirala	94	158298
	Tasgaon	64	213205
	Walwa	96	427377
Kolhapur	Bavda	39	32525
	Bhudargad	114	144910
	Hatkanangle	58	709628
	Kagal	86	248237
	Karveer	125	906866
	Panhala	130	238383
	Radhanagri	114	188107
	Shahuwadi	133	176859
	Shirol	54	359179
3	21	2536	68,94,862

Source: Provisional Census 2011

3.5 Land use in the Krishna river basin –

The land use pattern can be broadly categorized into forest land, non-agricultural land and cultivable land. From the Satara district 51%, from Sangli district about 49% (except Palus Taluka, land use is not available for it), from Kolhapur district 74.29% land is covered in the Krishna River basin. The total land cover of talukas in Krishna basin is 8109426 Ha. Out of this 604310 ha is under forest, 376616 ha is used for non-agricultural purposes and 7128500 ha is cultivable land. The talukawise details of land use against total area of district are reported in the table given below:

Table no 3.5 Land use in the Krishna river Basin in Maharashtra

District	**Taluka**	**Forest land (Ha)**	**Non-agricultural land (Ha)**	**Cultivable land (Ha)**	**Total (Ha)**	**Total area of district (Ha)**
Satara	Karad	10602	5969	799123	104211	**1058243**
	Koregaon	10499	8764	67019	94840	
	Patan	27720	15835	119026	104211	
	Satara	8500	13044	86322	87953	
	Wai	12766	2976	42459	61909	
	Jaoli	19782	11392	44986	86895	
	Total	**89869**	**57980**	**1158935**	**540019**	
Sangli	Khanapur	10936	13324	108342	132602	**861065**
	Miraj	1079	5850	80635	92624	
	Palus	NA	NA	NA	NA	
	Shirala	13122	4826	47067	1962	
	Tasgaon	4961	7994	96222	111259	
	Walwa	2952	1805	67023	78781	
	Total	**33050**	**33799**	**399289**	**417228**	
Kolhapur	Gaganbavda	10626	5462	10848	28228	**776261**
	Bhudargad	23790	3192	32863	64446	
	Hatkanangle	1433	3588	50010	60937	

	Kagal	1114	1617	47456	54754	
	Karveer	804	9358	48926	67113	
	Panhala	11591	7096	33161	56871	
	Radhanagri	26775	14328	35113	89232	
	Shahuwadi	21912	18507	50329	104352	
	Shirol	864	2742	42279	50783	
	Total	**98909**	**65890**	**350985**	**576716**	
	Grand total	**604310**	**376616**	**7128500**	**8109426**	

Source: District statistical reports of Satara, Sangli, Kolhapur (2012)

3.6 Cropping pattern -

Large area from Satara, Sangli and Kolhapur is under cultivation. The major crops in this districts 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.

3.7 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 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 Satara is 415259, Sangli is 494102 and Kolhapur is 716520. Among that in Satara district 75011 are exotic hybrid cattle, 99605 are local hybrid cattle, 240643 are buffaloes; in Sangli district 63880 are foreign hybrid cattle, 70236 are Indian hybrid cattle, 359986 are buffaloes; in Kolhapur district 124655 are foreign hybrid cattle, 89898 are Indian hybrid cattle, 501967 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 3.6 Number of Cattle in the Krishna River Basin in Maharashtra

Districts	Foreign Hybrid Cows and oxen	Indian Hybrid Cows and oxen	Buffalos	Total
Satara	75011	99605	240643	**415259**
Sangli	63880	70236	359986	**494102**
Kolhapur	124655	89898	501967	**716520**
Total	**263546**	**259739**	**1102596**	**1625881**

Source: District statistical reports of Satara, Sangli, Kolhapur (2012)

3.8 Industries –

Apart from agriculture in the basin variety of industries have been established in the Krishna river basin within all the three districts. Depending upon the type of production these industries are categorized as red, orange and green. There are a total of 11894 industries; among them 2212, 1843 and 7839 industries are from red, orange and green categories respectively. Total water consumption of the industries belonging to three categories from three district is 223869.893 m^3/day. Maximum water consumption took place in red category industries whose number is maximum in Kolhapur district. Maximum number of industries is located in Kolhapur district followed by Sangli and Satara districts. The number of industries category wise, their consumption of water and effluent generation from all districts is mentioned in the bellow table no 3.7

Table no 3.7 District and Category wise water consumption and effluent generation from Industries from the Krishna River Basin in Mahararashtra

District	Category	Water Consumption	Industrial Effluent	Domestic Effluent	Total Effluent
	RED				
Satara	61	16221.99	8307.63	3732.47	12040.1
Sangli	370	51228.402	4889.445	2289.02	7178.465
Kolhapur	1781	131388.87	90204.48	9249.752	99454.232
Sub- total	**2212**	**198839.262**	**103401.555**	**15271.242**	**118672.797**
	ORANGE				
Satara	531	2247.305	720.97	531.315	1252.285
Sangli	557	1217.625	290.21	509.11	799.32
Kolhapur	755	10090.65	1306.91	3095.5	4402.41
Sub- total	**1843**	**13555.58**	**2318.09**	**4135.925**	**6454.015**
	GREEN				
Satara	652	1738.556	72.15	883.802	955.952
Sangli	2000	1845.235	3.6	1392.841	1432.894
Kolhapur	5187	7891.26	1594.65	3919.56	5514.21
Sub- total	**7839**	**11475.051**	**1670.4**	**6196.203**	**7903.056**
TOTAL	**11894**	**223869.893**	**107390.045**	**25603.37**	**133581.976**

All the industries mentioned in table no 3.7 are situated in MIDC areas in the three districts. These MIDC areas are located in the vicinity of rivers such as Krishna, Panchganga, Yerla, Vasna and Koyna. Maximum number i.e. 8 MIDCs are located near to Krishna river followed by 7 industrial areas are located near to Panchaganga river. Provisions of River restriction zone are seemed to be violated. Hence these industrial pockets have potential to be a major source of pollution. The details of MIDc and river along with the distance are reported in table no 3.8

Table no 3.8 List of MIDCs and their distance from nearby river

Sr. No.	Name of MIDC	Direction	Distance from river	Name of river
1	Five star MIDC, Kagal	E	5.50	Panchganga
2	Gokul Shirgaon MIDC	E	6.62	Panchganga
3	Shiroli MIDC	W	0.20	Panchganga
4	Ichalkaranji Co. of Industrial Estate	S	2.12	Panchganga
5	Laxmi - Hatkanangle Co. of Industrial Estate	S	5.59	Panchganga
6	Parwati – Yadraw Co. of Industrial Estate	S	4.81	Panchganga
7	Akiwate – Jaisingpur Co. of Industrial Estate	W	3.00	Panchganga
8	Kadegaon MIDC	N	1.03	Krishna
9	Khanapur MIDC	N	2.98	Yerla s/b
10	Miraj MIDC	S	6.39	Krishna
11	Palus MIDC	S	6.55	Krishna
12	Shirala MIDC	S	3.91	Krishna
13	Tasgaon MIDC	N	0.45	Yerla s/b
14	Walwa Islampur – MIDC	E	1.26	Krishna
15	Satara MIDC	E	1.06	Krishna
16	Wai MIDC	S	2.38	Krishna
17	Patan MIDC	S	0.16	Koyna
18	Karad MIDC	E	0.49	Krishna
19	Koregaon MIDC	W	1.57	Vasna

E- East, W- West, N- North, S- South

3.8.1 Sugar Industries and Distilleries –

The entire Krishna basin region is known as sugar belt. Sugarcane is one of the major cash crops in this area. There are 34 sugar factories and distilleries. Many sugar industries are located in Krishna river basin. The establishment of sugar factories took place since the decade of 1960s. Majority of the sugar industries are cooperative industries. However their working efficiency is questionable. List of sugar

industries their distance from nearby river and direction from river bank is mentioned in the following table no 3.9.

Table no 3.8 List sugar industries and their distance from nearby river

Sr. No.	Name of Sugar Ind.	Direction	Distance from nearest river (Km)	Name of river
1	Shri. Tatyasaheb Kore, Warna S.S.K	N	2.98	Warna
2	Renuka S.S.K, Ichalkarangi	W	5.17	Panchganga
		W	0.3	Kabnur Nala
3	Kumbhi Kasari SSK Ltd	N	3.24	Kasari
		W	0.76	Kumbhi
		S	2.41	Kumbhi
4	Shri Dudhganga Vedganga SSK Ltd	N	0.49	Dudhganga
5	Shri Bhogawati Sahakari S.S.K	N	0.61	Bhogavati
6	Shri Datta Shetakari SSK Ltd., Shirol	S	2.75	Panchganga
		E	5.7	Krishna
7	Ch. Shahu S.S.K, Kagal	S	2.59	Dudhganga
8	Jawahar Shetkari Sahakari S.S.K, Hupri	S	4.19	Dudhganga
		N	4.52	Panchganga
9	Ch. Rajaram S.S.K, Ka. Bawda	N	0.49	Panchganga
		W	0.68	Panchganga
10	U. Gaikwad S.S.K, Bambawde	N	3.27	Kadvi
11	Sharad S.S.K, Narande	N	2.97	Warna
12	Padamshree Dr.D.Y.Patil Sahakari S.S.K Ltd.	N	0.31	Rupni
			0.35	Rupni
13	Shri Datta Sahakari Sakhar Karkhana Ltd (Dalmia SSK)	S	1.55	Kasari
14	Shri. Gurudatta, Takliwadi, Shirol	S	2.75	Panchganga
		E	5.7	Krishna
15	M/s. Vasantdada Shetkari S. S. K. Ltd.	W	3.69	Krishna

16	M/s. Rajarambapu Patil SSK Ltd.	N	3.06	Krishna
17	M/s. Vishwasrao Naik SSK Ltd.	S	1.97	Morna, Warana
18	M/s Hutatma Kisan Ahir S.S.K. Ltd.	E	1.23	Krishna
19	M/s. Tasgaon Palus Taluka SSK Ltd.	E	1.82	Yerala
20	M/s. Sonhira Sahakari Sakhar Karkhana Ltd. Tal-, Dist-Sangli.	E	5.5	Yerala
21	M/s. Kranti Sahakari Sakhar Karkhana Ltd.	W	6.91	Krishna
		E	3.73	Yerala
22	M/s. Cane Agro Energy India Ltd. Kadgaon	E	4.28	Yerala
23	M/s. Udgiri Sugar & Power Ltd	W	2.83	Krishna
24	M/s. Mohanrao Shinde SSK Ltd.	N	12.36	Krishna
25	Mahadik Sugars	S	0.2	Dudhganga Canal
		S	0.63	Dudhganga
26	S. Mandlik, S.S.K, Kagal	S	1.84	Chikotra
		N	2.62	Vedganga
27	M/S Yashwantrao Mohite Krishna S.S.K Ltd Rethare (B.K)	N	2.35	Krishna
		S	1.58	Krishna
28	M/S Kissanveer satara sahakari sakhar karkhana Ltd, Bhuinj	W	3.12	Krishna
29	M/S Rayat S.S.K Ltd Shewalewadi (Mahasoli)	W	0.41	Krishna
30	M/S Sahayadri S.S.K Ltd Yashwant Nagar	W	1.32	Krishna
31	M/S Jayant SSK Ltd	E	3.71	Krishna
32	M/S Loknate Balasaheb Desai S.S.K Ltd	N	1.54	Koyna
33	M/S Ajinkyatara S.S.K Ltd	W	1.47	Urmodi
34	Senapati Kapshi S.S.K		0.88	Chikotra

3.9 Other developmental activities –

Major and minor minerals are mined in the area. Major mineral like bauxite is mined in the basin area widely. Minor minerals like, stones, fertile soil, sand is excavated widely in the Krishna 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 rivers.

Chapter – IV

Observations

The water from river Krishna and its tributaries is used for various anthropogenic activities. Water 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; sand mining from river bed; excavation of fertile soil from the river banks for brick making; etc. are reported on the banks of rivers.

Considering the growing pressure of anthropogenic activities MPCB is monitoring the river water. Following tables show the river water analysis from river Krishna and its tributaries. Based on these analysis pollution stretches were identified and sampling sites were identified.

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, sand 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.

4.2 General Observations of Krishna River Basin in Maharashtra –

In order to understand the extent of pollution it is essential to complete a basin wise study of all tributaries of any major river. The following points need to be considered while undertaking such a study.

- Extent of river, gradient, geographical structure, area, sub-basins (including its tributaries and sub-tributaries), dams and percolation tanks built on it, water management, dependent agriculture, villages and cities, availability of drinking water and its quality, factors causing pollution and its present status.
- Brick kilns, soil and sand usage from river/ river bed, fishing and other supplementary activities.
- Impact of activities like washing of clothes, animals and bathing in river.
- Management of crematoriums and methods used their in – disposal of ash and other ritualistic offerings and its impact.

- Pollution due to religious reasons and its present status – Ganapati / Durga Idol immersion.
- Impact of presence of religious places on the river banks.
- Study the impact of use of fertilisers, pesticides, weedicides in the region near river banks.
- K T Weirs in the river bed and its method of compounding water, water release and related issues.

The major causes of river pollution are discussed as bellow:

4.2.1 Domestic Sewage –

There is no efficient sewage treatment facility in the city or village. The sewage generated in the villages and cities are partially treated and many times are untreated which is disposed of in the river. During the study status of villages and cities are reported.

The total population of 6894862 belonging to 2536 villages from 21 talukas of three districts resides in Krishna river basin. Per person average 70 – 100 L of sewage is generated. According to this in Krishna basin per day 482640340 L to 689486200 L domestic sewage is generated. From which 885629 population from 245 villages lives on the bank of river that can directly dispose of their partially treated on untreated sewage into river.

In the entire Krishna River stretch the villages, towns, municipal corporations which are within the 3 Kms area from the river were identified for study. As 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. The total population of about 8,85,629 lives in this expanse. On the left side of the river bank there were 245 villages and towns with population of 3,82,226 and on the right side of the river there were 249 villages and towns with a population of 5,03,406. On an average per day per head 70 – 100 L of sewage or waste water is generated. Hence in total in the study area 61994030 L to 88562900 L of sewage is generated per day. As mentioned earlier there is no efficient facility which will treat this water. Hence, these settlements released untreated or partially treated domestic sewage directly

disposed into the river. The details of population and the villages are shown in the annexure I.

4.2.2 Industrial effluent –

A variety of industries have been established in the Krishna river basin within all the three districts namely Satara, Sangli and Kolhapur. All the industrial areas fall within the maximum flood line area. Hence, It is essential to study the impact of these areas and its effluents. The following issues need to be considered with respect to the same: Number of industries, their classification, amount of industrial effluents and waste generated and process of treatment and disposal, whether separation of industrial and domestic wastes exists, etc.

Depending upon the type of production these industries are categorised as red, orange and green. There are total of 11894 industries among them respectively 2212, 1843 and 7839 industries are from red, orange and green categories. A majority of these industries are situated in the district of Kolhapur. The MIDC areas of Satara, Sangli and Kolhapur have 769, 1898 and 3863 industries respectively.

The non – MIDC areas of Satara, Sangli and Kolhapur have 477, 1029 and 3860 industries respectively. These industries consume water for both domestic and industrial purpose. Their details of water consumption and effluent generation are mentioned in table no 4.2. Maximum number of industries is located in Kolhapur district followed by Sangli and Satara districts. Highest number of red category industries is located in Kolhapur district. The detailed MIDC wise distribution of industries is mentioned in table no 4.3.

All the industries required large amount of water for various process. Among them red category consumes largest portion of it. The total water consumption is 223896.893 m^3 out of which 88.22 % of water is consumed by Red Category industries, while the Orange and Green categories consume 6.06 % and 5.12 % of water respectively. The total effluent generated in these industries is 133581.976 m^3 out of which 80.39 % is industrial effluent and 19.61 % is domestic effluent. The breakup of effluent generated for red, orange and green categories is 89.25 %, 4.83% and 5.91 % respectively.

The treatment of effluent generated by industries is an important issue. Apart from Kagal MIDC the other industrial areas do not have a common effluent treatment plant. During the industrial visits following facts were noted regarding industries:

- There is a mixing of domestic and industrial effluent in all the MIDC's. As a result the industrial effluent undergoes dilution to an extent and hence proper treatment of industrial effluent does not take place. There is an increase in the total amount of effluent to be treated due to new units being setup and expansion of existing industrial units.

- The treated effluent is to be utilized in the industrial area for e,g. for tree plantation but no such use of water was visible, except Kagal MIDC and Lakshmi cooperative industrial estate.

- Some of the ETP's were not working to their full capacity. The hazardous wastes created from ETP are to be sent to CHWTSDP for treatment as per rules, other solid wastes are also not disposed of properly. However, these rules were seemed to be violated.

- Sugar factories as well as other industries prominently use wood as a fuel. This wood comes from the extremely fragile and ecologically sensitive Western Ghats. Approximately 150 – 180 trucks per day are used in Kolhapur district, 120 and 150 trucks respectively in the districts of Sangli and Satara.

- The process equipment as well as treatment facilities in most of the factories has become old and obsolete. Most of the processing units, equipment, pipelines are non-functional, have developed leakages leading to accidents in an increasing order.

Table no 4.2 District and Category wise water accounts of Industries from the Krishna River Basin in Mahararashtra

District	Category	Water Account (cubic meter/day)					
		Industrial Consumption	Domestic Consumption	Total Consumption	Industrial Effluent	Domestic Effluent	Total Effluent
		1	2	1 + 2 = 3	4	5	4+5
	RED						
Satara	61	11361.57	4860.42	16221.99	8307.63	3732.47	12040.1
Sangli	370	8732.902	42495.5	51228.402	4889.445	2289.02	7178.465
Kolhapur	1781			131388.87	90204.48	9249.752	99454.232
Sub- total	**2212**			**198839.262**	**103401.555**	**15271.242**	**118672.797**
	ORANGE						
Satara	531	1260.17	987.135	2247.305	720.97	531.315	1252.285
Sangli	557	494.29	723.335	1217.625	290.21	509.11	799.32
Kolhapur	755			10090.65	1306.91	3095.5	4402.41
Sub- total	**1843**			**13555.58**	**2318.09**	**4135.925**	**6454.015**
	GREEN						
Satara	652	215.701	1522.855	1738.556	72.15	883.802	955.952
Sangli	2000	414.95	1430.285	1845.235	3.6	1392.841	1432.894
Kolhapur	5187			7891.26	1594.65	3919.56	5514.21
Sub- total	**7839**			**11475.051**	**1670.4**	**6196.203**	**7903.056**
TOTAL	**11894**			**223869.893**	**107390.045**	**25603.37**	**133581.976**

Water is an important requirement for most of the industries. Use of water leads to generation of effluents which needs to be disposed of properly. The above table shows the category wise distribution of the industries in the three districts of river basin along with their water consumption and effluent generation.

Table no 4.3 District and Category wise Effluent generation from of Industries in the Krishna River Basin in Mahararashtra

District	Name of MIDC	Category			Total Consumption M^3/ day	Industrial Effluent M^3/ day	Domestic Effluent M^3/ day
		RED	ORANGE	GREEN			
Satara	Satara MIDC	15	208	352	2401.50	1176.34	991.00
	Wai MIDC	4	36	62	651.90	125.50	345.99
	Patan MIDC	1	9	9	47.07	11.55	13.29
	Karad MIDC	9	18	7	648.75	373.5	209.22
	Koregaon MIDC	4	16	17	3280.52	202.75	2162.33
	Non MIDC	28	261	205	13034.03	7271.56	1785.41
Sangli	Kadegaon MIDC	5	10	97	87.90	46.90	104.79
	Khanapur MIDC	7	6	60	47.12	3.00	39.69
	Miraj MIDC	188	155	1055	4100.32	1642.55	1644.07
	Palus MIDC	30	24	59	2560.80	1404.74	570.22
	Shirala MIDC	6	5	9	653.70	283.00	76.93
	Tasgaon MIDC	3	5	7	265.20	243.15	9.22
	Walwa MIDC	53	32	82	2130.53	901.26	393.80
	Non MIDC	78	303	631	4507.71	779.56	1343.03
Kolhapur	Gokul Shirgaon MIDC	154	55	247	5652.54	1898.63	1809.48
	Five Star Kagal MIDC	114	62	859	32119.72	23168.44	1047.44
	Shiroli MIDC	237	66	602	2356.03	516.98	904.39
	Ichalkaranji MIDC	269	23	599	27014.58	21236.94	1146.42
	Laxmi - Hatkanangle MIDC	56	24	184	2,667.55	1618.05	434.67
	Parwati - Yadraw MIDC	30	11	185	4,812.86	2,973.95	324.55
	Akiwate - Jaisingpur MIDC	26	8	52	3066.01	2759.63	270.56
	Non MIDC	895	506	2459	111763.55	38832.16	9976.85
		2212	**1843**	**7839**	**223869.89**	**107470.10**	**25603.37**

Table no 4.3 elaborates MIDC areas, category wise number of industries in three districts. In non MIDC areas also red and orange category industries were reported which is to be considered seriously. These industries could pose threat to settlements in the vicinity. Total water consumption my MIDC and non MIDC industries is 223869.89 M^3/ day. Effluent generated is categories as industrial effluent and domestic effluent. Quantity of industrial effluent is 107470.10 M^3/ day and quantity of domestic effluent is 25603.37 M^3/ day.

4.2.3 Sugar Industry –

The entire Krishna basin region is known as sugar belt of Maharashtra state. Sugarcane is one of the major cash crops in this area. In Satara, Sangli and Kolhapur districts 32678 ha, 51860 ha and 93041 ha of land is under sugarcane cultivation respectively.

The establishment of sugar factories took place since the decade of 1960s. Majority of the sugar industries are cooperative industries. There are total of 34 sugar industries and 19 distilleries in this area. However their working efficiency is questionable. Maximum number (17) of sugar industries are located in Kolhapur district followed by Sangli (10) and Satara (7). In case of distilleries maximum number of distilleries (09) are located in Sangli district which followed by Kolhapur and Satara district (5 each). During the study period the sugar industries were closed as it was not crushing period for them. Hence it was not possible to do detailed study of sugar industries and their impact on the rivers.

Sugar industries and distilleries use large amount of water, generating large amount of effluent. The effluent generated in the industries is many times released into the river water with or without partial treatment. Many industries have lagoons or solar ponds to store untreated effluent. 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 industries and distilleries create sudden shock in the river patch leading to odour to river water and massive fish kills in the river. The table no 4.4 show the number of sugar industries and distilleries in the area.

Table no 4.4 Sugar Industries and Distilleries in the Krishna River Basin in Maharashtra

District	Sugar Industries	Distilleries	Total
Satara	07	05	**12**
Sangli	10	09	**19**
Kolhapur	17	05	**22**
Total	**34**	**19**	**53**

The detailed list of sugar industries and distilleries in Krishna river basin is mentioned in table no 4.5 and 4.6 respectively. Their water consumption and effluent generation is also mentioned in these tables. The sanctioned crushing capacity of sugar industries range from 1250 Mt/D to 8000 Mt/D. Total industrial water consumption by 34 sugar industries is 8325 CMD and total domestic water consumption is 1785 CMD which gives rise to 6170 CMD industrial effluent and 1375 CMD domestic effluent respectively. Hence total of 7545 CMD effluent is generated. From distilleries total of 6930.18 CMD effluent is generated. Some of the effluent generated is reused for agricultural purposes. However exact details of amount of effluent reused for agriculture and for other purposes are not available.

Though sugar industries were closed in the study period some facts were noted and mentioned bellow. These are some of the major issues related to sugar industries and distilleries.

Table no 4.5 List sugar industries, their water consumption and effluent generation in Krishna River Basin in Maharashtra

Sr. No.	Name of Sugar Ind.	Sanctioned crushing capacity (MT/D)	Industrial water consumption (CMD)	Domestic water consumption (CMD)	Industrial Effluent (CMD)	Domestic Effluent (CMD)	Total effluent generated (CMD)
1	Shri. Tatyasaheb Kore, Warna S.S.K	7500	100	700	80	700	780
2	Renuka S.S.K, Ichalkarangi	5000	300	1642	200	580	780
3	Kumbhi Kasari SSK Ltd	3000	165	620	150	380	530
4	Shri Dudhganga Vedganga SSK Ltd	4500	89	3375	72.60	492.70	565.3
5	Shri Bhogawati Sahakari S.S.K	4000	75	1200	60	450	510
6	Shri Datta Shetakari SSK Ltd., Shirol	7000	100	700	80	700	780
7	Ch. Shahu S.S.K, Kagal	5000	100	3000	80	1000	1080
8	Jawahar Shetkari Sahakari S.S.K, Hupri	7500	676	1450+1025	200	750	950
9	Ch. Rajaram S.S.K, Ka. Bawda	2200	900	500	450	350	800
10	U. Gaikwad S.S.K, Bambawde	2500	100	300	80	150	230
11	Sharad S.S.K, Narande	2500	100	300	80	150	230

12	Padamshree Dr.D.Y.Patil Sahakari S.S.K Ltd.	2500	100	810	90	270	360
13	Shri Datta Sahakari Sakhar Karkhana Ltd (Dalmia SSK)	2500	100	750	80	540	620
14	Shri. Gurudatta, Takliwadi, Shirol	2500	100	300	80	150	230
15	M/s. Vasantdada Shetkari S. S. K. Ltd.	7500	500	60	370	60	430
16	M/s. Rajarambapu Patil SSK Ltd.	4000	446	100	416	80	496
17	M/s. Vishwasrao Naik SSK Ltd.	2500	600	150	400	100	500
18	M/s Hutatma Kisan Ahir S.S.K. Ltd.	2500	200	50	200	50	250
19	M/s. Tasgaon Palus Taluka SSK Ltd.	2750	450	50	400	45	445
20	M/s. Sonhira Sahakari Sakhar Karkhana Ltd. Tal-, Dist-Sangli.	4000	450	80	250	60	310
21	M/s. Kranti Sahakari Sakhar Karkhana Ltd.	4000	Cooling- 110 Pro- 285	87	Rec – 110 Eff- 228	77	305
22	M/s. Cane Agro Energy India Ltd. Kadegaon	2500	230	30	200	25	225
23	M/s. Udgiri Sugar & Power Ltd	2500	370	20	260	18	278

24	M/s. Mohanrao Shinde SSK Ltd.	2500	500	50	210	30	240
25	Mahadik Sugars	1250	350	50	250	30	280
26	S. Mandlik, S.S.K, Kagal	2500	100	300	80	150	230
27	M/S Yashwantrao Mohite Krishna S.S.K Ltd Rethare (B.K)	7500	3125	355	2800	355	3155
28	M/S Kissanveer satara sahakari sakhar karkhana Ltd, Bhuinj	3000	150	180	100	160	260
29	M/S Rayat S.S.K Ltd Shewalewadi (Mahasoli)	7500	820	150	500	120	620
30	M/S Sahayadri S.S.K Ltd Yashwant Nagar	7500	700	250	300	200	500
31	M/S Jaywant SSK Ltd	1500	350	50	250	30	280
32	M/S Loknete Balasaheb Desai S.S.K Ltd	7000	580	200	200	125	325
33	M/S Ajinkyatara S.S.K Ltd	8000	1050	150	1020	132	1152
34	Senapati Kapshi S.S.K*	--	--	--	--	--	--
	Total	**53250**	**8325**	**1785**	**6170**	**1375**	**7545**

Source – Maharashtra Pollution Control Board, * Industry is not yet working.

Table no 4.6 List Distilleries, their water consumption and effluent generation in Krishna River Basin in Maharashtra

Sr. No.	Name of Distillery	Industrial water consumption (CMD)	Domestic water consumption (CMD)	Industrial Effluent (CMD)	Domestic Effluent (CMD)	Total effluent generated (CMD)
1	Saideep traders, ichalkaranji	620	0.4	540	0.3	540.3
2	Kumbhi Kasari SSK Ltd	427	1.7	303	1.5	304.5
3	Shri Bhogawati Sahakari S.S.K	327	2.0	230	2.0	232
4	Shri Datta Shetakari SSK Ltd., Shirol	750	6.0	435	3.0	438
5	Kolhapur Sugar Mill, kolhapur	575	5.0	525	4.0	529
6	M/s. Vasantdada Shetkari S. S. K. Ltd.	700	2.50	560	2.00	562
7	M/s. Sarvodaya SSK Ltd., karad	300	0.1	250	0.08	250.08
8	M/s. Rajarambapu Patil SSK Ltd.	775	10	630	08	638
9	M/s. Vishwasrao Naik SSK Ltd.	275	10	144	08	152
10	M/s Hutatma Kisan Ahir S.S.K. Ltd.	330	15	240	1.50	241.5
11	M/s. Yashwant SSK Ltd.	600	3.75	360	3.00	363

12	M/s. Sonhira Sahakari Sakhar Karkhana Ltd. Tal-, Dist-Sangli.	350	5.00	240	4.00	244
13	M/s. Kranti Sahakari Sakhar Karkhana Ltd.	285	87	228	77	305
14	M/S Yashwantrao Mohite Krishna S.S.K Ltd Rethare (B.K)	1220	5.00	1190	5.00	1195
15	M/S Kissanveer satara sahakari sakhar karkhana Ltd, Bhuinj	400	12	210	10	220
16	M/S Sahayadri S.S.K Ltd Yashwant Nagar	750	1.00	200	0.8	200.8
17	M/S Ajinkyatara S.S.K Ltd	165	8.00	150	4.00	154
18	Yashraj Ethanol Processing Pvt. Ltd	300	15	214	12	226
19	Khandoba Prasanna Sakhar Karkhana Ltd.	165	10	126	09	135
	Total	**9314**	**199.45**	**6775**	**155.18**	**6930.18**

Source – Maharashtra Pollution Control Board

Some of the major facts about sugar industries are as follows:

- 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.

Considering the above issues separate detailed study is need to be undertaken regarding sugar industries and distilleries.

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. As runoff moves, it picks up and carries pollution, which

it can deposit into ponds, lakes, coastal waters, and underground sources of drinking water.

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 1306941 Ha area is under cultivation and 583784 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 1.75 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 4.5.

Table no 4.5 Total Cultivated Area and Sale of Chemical Fertilisers in the Krishna River Basin in Maharashtra

District	Land under cultivation (ha)	Sale of Fertilisers MT	Per hectare use MT
Satara	354414	138492	2.55
Sangli	336831	**178728**	**1.88**
Kolhapur	330734	**266564**	**1.24**
Total	**1021979**	**583784**	**1.75**

Source: District statistical reports of Satara, Sangli, Kolhapur (2012)

4.2.5 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.

According to animal census of 2007 total number of cattle in Satara is 415259, Sangli is 494102 and Kolhapur is 716520. Among that in Satara district 75011 are exotic hybrid cattle, 99605 are local hybrid cattle, 240643 are buffaloes; in Sangli district 63880 are foreign hybrid cattle, 70236 are Indian hybrid cattle, 359986 are buffaloes; in Kolhapur district 124655 are foreign hybrid cattle, 89898 are Indian hybrid cattle, 501967 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. 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.

4.2.6 Religious wastes

There are number of religious places on the bank of Krishna River and its tributaries such as Nrusinhwadi, Aundumber, Wai, Sangam mauli; 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.

4.2.7 Solid waste management

Waste is an integral bye product of the modern life style. As such it is essential to manage wastes properly. The waste created 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. As per available data the total waste generated in this region is 11298.7723. 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 hospitals on the bank of rivers was directly entering into the river water without any treatment.

Another important factor that leads to pollution is improper solid waste disposal. The above table shows details of type of waste generation in each of the three districts. It also shows amount treated. The total hazardous waste generated is 1032.264 MT /month out of which 889.73 is treated while all the waste from Satara is left untreated. The biomedical waste generated is 3.84938 MT / day out of which all the waste is treated. The total quantity of Municipal solid waste generated is 16445.5 MT / month out of which only 1220 MT / month is treated. The details of waste management are mentioned in the table no 4.6

Table no. 4.6 Details of solid waste generation and its treatment

Sr. no.	Waste Management Details	SATARA	SANGLI	KOLHAPUR
a)	**Hazardous Waste (HW)**			
1	No. of Hazardous Waste generating units	179	65	205
2	No. of Authorization issued by MPCB as on 31/03/2014	179	65	134
3	Quantity of H.W. generated (MT/Month)	97.791	164.473	770
4	Quantity of H.W. treated (MT/Month)		164.73	725
5	Units with own adequate treatment & disposal facility	Nil	Nil	Nil
6	Quantity of waste treated in their own facility (MT/Month)	Nil	Nil	Nil
7	Developed Common Treatment & Disposal Facilities	Nil	Nil	Nil
8	Units joined to common facilities	65	31	134
9	Quantity of waste treated at common facility (MT/Month)	97.791	2.61	725
b)	**Bio-Medical Waste (BMW)**			
1	No. of Health Care Establishments (HCEs)	1118	1364	1773

2	No. of Authorization Issued as on 31/03/2014	865	698	1774
3	Quantity of BMW Generated (MT/day)	1.21438	0.885	1.75
4	Quantity of BMW treated (MT/day)	1.21438	0.885	1.75
5	HCEs with own treatment & disposal facilities	1	73	84
6	Quantity of waste treated in their own facility (MT/day)	0.16373	0.16876	0.65
7	HCEs joined to common facilities	1981	1274	1441
8	Quantity of waste treated at common facility (MT/day)	1050.65	885	1.1
c)	**Municipal Solid Waste (MSW) Management**			
1	No of local bodies	9	6	10
1	No. of Authorization Issued under MSW Rules as on 31/03/2014	2	5	9
2	Quantity of Solid waste Generated in (MT/Month)	125.5	6870	9450
3	Quantity of Solid waste Treated (MT/Month)	Nil	1170	50
4	Local bodies having their own treatment & disposal facilities.	3	4	4
5	Quantity of Solid waste Treated in their own facilities (MT/Month)	Nil	1170	Nil
6	Local Bodies joined to common facilities (if any)	Nil	Nil	Nil

4.2.8 River water management -

River water management is a crucial factor. The water management system at rivers Krishna and Koyana is completely different from other places. There are very few cananls in the river basin. The main river bed is used as a canal. All the major dams in Western Ghats in Maharashtra are located on the river origin area of Krishna and its tributaries. In some cases two major dams were built in nearby areas considering the geographical and hydrological conditions of this area. Regular discharge of water from these dams is carried out to fulfill the needs of villages, towns, cities, industries and agriculture. However to store such water in downstream of dam weirs are built in the river bed. These weirs are also used as bridge for passing from one bank to another bank. These are exclusively known as Kolhapur type of weirs.

4.2.8.1 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 river bank facilitating transport through and fro. The usual practise with respect to weirs is to allow passage of water through the weirs at periodic intervals of 8 to 15 days. Stakeholders for purpose of irrigation use this water.

The weirs prove to be obstacles to flow of water. These weirs are creating a chain of pools by altering the natural character of river in the river bed. This leads to the altering the rivers natural characteristic, affecting river biodiversity and ecosystem. Along with this industrial effluent, domestic sewage, agricultural runoff, solid waste from the settlements on both the banks intrudes into the river bed. The water between two consecutive weirs remains stagnant for about 15 days of time interval while sewage and industrial effluents continuously enters the river and thereby increases the intensity of pollution. Hence, water quality of river gets deteriorate from first to eighth day. Further it rapidly deteriorated. To identify exact impact, it is necessary to carry out continuous monitoring of river water between two consecutive weirs.

There are 16 K T weirs on the Krishna River. They are located at Rajapur, Maishal, Sangli, Digraj, Nagthane, Pharnewadi/Borgaon, Bahe, Khodshi, Umbraj, Kavale, Shirgaon, Kameri, Vandan, Jihe, Chinchnor Vandan, Angapur Vandan. The details of number of K.T. weirs is mentioned in the table no 4.7

Table no 4.7 Rivers and Number of K T Weirs

Sr No	Name of the River	Number of K T Weirs
1	Vedganga	20
2	Bhogawati	08
3	Dudhganga	08
4	Tulashi	10
5	Dhamani	04
6	Kumbhi	16
7	Kasari	19
8	Panchaganga	09
9	Kadvi	08
10	Warna	11
11	D Mand	02
12	Koyana	02
13	Wang	02
14	Tarali	0
15	U Mand	04
16	Urmodi	09
17	Venna	01
18	Krishna	16
19	Yerala	05
20	Wasna	03

4.2.8.2 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 of sand, 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 need to be discussed and studied in detail.

4.2.9 Brick Making

The natural vegetation on the banks of the river has been destroyed either in the process of agricultural expansion or during removal of soil for converting it into brick kilns. The use of 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 basins.

Various studies show that there are adverse effects of brick industries on soil, water, air, vegetation and human health. Bricks are mainly made of soil and numbers of additives are added to the soil to increase the strength of bricks. The use of excessive amount of soil causes soil degradation. Besides these, the waste along with water flows back in the river, increasing the total solids, suspended solids, dissolved oxygen, calcium hardness, total hardness etc.

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.

During the field survey number of brick making units was observed. The units were located in the stretch from Sonjirwadi d/s to Sultanpur, at Umbraj u/s and d/s sand excavation and brick manufacturing units were observed. From Kasbe Digraj to Sangli, at Haripur, Samarthnagar near Chinchwad large number of units were observed.

It was observed that due to excessive digging for clay the vegetation has been cut at these sites which have led to soil depletion. Moreover, after digging the sites are left as such and fresh plantation is not done, which leads to land degradation and depletion of vegetation.

4.2.10 Sand mining -

Sand extraction from the river is another serious threat to the riparian system in this region. Enormous amount of sand is extracted from River Krishna and its tributaries. This is carried out in illegal manner. Because of sand extraction the flora and fauna of Natural River system gets affected. Planktons, nektons are adversely affected by drilling and pumping of river bed. The depth of the pool increases and due to transport of sand by trucks near the river, river banks get damaged and pool erosion is observed in the various parts of the Warna river. In the Krishna River stretch during field survey at following locations extensive sand mining was observed.

- In Satara district at Menawali ghat to 500 m d/s sand mining was observed. At Ozarde bandhara d/s to Anpathwadi near Kadegaon also sand mining was reported.

- At stretch from NH4 d/s, Bhuinj d/s upto Khadki at Chandewadi extensive sand mining was done. Near Asale digging of wells in river bed along with sand mining was observed.
- At the u/s and d/s of Maradhe sand mining was observed. Large sand mining units were observed at Wadoth d/s.

- Near Mangalpur at 8 locations sand mining is carried out by pumping. Along with this a big sand depot was observed at Dhondwadi near Tasgaon, where roads were constructed in the river bed.

- Sand mining was also observed at d/s of Fadtarwadi bandhara, Targaon, Venegaon bandhara near Koparde. At Perle 22 pumping locations were reported.

- Sand mining using conveyor belts was reported at Wazewadi bandhara. At Umbraj u/s and d/s, Tembhu project d/s, Karve, Kareteke are some other places where sand mining was observed.

- From Dushire to Atake stretch continuous sand mining was observed. Some of the places such as Rethare, Audumbar and Nrusinhawadi to Gaurwad were noted with sand mining.

The sand mining is carried out in unscientific manner without any concern of ecology or the hydrology of the river.

4.2.11 Saline Soil -

Soil salinity is the salt content in the soil; the process of increasing the salt content is known as Salinization. Salt is a natural element of soils and water. Salination can be caused by natural processes such as mineral weathering or the

gradual withdrawal of an ocean. It can also be caused by artificial processes such as irrigation. The excess accumulation of salts, typically most pronounced at the soil surface, can result in salt-affected soils. Salts may rise to the soil surface by capillary transport from a salt-laden water table and then accumulate due to evaporation. They can also become concentrated in soils due to human activity, for example the use of potassium as fertilizer, which can form sylvite, a naturally occurring salt. As soil salinity increases, salt effects can result in degradation of soils and vegetation. The ions responsible for salinization are: Na+, K+, Ca2+, Mg2+ and Cl-

Salinization as a process can result from:

- High levels of salt in water.
- Landscape features that allow salts to become mobile (movement of water table).
- Climatic trends that favor accumulation.
- Human activities such as land clearing.

Large size of saline soil was noted in Sangli district i.e. 5000 ha. The total saline soil in the Kolhapur district is 3700 ha. The places such as Kasabe Digraj, Khodashi, patches near Shirol are suffering with the problem of Saline soil.

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 Krishna 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 especially at Sangam mauli, Nrusinhwadi, Aundumber, Wai and 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.

4.3.1 Visit to Sangli district

At Sahyadri Starch Ltd. Miraj the ETP consisted of equilisation and collection tanks, buffer tank, UASB, facultative tank, aeration, clarifiers, RO, sludge drying beds. The water which had undergone the reverse osmosis process was recycled and reused within the unit while the remaining water was given for irrigation. There were scrubbers for sulphur extraction. The heat produced during the process was trapped and reused for steam generation. A part of the maize grain is used for starch manufacturing while its outer cover is separated for oil extraction. Some parts of the remains after oil extraction are used as manure while the reaming waste which consisted of both solids as well as liquids was found lying in the premises. A general lack of housekeeping was observed in the premises.

The Ramvishwas dairy at Miraj plant is just 50 m away from river and lies in the flood prone area. The ETP was not in proper working condition and the space provided for it was insufficient. A lot of sludge was present in the treated effluent indicating improper treatment. There was bad odor in the premises and a general lack of housekeeping.

The ETP of Sharad Sugar plant had a capacity of 1000 m^3. The ETP consisted of Screening tank, Skimming tank, Equalization tank, Primary clarifier, UASB, Surface aeration, Secondary holding tank. The treated effluent is provided for the irrigation purposes at neighboring farms. Several leakages in the supply lines were observed.

At Bhilawadi in B G Chitale Dairy the ETP consisted of equilisation tanks, diffused aeration tank, scuppers for sludge collection from top, clarifier and UASB. All the units were properly maintained and treated effluent was used for irrigation of 95 acres of land. Housekeeping was excellent and the unit is an ideal example of proper operation and maintenance of ETP and Housekeeping.

A trench filled with saline water was seen between Kawate Piran and Samdoli. The agricultural land between these villages has become saline. In order to reduce salinity of land the Agricultural department has dug a number of trenches on the saline land. By the flow of gravity, all the saline water from these lands is

collected in a main trench which ultimately led to Warna River. Another stretch of saline land was observed at Kasbe Digraj. It was also observed that many of the farmers had adopted the practice of drip irrigation for avoiding excess use of water.

At Bansi Paper Mill ETP was functional. The effluent was collected in the holding tank where the fibers settle down and the settled particles are then removed from the bottom and then the entire water is reused in the processes. The effluent contained traces of the chemicals used in the processes which reduced the demand for more chemicals to be added. The settled sludge was dried on the sludge drying beds and then used for landfilling. There was no proper housekeeping both in the manufacturing units as well as on the ETP site. The effluent was seen going towards the Warna River.

On Kasbe Digraj road - Near Bansi Paper Mill is the solid waste dumping site for Sangli, Miraj and Kupwad. It was observed that untreated solid waste along with the bio-medical waste was being dumped on open land along with the untreated waste from septic tank. Also incineration ash was directly disposed with MSW. Thus in short there was no segregation of waste nor was there any use of scientific method used for waste disposal. This site is at a distance of 1.9 km from the Warna River towards west and 2.2 km from Krishna River towards east. A lot of lagoons were seen formed by leachates and the discharge of BANSI Industries a paper mill was also visible into the lagoons. Thus the risk of leachates entering into the river water is extremely high and it is a great threat to the river.

In Miraj, an area was found which consisted of bio-medical waste facility, solid waste dumping station, slaughter house and oxidation ponds for waste water treatment all at one location. The solid waste was dumped on open land without segregation which could cause the nuisance of rodents, scavengers and insects. The slaughter house had advanced technologies for slaughtering of animals and other processes. The waste water generated from the slaughter house which has high amount of blood is treated in separate treatment unit. However, the treated water had red colour indicating traces of blood in it. This treated water was further send to oxidation pond and then for irrigation purpose. Solid waste of slaughter compost yard not properly maintained.

At Rajarambapu Patil Sahakari Dudh Sang ETP was present but not properly operated and maintained. Anaerobic treatment followed by aerobic treatment is given and the treated effluent is used for agriculture. Proper housekeeping was absent.

In the Satyasai, Pratibha and Prerana Industries a common ETP was provided for these three industries. The ETP was not properly operated and maintained. Major problem of colour removal from the effluent was observed. All the treatment units were not in operation. The treated effluent, dark green in colour was discharged into an artificial pond.

Apart from these industries there are some other units which are major pollutants in the district. Hutatma dudh, Viraj alcohol, Ram Vishwas dairy, Mairaj railway junction, Kirloskar brothers Ltd, Yashwant glucose factory, Patil Dairy at Palus were also observed to be more or less contributors of pollution of river.

4.3.2 Satara district

At Krishna Hospital, Karad the STP was closed for repairs and modification work was going on. All the waste generated was stored in a kachha lagoon and then was released through underground pipes outside the hospital's campus. An outlet was observed at the North East corner of the hospital campus. Incineration ash was observed near incinerator room. Syringes, bottles etc was observed lying in the campus. Waste piles were observed at different places without any type of segregation. There was an old plant towards east, 500 m away from Krishna Hospital in Koyna Colony where the effluent was discharged without any treatment. This plant had "Root Zone Technology", but it was not working in proper condition. Excess of water was given for agriculture. At both the sites no disinfection was done and was left through the open drains. There is a possibility that this water may be mixing with the Krishna River.

At the Chitale Chilling plant at Tasawde the ETP was found to be in working condition and the treated effluent is used for gardening. At Hindustan Sizing the

effluent production was 8000 l/d. the ETP was functioning properly and the treated water used for gardening.

At the Royal Food a large amount of effluent was generated. However the ETP was closed and the effluent was released into the natural drains. Pulp waste was dumped on the nearby hilly area towards north. Leachates produced due to this deposition travel towards the natural drainage across the highway which would ultimately reach the river.

At Santosh Milk also the ETP was non-functional. Septic in the culture was observed. Leakages were observed in many places across the plant and campus. There was a lack of proper maintenance. The effluent was discharged into the MIDC gutters.

At Prabhune Engineering plating process is carried out which uses a lot of water. ETP was present and the effluent was recycled after treatment. Hazardous waste was stored in the lagoons for a long duration. Leakages were observed in the premises. And no housekeeping for ETP site was done.

It was found that Garware Bestreach ETP was not functioning properly. An outlet was observed in the campus connecting to the natural drains. White dust from the process was observed in the effluent. At the Mapro Food Plant at Wai the water consumption is 60,000 l/ d. The ETP was not in full-fledged working condition. It was partially under construction and modification. Solid waste was not observed anywhere in the campus. The treated effluent was used for 30 acres agricultural land and 25 acres of garden area. The sludge drying beds were closed.

At Malas food the ETP was functioning properly but it was poorly managed. The housekeeping was also of a poor quality. The treated effluent was partially left in the natural drains and partially stored in kachha lagoons.

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.

At Sahyadri Sahakari Sugar Karkhana the following were the observations:-

There was a lagoon 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. Compost yard used for storage of pressmud was lined with tiles. Concrete platforms were used for spreading the press mud and spentwash is spread over it. Bagass bricks were packed in plastic sheets in order to protect from rain. One lagoon was used for sludge settling. The ash scattered in the premises was further supplied to brick manufacturers according to the employees of the SSK. It was observed that the effluent from the distillery was being filled in tankers and sent for disposal approximately 1.5 km away in agricultural fields. Ten such tankers were observed. On further enquiry the farmers from the area told the field team that it was recurrent practice to dispose effluent in this manner.

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 for 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 are 10 sampling stations on Krishna, Venna, Urmodi, Koyana rivers; in Sangli district there are 6 sampling stations on Krishna and Warna river; in Kolhapur district there are 6 sampling stations on Panchaganga and Krishna river. 26 water parameters are analysed for monitoring. Details of the sampling stations are mentioned in the following table.

Table no. 5.1 Sampling Stations

Sr No	Sampling Stations
Satara District	
1	Venna River, A/p- Mahuli, Satara
2	Urmodi River, A/p- Nagthane, Satara
3	Venna River, Mahabaleshwar
4	Krishna River, Krishna Bridge, Karad
5	Krishna River (Dhom Dam), Mahabaleshwar
6	Venna River, Varye, Satara
7	Krishna River, Kshetra Mahuli, Satara
8	Krishna River, Sangam Mahuli, Satara
9	Koyna River At- Karad, Tal-Karad, Dist-Satara
10	Krishna River, Wai, Tal-Wai, Dist-Satara

Sangli District	
11	Krishna River Water at Mai ghat Sangli
12	Krishna River Water at Walwa D/S of Islampur
13	Warna River Water at Samdoli
14	Bahe K.T.Weir Bahe Tal.- Walwa
15	Borgaon K.T.Weir Borgaon Tal.- Walwa
16	Mangle Bridge Mangle Tal. Shirala
Kolhapur District	
17	Panchganga River water at Balinga U/S of Kolhapur Town
18	Panchganga River water at Balinga D/S of Kolhapur Town (NH-4 Bridge)
19	Panchganga River water at Ichalkaranji Ghat
20	Panchganga at River shirol near intake well
21	Krishna at Kurundwad
22	Krishna at Rajapur Weir

The GEMS Minar data of 22 river sampling sites from three districts was procured from the MPCB. The data from 2011 to 2013 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 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 tables bellow -

Table no. 5.2 River Water Analysis from Satara District (2011 – 20130 with standard Deviation

	Parameter	A-II River std	Venna River, Mahabaleshwar				Urmodi River, A/p- Nagthane Satara				Venna River, A/p- Mahuli, Satara			
			Winter	Summer	Rainy	Average	Winter	Summer	Rainy	Average	Winter	Summer	Rainy	Average
1	**pH**	6.5 to 9.0	8.03 ± 0.38	7.83 ± 0.51	7.93 ± 0.40	7.93 ±0.43	8.13 ± 0.38	7.96 ± 0.46	8.10 ± 0.40	8.06 ± 0.41	8.11 ± 0.37	7.95 ± 0.40	8.16 ± 0.40	8.07 ± 0.39
2	**Conductivity**	-	152.80 ± 63.37	131.81 ± 55.74	156.29 ± 64.90	146.34 ± 60.61	353.88 ± 120.87	280.92 ± 147.54	258.42 ± 54.62	298.32 ± 120.81	343.40 ± 67.76	377.64 ± 118.01	367.88 ± 121.57	363.22 ± 103.49
3	**BOD**	5.0 Mg/l	4.36 ± 0.66	4.74 ± 1.78	3.77 ± 0.63	4.31 ± 1.22	6.69 ±1.35	6.93 ± 1.72	5.25 ±1.63	6.33 ± 1.71	6.99 ± 1.49	6.62 ± 1.58	6.31 ± 1.33	6.65 ± 1.46
4	**Nitrate (N)**	45 mg/l	1.69 ± 4.90	0.33 ± 0.29	0.49 ± 0.46	0.83 ± 2.84	0.86 ± 0.93	0.61 ± 0.88	0.64 ±0.63	0.70 ± 0.82	0.94 ± 1.04	0.65 ± 0.87	0.92 ± 1.22	0.83 ± 1.02
5	**Ammonia**	1.5 mg/l	0.27 ± 0.20	0.52 ± 0.42	0.27 ± 0.21	0.35 ± 0.31	0.38 ± 0.26	25.22 ± 78.40	0.31 ± 0.20	8.64 ± 4.01	0.39 ± 0.24	0.75 ± 0.60	0.43 ± 0.28	0.52 ± 0.42
6	**Total Coliform**		325.76 ± 130.30	637.50 ± 624.52	373.33 ± 152.96	452.31 ± 407.00	1016.66 ± 456.96	1307.14 ± 428.71	868.18 ± 373.84	1082.43 ± 466.63	1022.08 ± 622.05	1116.92 ± 607.14	935.00 ± 432.47	1032.43 ± 560.27
7	**Faecal Coliform 100 ml**		29.38 ± 26.10	79.79 ± 106.30	24.33 ± 8.34	45.92 ±69.03	119.23 ± 55.52	165.00 ± 84.26	103.33 ± 68.00	130.77 ± 73.86	141.07 ± 80.78	193.43 ± 106.64	129.58 ± 69.88	156.33 ± 90.43
8	**C.O.D.**	-	12.69 ± 4.64	16.57 ± 6.05	14.67 ± 3.11	14.69 ± 4.98	23.69 ± 4.46	22.86 ± 5.07	18.67 ± 5.98	21.85 ± 5.49	22.15 ± 5.06	20.86 ± 4.75	19.33 ± 6.11	20.82 ± 5.29
9	**TKN**		1.64 ± 0.93	1.38 ± 0.63	1.48 ± 0.98	1.50 ± 0.84	1.92 ± 0.79	2.25 ± 1.23	1.99 ± 1.98	2.06 ± 1.14	2.13 ± 0.91	2.57 ± 1.23	2.09 ± 1.84	2.28 ± 1.34
10	**TDS**	-	115.62 ± 48.69	94.43 ± 40.76	105.66 ± 38.73	104.95 ± 42.79	268.15 ± 95.08	205.14 ± 120.77	182.83 ± 39.44	219.28 ± 98.01	260.84 ± 55.43	266.00 ± 86.47	257.25 ± 95.25	261.59 ± 78.54
11	**Total Fixed Solids**	-	91.85 ± 34.93	78.79 ± 32.59	88.08 ± 37.95	86.00 ± 34.61	223.38 ± 78.73	173.00 ± 100.38	151.08 ± 37.37	183.05 ± 82.01	217.46 ± 43.90	222.93 ± 75.68	220.08 ± 92.26	220.23 ± 70.98
12	**T.S.S.**	-	16.77 ± 17.67	8.93 ± 4.53	17.42 ± 10.20	14.15 ± 12.31	19.46 ± 8.99	21.50 ± 29.16	20.75 ± 14.52	20.59 ± 19.45	18.69 ± 8.08	13.64 ± 7.09	20.50 ± 10.07	17.44 ± 8.78
13	**Turbidity**	-	0.83 ± 1.05	0.77 ± 0.47	2.56 ± 3.14	1.35 ± 2.00	1.70 ± 3.70	0.79 ± 0.52	3.59 ± 8.87	1.96 ± 5.35	1.03 ± 1.53	0.59 ± 0.34	2.56 ± 5.57	1.36 ± 3.24

14	**Hardness**	500 mg/l	39.23 ± 20.09	37.71 ± 16.28	39.33 ± 16.41	38.72 ± 17.23	151.08 ± 48.19	95.14 ± 53.97	99.00 ± 23.99	114.97 ± 50.68	155.38 ± 42.79	145.86 ± 54.87	153.16 ± 48.14	151.28 ± 47.92
15	**Fluoride**	1.5 mg/l	0.84 ± 0.56	0.67 ± 0.38	0.67 ± 0.32	0.73 ± 0.43	1.23 ± 0.59	0.85 ± 0.56	0.76 ± 0.32	0.95 ± 0.54	1.26 ± 0.56	0.75 ± 0.47	0.74 ± 0.31	0.92 ± 0.51
16	**Boron**	-	0.28 ± 0.14	0.23 ± 0.19	0.31 ± 0.30	0.27 ± 0.22	0.33 ± 0.11	0.36 ± 0.17	0.23 ± 0.06	0.31 ± 0.13	0.33 ± 0.13	0.45 ± 0.23	0.32 ±0.18	0.37 ± 0.19
17	**Chloride**	600 mg/l	21.23 ± 13.80	27.036 ± 21.79	27.13 ± 26.78	25.13 ± 20.93	36.46 ± 16.94	43.29 ± 22.66	39.83 ± 27.93	39.95 ± 22.37	35.31 ± 11.76	61.46 ± 46.29	47.17 ± 34.54	48.00 ± 34.73
18	**Sulphate**	400 mg/l	5.47 ± 4.08	4.86 ± 3.05	10.46 ± 10.55	6.79 ± 6.85	14.75 ±8.44	12.18 ± 7.29	8.70 ± 4.48	11.97 ± 7.25	9.98 ± 8.33	18.73 ± 24.97	19.48 ± 14.34	16.04 ± 17.71
19	**Total Alkalinity**	-	31.69 ± 15.03	27.57 ± 15.42	29.35 ± 13.00	29.49 ± 14.31	127.38 ± 43.33	78.57 ± 46.64	84.50 ± 24.84	96.67 ± 44.79	135.23 ± 44.43	126.14 ± 53.14	136.00 ± 44.87	132.21 ± 46.83
20	**P-alkalinity**	-	5.00 ± 192	28.00 ± 7.45	4.00 ± 1.15	10.50 ± 4.61	6.23 ± 3.58	11.33 ± 5.67	5.00 ± 1.99	7.84 ± 4.08	9.00 ± 3.40	10.00	6.67 ± 3.06	8.29 ± 3.33
21	**Sodium**	-	7.48 ± 3.40	6.93 ± 4.30	10.30 ± 5.14	8.15 ± 4.45	18.02 ±12.07	16.87 ± 12.56	14.88 ± 7.73	16.64 ± 10.90	16.15 ± 7.31	22.76 ± 15.34	42.51 ± 90.33	26.64 ± 50.81
22	**Potassium**	-	1.04 ± 0.29	3.46 ± 8.81	1.42 ± 0.72	2.02 ± 5.29	2.23 ± 1.49	2.64 ± 2.79	2.27 ± 1.28	2.39 ± 1.97	1.95 ± 0.92	1.96 ± 0.81	2.86 ± 2.32	2.23 ± 1.49
23	**Calcium**	-	15.08 ± 10.12	15.85 ± 12.47	21.00 ± 14.95	17.18 ± 12.53	65.90 ± 20.55	46.66 ± 36.31	45.66 ± 15.83	52.77 ± 27.31	74.43 ± 35.96	60.91 ± 39.57	79.50 ± 40.81	71.14 ± 38.61
24	**Magnesium**	-	22.87 ± 14.28	14.76 ± 10.11	21.42	19.64 ± 14.21	72.17 ± 33.38	44.62 ± 41.38	43.86 ± 26.53	53.57 ± 36.32	71.84 ± 26.15	60.15 ± 38.53	60.38 ± 35.36	64.12 ± 33.41
25	**Phosphate**	-	0.37 ± 0.31	0.88 ± 2.19	0.56 ± 0.39	0.61 ± 1.32	0.47 ± 0.31	0.46 ± 0.29	0.57 ± 0.37	0.50 ± 0.32	0.49 ± 0.33	0.51 ± 0.40	0.57 ± 0.29	0.52 ± 0.34
26	**D. oxygen**	4.0 mg/l	5.82 ± 0.17	5.48 ± 0.44	5.74 ± 0.25	5.67 ± 0.34	5.07 ± 57	4.84 ± 0.49	5.48 ± 0.44	5.11 ± 0.56	4.97 ± 0.54	4.97 ± 0.59	4.98 ± 0.63	4.97 ± 0.57

	Parameter	A-II River std	Krishna River, Krishna Bridge, Karad				Krishna River (Dhom Dam), Mahabaleshwar				Venna River, Varye, Satara			
			winter	Summer	Rainy	Average	winter	Summer	Rainy	Average	winter	Summer	Rainy	
1	**pH**	6.5 to 9.0	8.00 ± 0.40	7.76 ± 0.51	8.06 ± 0.46	7.93 ± 0.47	7.87 ± 0.46	7.73 ± 0.47	8.01 ± 0.47	7.87 ± 0.47	8.01 ± 0.43	7.90 ± 0.40	8.08 ± 0.40	7.99 ± 0.41
2	**Conductivity**	-	285.79 ± 120.54	193.58 ± 69.47	217.75 ± 88.96	231.76 ± 100.64	156.33 ± 44.28	154.79 ± 57.80	149.91 ± 77.68	153.80 ± 59.30	303.06 ± 84.52	322.31 ± 64.17	301.33 ± 114.26	309.44 ± 86.83
3	**BOD**	5.0 Mg/l	6.94 ± 1.87	5.68 ± 1.09	5.33 ± 1.45	5.99 ± 1.62	3.94 ± 0.92	3.58 ± 1.23	3.63 ± 1.24	3.71 ± 1.12	6.30 ± 1.13	6.07 ± 1.81	5.65 ± 1.44	6.02 ± 1.48
4	**Nitrate (N)**	45 mg/l	0.62 ± 0.79	0.53 ± 0.53	0.56 ± 0.43	0.57 ± 0.59	0.86 ± 2.21	0.42 ± 0.64	0.37 ± 0.28	0.55 ± 1.32	0.63 ± 0.54	0.34 ± 0.18	0.57 ± 0.74	0.51 ± 0.53
5	**Ammonia**	1.5 mg/l	0.41 ± 0.26	2.97 ± 8.94	0.49 ± 0.35	1.35 ± 5.37	0.34 ± 0.22	0.46 ± 0.36	0.34 ± 0.29	0.38 ± 0.30	0.42 ± 0.23	0.65 ± 0.29	0.36 ± 0.19	0.48 ± 028
6	**Total Coliform**		985.00 ± 627.15	1184.50 ± 729.00	1110.00 ± 637.86	1116.00 ± 684.12	310.00 ± 395.19	608.85 ± 671.07	271.25 ± 153.11	400.00 ± 477.64	922.50 ± 537.54	1133.92 ± 521.98	1104.16 ± 379.27	1057.76 ± 492.65
7	**Faecal Coliform 100 ml**		197.07 ± 130.97	211.78 ± 122.29	220.00 ± 90.33	209.41 ± 113.95	30.07 ± 26.55	90.43 ± 105.87	22.92 ± 8.09	49.54 ± 71.03	127.23 ± 62.79	217.29 ± 181.88	127.08 ± 38.76	159.51 ± 122.13
8	**C.O.D.**	-	23.69 ± 5.28	18.57 ± 5.57	18.00 ± 4.35	20.10 ± 5.62	12.15 ± 3.69	12.29 ± 4.29	12.33 ± 4.67	12.26 ± 4.11	20.00 ± 3.65	19.71 ± 7.59	18.33 ± 4.96	19.38 ± 5.62
9	**TKN**		2.06 ± 0.63	2.29 ± 1.09	1.96 ± 1.38	2.11 ± 1.05	1.34 ± 0.84	1.38 ± 0.67	1.20 ± 0.76	1.31 ± 0.74	1.54 ± 0.66	1.94 ± 0.92	1.72 ± 1.62	1.74 ± 1.10
10	**TDS**	-	212.69 ± 94.75	142.86 ± 47.88	144.16 ± 53.20	166.54 ± 74.38	118.85 ± 36.08	113.43 ± 41.90	101.83 ± 45.66	111.67 ± 40.80	225.00 ± 52.66	229.57 ± 46.97	199.58 ± 75.00	218.82 ± 58.58
11	**Total Fixed Solids**	-	177.54 ± 76.07	125.64 ± 45.92	120.33 ± 49.26	141.31 ± 62.69	99.08 ± 28.79	95.36 ± 32.11	85.42 ± 41.93	93.54 ± 34.00	188.53 ± 45.05	193.64 ± 39.36	170.25 ± 70.44	184.74 ± 52.03
12	**T.S.S.**	-	17.38 ± 8.92	11.14 ± 5.97	23.33 ± 12.74	16.97 ± 10.47	14.46 ± 6.97	8.64 ± 4.97	14.58 ± 7.92	12.41 ± 7.08	15.62 ± 7.53	10.71 ± 5.57	16.97 ± 7.17	14.26 ± 7.13
13	**Turbidity**	-	30.88 ± 108.20	0.76 ± 0.49	3.66 ± 6.60	11.70 ± 62.45	0.61 ± 0.28	0.70 ± 0.19	4.07 ± 8.54	1.71 ± 4.87	1.49 ± 3.64	0.71 ± 0.44	1.82 ± 2.43	1.31 ± 2.49
14	**Hardness**	500 mg/l	101.54 ± 55.88	57.07 ± 23.94	63.33 ± 31.70	73.82 ± 43.29	52.15 ± 20.44	52.71 ± 18.56	41.33 ± 21.55	49.03 ± 20.28	181.07 ± 164.87	126.57 ± 44.66	132.16 ± 51.97	146.46 ± 103.29

15	**Fluoride**	1.5 mg/l	4.77 ± 12.99	0.72 ± 0.57	0.82 ± 0.27	2.14 ± 7.56	0.77 ± 0.55	0.65 ± 0.35	0.49 ± 0.30	0.65 ± 0.42	0.98 ± 0.49	0.74 ± 0.42	0.59 ± 0.27	0.77 ± 0.43
16	**Boron**	-	0.36 ± 0.14	0.35 ± 0.11	0.29 ± 0.12	0.34 ± 0.12	0.27 ± 0.10	0.24 ± 0.15	0.24 ± 0.10	0.25 ± 0.12	0.34 ± 0.19	0.38 ± 0.21	0.27 ± 0.09	0.33 ± 0.18
17	**Chloride**	600 mg/l	35.15 ± 20.86	36.43 ± 13.15	34.08 ± 22.51	35.28 ± 18.55	24.35 ± 18.33	27.85 ± 14.06	28.58 ± 29.72	26.91 ± 20.81	28.81 ± 12.56	43.43 ± 22.37	31.92 ± 22.15	35.01 ± 20.13
18	**Sulphate**	400 mg/l	11.49 ± 6.91	11.72 ± 9.52	7.94 ± 3.72	10.48 ± 7.28	4.69 ± 2.83	7.92 ± 8.80	5.65 ± 3.42	6.15 ± 5.86	6.33 ± 3.48	9.89 ± 7.86	5.61 ± 4.20	7.39 ± 5.81
19	**Total Alkalinity**	-	85.85 ± 53.19	47.71 ± 22.50	52.83 ± 25.62	62.00 ± 39.41	37.69 ± 16.14	40.29 ± 13.89	32.67 ± 17.04	37.08 ± 15.57	111.50 ± 55.31	111.71 ± 44.97	107.17 ± 42.91	110.21 ± 46.95
20	**P-alkalinity**	-	11.00 ± 5.02	NIL	5.33 ± 2.61	7.60 ± 3.24	6.00 ± 1.66	NIL	NIL	6.00 ± 0.96	62.67 ± 45.73	64.00 ± 44.09	6.00 ± 2.84	44.22 ± 36.91
21	**Sodium**	-	15.44 ± 9.93	14.76 ± 15.68	14.62 ± 7.33	14.94 ± 11.44	10.75 ± 8.51	9.31 ± 4.82	8.59 ± 5.02	9.57 ± 6.24	12.91 ± 6.53	15.54 ± 6.28	13.78 ± 7.82	14.12 ± 6.78
22	**Potassium**	-	2.17 ± 2.11	1.39 ± 0.70	2.19 ± 1.36	1.90 ± 1.50	1.38 ± 1.24	1.07 ± 0.39	1.51 ± 0.83	1.31 ± 0.88	1.75 ± 1.11	1.84 ± 0.79	2.12 ± 1.31	1.89
23	**Calcium**	-	46.45 ± 36.93	20.57 ± 11.82	28.00 ± 17.93	31.48 ± 26.38	18.12 ± 9.46	19.51 ± 11.66	19.00 ± 12.46	18.89 ± 10.96	69.54 ± 38.38	52.94 ± 33.38	60.00 ± 29.96	60.65 ± 33.99
24	**Magnesium**	-	51.64 ± 28.42	20.80 ± 9.89	26.37 ± 15.79	32.79 ± 23.42	25.59 ± 10.73	23.56 ± 15.64	16.52 ± 9.45	22.07 ± 12.68	58.82 ± 29.96	52.09 ± 32.96	57.90 ± 37.37	56.12 ± 32.69
25	**Phosphate**	-	0.52 ± 0.31	0.50 ± 0.44	0.58 ± 0.49	0.53 ± 0.41	0.38 ± 0.32	0.33 ± 0.29	0.64 ± 0.50	0.44 ± 0.39	0.43 ± 0.33	0.39 ± 0.31	0.44 ± 0.37	0.42 ± 0.33
26	**D. oxygen**	4.0 mg/l	5.25 ± 0.52	5.33 ± 0.29	5.56 ± 0.42	5.38 ± 0.42	6.02 ± 0.24	5.89 ± 0.18	5.93 ± 0.23	5.95 ± 0.21	5.39 ± 0.30	5.07 ± 0.56	5.42 ± 0.38	5.28 ± 0.45

	Parameter	A-II River std	Krishna River, Kshetra Mahuli, Satara				Krishna River, Sangam Mahuli, Satara			
			winter	Summer	Rainy	Average	winter	Summer	Rainy	Average
1	**pH**	6.5 to 9.0	8.03 ± 0.41	8.05 ± 0.44	8.20 ± 0.44	8.09 ± 0.42	8.079 ± 0.37	8.08 ± 0.47	8.12 ± 0.38	8.09 ± 0.40
2	**Conductivity**	-	464.47 ± 149.85	498.11 ± 79.81	374.93 ± 90.24	449.00 ± 119.71	417.94 ± 101.37	436.33 ± 119.52	349.95 ± 102.41	403.62 ± 111.99
3	**BOD**	5.0 Mg/l	6.19 ± 1.25	6.30 ± 2.03	5.68 ± 1.93	6.07 ± 1.75	6.06 ± 1.35	6.42 ± 1.48	5.65 ± 1.53	6.07 ± 1.45
4	**Nitrate (N)**	45 mg/l	1.37 ± 2.02	0.56 ± 0.59	1.02 ± 1.14	0.97 ± 1.38	1.09 ± 1.32	0.73 ± 0.91	1.14 ± 1.33	0.98 ± 1.18
5	**Ammonia**	1.5 mg/l	0.42 ± 0.19	0.55 ± 0.37	0.38 ± 0.27	0.46 ± 0.30	0.42 ± 0.28	0.68 ± 0.45	0.33 ± 0.20	0.49 ± 0.36
6	**Total Coliform**		945.63 ± 634.95	1450.00 ± 650.11	1366.66 ± 754.18	1275.58 ± 725.79	1027.50 ± 691.85	1507.69 ± 481.98	1460.00 ± 775.13	1350.77 ± 740.29
7	**Faecal Coliform 100 ml**		188.23 ± 121.33	220.71 ± 109.47	198.63 ± 71.84	203.21 ± 102.86	208.33 ± 104.76	212.14 ± 69.99	216.81 ± 62.62	212.30 ± 78.89
8	**C.O.D.**	-	20.62 ± 4.27	19.71 ± 7.92	18.00 ± 5.78	19.49 ± 6.17	19.07 ± 5.92	21.43 ± 5.11	18.66 ± 4.92	19.79 ± 5.35
9	**TKN**		2.26 ± 0.95	2.71 ± 1.39	2.71 ± 2.07	2.56 ± 1.49	2.18 ± 0.93	2.46 ± 1.13	2.29 ± 2.30	2.32 ± 1.53
10	**TDS**	-	350.15 ± 109.78	348.71 ± 49.25	261.16 ± 81.46	322.26 ± 90.88	305.69 ± 73.63	308.85 ± 78.66	244.58 ± 86.68	288.03 ± 82.86
11	**Total Fixed Solids**	-	316.23 ± 158.62	295.00 ± 44.19	221.25 ± 81.91	279.38 ± 110.35	255.00 ± 60.39	263.00 ± 70.37	208.16 ± 83.54	243.46 ± 73.80
12	**T.S.S.**	-	21.23 ± 12.85	13.79 ± 6.02	25.33 ± 15.30	19.82 ± 12.49	21.77 ± 11.17	13.07 ± 6.53	27.33 ± 15.80	20.36 ± 12.73
13	**Turbidity**	-	1.01 ± 1.79	0.82 ± 0.96	2.80 ± 5.79	1.50 ± 3.44	0.56 ± 0.36	0.89 ± 0.86	4.74 ± 12.65	1.97 ± 7.09
14	**Hardness**	500 mg/l	170.46 ± 56.74	188.28 ± 44.11	166.00 ± 49.57	175.49 ± 49.91	179.92 ± 50.48	168.28 ± 47.01	131.51 ± 52.42	160.85 ± 52.66
15	**Fluoride**	1.5 mg/l	1.34 ± 0.57	0.71 ± 0.35	0.93 ± 0.32	0.98 ± 0.50	1.23 ± 0.62	0.84 ± 0.57	0.80 ± 0.45	0.96 ± 0.58

16	**Boron**	-	0.38 ± 0.16	0.43 ± 0.22	0.35 ± 0.19	0.39 ± 0.19	0.37 ± 0.15	0.39 ± 0.21	0.36 ± 0.19	0.38 ± 0.18
17	**Chloride**	600 mg/l	64.04 ± 38.96	58.43 ± 24.74	46.75 ± 26.81	56.71 ± 30.78	35.73 ± 15.18	55.71 ± 27.31	38.00 ± 27.64	43.60 ± 25.19
18	**Sulphate**	400 mg/l	12.88 ± 7.93	21.50 ± 14.05	13.62 ± 12.10	16.21 ± 12.09	15.39 ± 10.67	17.96 ± 14.89	19.65 ± 16.98	17.63 ± 14.08
19	**Total Alkalinity**	-	151.09 ± 52.61	168.00 ± 44.78	141.16 ± 45.21	154.11 ± 47.74	148.50 ± 58.82	148.57 ± 50.80	131.00 ± 40.08	143.00 ± 49.96
20	**P-alkalinity**	-	13.00 ± 6.11	25.33 ± 11.91	10.00 ± 4.83	16.50 ± 8.34	46.66 ± 29.99	16.50 ± 8.97	10.66 ± 5.21	23.80 ± 18.20
21	**Sodium**	-	24.52 ± 12.81	35.99 ± 18.64	20.13 ± 10.63	27.29 ± 15.81	17.83 ± 9.007	31.06 ± 29.33	16.93 ± 5.73	22.30 ± 19.33
22	**Potassium**	-	2.82 ± 1.96	2.20 ± 0.77	2.92 ± 1.99	2.63 ± 1.63	2.39 ± 1.59	2.25 ± 1.10	2.47 ± 1.18	2.37 ± 1.28
23	**Calcium**	-	78.83 ± 32.56	70.20 ± 30.05	77.33 ± 37.45	75.27 ± 33.61	81.66 ± 36.53	67.97 ± 37.56	73.66 ± 38.07	74.29 ± 36.84
24	**Magnesium**	-	86.99 ± 33.69	74.37 ± 33.98	70.99 ± 37.88	77.54 ± 34.88	89.89 ± 35.71	62.69 ± 30.36	64.54 ± 37.37	72.33 ± 35.80
25	**Phosphate**	-	0.60 ± 0.47	0.42 ± 0.26	0.69 ± 0.72	0.57 ± 0.51	0.60 ± 0.46	0.44 ± 0.41	0.65 ± 0.33	0.56 ± 0.41
26	**D. oxygen**	4.0 mg/l	5.44 ± 0.33	5.20 ± 0.49	5.26 ± 0.62	5.30 ± 0.49	5.35 ± 0.36	4.96 ± 0.38	5.44 ± 0.37	5.24 ± 0.42

	Parameter	A-II River std	Koyna River At- Karad, Tal-Karad, Dist-Satara				Krishna River, Wai, Tal-Wai, Dist-Satara			
			winter	Summer	Rainy	Average	winter	Summer	Rainy	Average
1	**pH**	6.5 to 9.0	8.01 ± 0.38	8.14 ± 0.23	7.98 ± 0.31	8.05 ± 0.31	8.16 ± 0.04	8.01 ± 0.26	7.88 ± 0.28	8.02 ± 0.24
2	**Conductivity**	-	203.55 ± 48.02	157.51 ± 52.49	200.73 ± 99.43	187.27 ± 71.79	285.50 ± 89.96	450.22 ± 73.33	238.00 ± 34.96	324.58 ± 114.46
3	**BOD**	5.0 Mg/l	5.31 ± 1.36	6.01 ± 1.31	5.25 ± 1.34	5.52 ± 1.35	6.92 ± 1.22	7.77 ± 1.31	8.10 ± 0.86	7.60 ± 1.21
4	**Nitrate (N)**	45 mg/l	0.35 ± 0.24	0.75 ± 1.08	0.42 ± 0.30	0.51 ± 0.67	0.38 ± 0.22	0.63 ± 0.73	0.25 ± 0.10	0.42 ± 0.45
5	**Ammonia**	1.5 mg/l	0.28 ± 0.18	0.72 ± 0.48	0.50 ± 1.23	0.50 ± 0.72	0.15 ± 0.07	1.05 ± 0.66	0.07 ± 0.01	0.43 ± 0.58
6	**Total Coliform**		1062.50 ± 650.60	1122.72 ± 494.73	1313.88 ± 707.63	1184.38 ± 682.02	1425.00 ± 324.04	1600.00 ± 00	1600.00 ± 740.65	1536.36 ± 476.32
7	**Faecal Coliform 100 ml**		236.25 ± 120.19	152.50 ± 95.41	245.42 ± 76.59	211.39 ± 105.08	195.00 ± 76.63	168.75 ± 31.70	180.00 ± 9.26	181.25 ± 47.33
8	**C.O.D.**	-	16.67 ± 5.35	18.67 ± 3.55	15.00 ± 3.46	16.78 ± 4.36	25.05 ± 3.59	23.00 ± 7.01	21.00 ± 5.55	23.02 ± 5.58
9	**TKN**		1.99 ± 0.36	2.53 ± 0.69	2.51 ± 1.40	2.34 ± 0.93	2.21 ± 0.31	2.50 ± 0.46	1.69 ± 0.62	2.14 ± 0.57
10	**TDS**	-	151.58 ± 41.21	111.00 ± 40.55	138.83 ± 69.37	133.81 ± 53.46	196.50 ± 28.46	316.50 ± 41.49	171.50 ± 17.39	228.17 ± 71.01
11	**Total Fixed Solids**	-	125.25 ± 31.35	91.83 ± 31.51	115.33 ± 60.43	110.81 ± 44.39	167.00 ± 23.88	266.50 ± 39.46	145.25 ± 14.60	192.92 ± 60.16
12	**T.S.S.**	-	11.83 ± 3.51	11.83 ± 4.13	16.83 ± 4.63	13.50 ± 4.66	14.50 ± 1.77	13.50 ± 4.87	20.00 ± 4.00	16.00 ± 4.64
13	**Turbidity**	-	2.59 ± 4.30	0.91 ± 0.36	9.97 ± 19.55	4.49 ± 11.91	3.12 ± 4.61	0.44 ± 0.07	15.33 ± 26.70	6.30 ± 16.35
14	**Hardness**	500 mg/l	58.50 ± 21.76	38.50 ± 17.77	70.17 ± 70.43	55.72 ± 44.53	115.00 ± 16.04	181.00 ± 18.80	105.00 ± 29.37	133.67 ± 40.43
15	**Fluoride**	1.5 mg/l	1.08	0.66	0.81	0.85	0.75	0.875	0.74	0.79

			± 0.56	± 0.31	± 0.19	± 0.41	± 0.04	± 0.53	± 0.08	± 0.30
16	**Boron**	-	0.43 ± 0.09	0.42 ± 0.16	0.33 ± 0.13	0.39 ± 0.14	0.38 ± 0.05	0.40 ± 0.23	0.31 ± 0.05	0.37 ± 0.14
17	**Chloride**	600 mg/l	28.50 ± 11.82	38.92 ± 16.05	26.50 ± 19.65	31.31 ± 16.64	29.00 ± 7.17	63.00 ± 18.53	24.75 ± 13.59	38.92 ± 21.96
18	**Sulphate**	400 mg/l	6.47 ± 2.83	4.39 ± 2.70	5.64 ± 3.98	5.50 ± 3.25	8.90 ± 7.97	28.31 ± 24.41	10.25 ± 4.96	15.82 ± 17.03
19	**Total Alkalinity**	-	44.83 ± 17.59	29.17 ± 14.92	50.17 ± 48.02	41.39 ± 31.20	88.00 ± 14.58	157.00 ± 19.74	87.50 ± 23.68	110.83 ± 38.29
20	**P-alkalinity**	-	6.00 ± 1.73	NIL	2.00 ± 0.58	4.00 ± 1.05	NIL	NIL	NIL	N.A.
21	**Sodium**	-	13.00 ± 5.74	9.37 ± 3.20	13.27 ± 9.83	11.86 ± 6.86	11.60 ± 4.07	20.13 ± 5.77	11.70 ± 6.61	14.48 ± 6.72
22	**Potassium**	-	2.00 ± 1.43	1.21 ± 0.51	2.08 ± 1.94	1.76 ± 1.76	2.22 ± 1.10	2.23 ± 0.73	2.25 ± 1.35	2.23 ± 1.04
23	**Calcium**	-	22.67 ± 13.08	16.17 ± 14.18	31.83 ± 40.52	23.56 ± 25.99	62.00 ± 13.52	93.50 ± 28.01	54.00 ± 22.67	69.83 ± 27.47
24	**Magnesium**	-	35.83 ± 13.00	22.33 ± 7.48	26.00 ± 14.49	28.18 ± 12.94	53.00 ± 3.21	87.50 ± 21.02	51.00 ± 6.84	63.83 ± 21.09
25	**Phosphate**	-	0.68 ± 0.43	0.29 ± 0.27	0.35 ± 0.33	0.44 ± 0.38	0.36 ± 0.11	0.27 ± 0.15	0.22 ± 0.05	0.29 ± 0.12
26	**D. oxygen**	4.0 mg/l	5.47 ± 1.89	5.57 ± 0.33	5.67 ± 0.24	5.57 ± 0.27	4.71 ± 0.20	4.46 ± .051	4.33 ± 0.11	4.50 ± 0.35

Data Source – Maharashtra Pollution control Board, ± indicates standard deviation from mean value

The river water analysis is carried out to show the general status of the rivers Venna, Urmodi and Krishna at various destinations in Satara district. Majority of the water parameters are within the prescribed standards of A-II River. Seasonal variation can be noted in case of few parameters. pH of all the sample ranges neutral as well as there is very minute deviation in its range. In all the three seasons the pH of the all sample show variation in fractions which is very minute. The parameters such as dissolved oxygen, fluorides, boron are within the limits and also show small deviation from its average reading. The downstream water samples are recorded with lower levels of dissolved oxygen. There is no considerable seasonal variation in dissolved oxygen, fluorides and boron levels. However Krishna river sample at Krishna bridge, Karad show slightly violating fluoride limits. The B.O.D. levels at all the stations except Venna River at Mahabaleshwar and Koyana river at Karad are slightly exceeded. There is a large amount of variation in the total coliform and fecal coliform number. The presence of coliforms indicates fecal contamination. 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 also show slight seasonal variations. These parameters are dependent on the ions in the water. As per the season the discharge of pollutants in the water also varies which gives rise to higher deviations from the average reading.

Table no. 5.3 River Water Analysis from Sangli District (2011-2013) with standard Deviation

	Parameter	A-II River std	Krishna River Water at Mai ghat Sangli				Krishna River Water at Walwa D/S of Islampur				Warna River Water at Samdoli			
			Winter	Summer	Rainy	Average	Winter	Summer	Rainy	Average	Winter	Summer	Rainy	Average
1	**pH**	6.5 to 9.0	8.1125 ± 0.47	7.88 ± 0.53	7.80 ± 0.36	7.93 ± 0.47	7.92 ± 0.44	8.07 ± 0.47	7.82 ± 0.49	7.88 ± 0.28	8.03 ± 0.46	7.79 ± 0.47	7.71 ± 0.46	7.85 ± 0.48
2	**Conductivity**	-	738.90 ± 444.74	667.22 ± 225.76	274.10 ± 148.27	573.60 ± 359.02	401.80 ± 273.47	475.62 ± 216.52	422.50 ± 384.37	297.65 ± 117.40	539.48 ± 399.13	306.05 ± 246.59	208.77 ± 66.43	349.05 ± 331.24
3	**BOD**	5.0 Mg/l	3.90 ± 1.68	5.51 ± 7.27	3.25 ± 1.39	4.29 ± 4.58	4.47 ± 4.54	3.14 ± 1.13	5.05 ± 4.94	5.21 ± 6.15	2.80 ± 1.15	5.10 ± 6.25	3.23 ± 1.12	3.78 ± 3.95
4	**Nitrate (N)**	45 mg/l	1.17 ± 0.86	1.42 ± 0.80	2.45 ± 3.07	1.70 ± 1.91	4.93 ± 19.14	11.88 ± 33.04	1.22 ± 0.51	2.89 ± 4.59	1.01 ± 0.62	1.55 ± 1.34	1.25 ± 0.72	1.30 ± 1.00
5	**Ammonia**	1.5 mg/l	0.47 ± 0.33	0.60 ± 0.18	0.45 ± 0.20	0.52 ± 0.25	0.51 ± 0.23	0.42 ± 0.24	0.57 ± 0.15	0.51 ± 0.26	0.37 ± 0.17	0.57 ± 0.17	0.47 ± 0.24	0.48 ± 0.21
6	**Total Coliform**		121.66 ± 21.25	118.00 ± 43.38	130.83 ± 43.78	123.35 ± 40.09	136.32 ± 36.05	134.61 ± 28.75	134.61 ± 41.83	140.00 ± 37.17	104.16 ± 21.51	101.53 ± 37.35	100.83 ± 29.06	102.16 ± 29.95
7	**Faecal Coliform 100 ml**		4.22 ± 2.33	13.75 ± 28.36	5.36 ± 3.11	8.19 ± 17.38	4.69 ± 2.27	4.18 ± 2.02	4.76 ± 1.78	5.08 ± 2.87	3.33 ± 1.73	3.33 ± 1.51	3.09 ± 1.80	3.25 ± 1.64
8	**C.O.D.**	-	26.90 ± 12.04	36.15 ± 19.79	28.00 ± 11.18	30.61 ± 15.24	30.27 ± 11.37	25.66 ± 6.91	36.62 ± 8.61	28.00 ± 14.77	26.18 ± 16.00	32.30 ± 16.21	27.66 ± 13.26	28.89 ± 15.07
9	**TKN**		0.39 ± 0.21	0.47 ± 0.34	0.33 ± 0.22	0.40 ± 0.27	0.46 ± 0.29	0.51 ± 0.29	0.50 ± 0.29	0.35 ± 0.28	0.38 ± 0.24	0.41 ± 0.33	0.33 ± 0.26	0.38 ± 0.27
10	**TDS**	-	595.27 ± 493.67	441.46 ± 237.56	229.25 ± 84.56	417.72 ± 332.81	267.04 ± 198.99	310.37 ± 94.01	309.20 ± 300.60	171.00 ± 34.14	404.18 ± 312.10	226.46 210.71	162.75 ± 47.54	259.53 ± 244.24
11	**Total Fixed Solids**	-	118.36 ± 136.45	296.61 ± 208.04	164.57 ± 109.33	198.14 ± 130.81	173.31 ± 194.37	180.50 ± 114.53	220.00 ± 94.40	107.75 ± 97.85	242.18 178.56	154.53 ± 116.38	113.00 ± 57.76	167.47 ± 191.23
12	**T.S.S.**	-	16.55 ± 8.65	20.40 ± 11.09	22.37 ± 11.39	19.70 ± 10.26	18.19 ± 5.06	15.37 ± 3.88	18.00 ± 6.09	21.25 ± 2.96	17.45 ± 6.22	17.23 ± 6.31	22.66 ± 12.38	19.11 ± 9.00
13	**Turbidity**	-	0.58	0.70	0.74	0.69	0.57	0.47	0.70	0.43	0.44	0.70	0.80	0.69

			± 0.33	± 0.26	± 0.72	± 0.50	± 0.30	± 0.26	± 0.10	± 0.25	± 0.27	± 0.38	± 0.73	± 0.54
14	**Hardness**	500 mg/l	152.18 ± 115.50	138.61 ± 73.30	126.54 ± 51.31	139.09 ± 82.02	123.33 ± 52.77	148.22 ± 71.95	100.60 ± 41.17	123.75 ± 26.64	136.54 ± 51.16	93.69 ± 43.14	96.50 ± 24.42	107.72 ± 43.34
15	**Fluoride**	1.5 mg/l	0.24 ± 0.07	0.75 ± 0.19	1.48 ± 0.43	0.82 ± 0.27	1.03 ± 0.39	0.16 ± 0.05	NIL	1.46 ± 0.67	0.12 ± 0.03	0.65 ± 0.17	1.46 ± 0.42	0.75 ± 0.26
16	**Boron**	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
17	**Chloride**	600 mg/l	100.31 ± 201.15	61.50 ± 84.47	24.95 ± 15.40	61.18 ± 123.84	26.09 ± 12.18	29.88 ± 12.63	20.95 ± 5.14	28.25 ± 16.52	20.36 ± 13.02	20.65 ± 7.57	20.93 ± 9.84	20.66 ± 10.01
18	**Sulphate**	400 mg/l	99.86 ± 94.91	89.60 ± 52.69	33.29 ± 23.53	73.97 ± 66.87	37.70 ± 31.24	47.86 ± 41.58	37.83 ± 33.37	27.37 ± 9.33	38.73 ± 35.70	33.73 ± 29.19	19.20 ± 11.74	30.42 ± 27.68
19	**Total Alkalinity**	-	108.18 ± 47.18	304.69 ± 64.88	234.16 ± 78.12	221.14 ± 468.11	111.89 ± 29.99	105.88 ± 34.39	130.40 ± 25.22	95.50 ± 18.07	116.90 ± 83.97	102.46 ± 48.15	81.33 ± 15.54	99.83 ± 55.60
20	**P-alkalinity**	-	NIL	2.10 ± 0.84	4.00 ± 1.61	3.05 ± 1.05	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
21	**Sodium**	-	83.59 ± 71.15	71.97 ± 32.26	45.92 ± 23.98	66.36 ± 46.40	40.65 ± 20.66	43.78 ± 29.05	42.82 ± 12.29	34.80 ± 19.62	39.27 ± 28.23	41.68 ± 24.39	32.08 ± 15.70	37.71 ± 23.00
22	**Potassium**	-	11.67 ± 12.85	7.76 ± 8.40	5.53 ± 8.16	8.11 ± 9.83	6.48 ± 5.46	5.88 ± 4.49	6.25 ± 5.87	7.38 ± 6.36	5.26 ± 6.39	4.23 ± 4.00	4.23 ± 4.41	4.53 ± 4.85
23	**Calcium**	-	56.58 ± 56.07	40.11 ± 26.56	29.70 ± 11.96	41.68 ± 36.17	41.57 ± 45.70	66.50 ± 70.56	32.27 ± 23.57	25.12 ± 10.88	42.85 ± 28.84	21.11 ± 12.85	22.21 ± 12.01	28.12 ± 20.62
24	**Magnesium**	-	44.03 ± 73.27	21.03 ± 29.72	13.27 ± 6.58	25.47 ± 45.29	22.52 ± 23.05	34.05 ± 28.26	19.26 ± 24.50	13.61 ± 3.34	26.54 ± 15.49	15.96 ± 14.07	12.59 ± 3.38	32.90 ± 85.58
25	**Phosphate**	-	1.16 ± 0.63	1.65 ± 0.95	1.31 ± 0.55	1.38 ± 0.73	1.89 ± 2.85	3.20 ± 4.76	1.29 ± 0.67	1.15 ± 0.44	1.67 ± 0.48	1.43 ± 0.72	1.94 ± 2.45	37.20 ± 203.05
26	**D. oxygen**	4.0 mg/l	6.50 ± 0.77	6.26 ± 1.88	6.59 ± 2.04	6.44 ± 1.66	6.55 ± 0.63	6.55 ± 0.67	6.29 ± .0.62	6.87 ± 0.47	6.73 ± 0.64	6.70 ± 0.69	6.90 ± 0.58	6.78 ± 0.63

	Parameter	A-II River std	Bahe K.T.Weir Bahe Tal.- Walwa				Borgaon K.T.Weir Borgaon Tal.- Walwa				Mangle Bridge Mangle Tal. Shirala			
			Winter	Summer	Rainy	Average	Winter	Summer	Rainy	Average	Winter	Summer	Rainy	Average
1	**pH**	6.5 to 9.0	7.90 ± 0.32	7.53 ± 0.47	7.92 ± 0.52	7.77 ± 0.47	8.06 ± 0.23	7.54 ± 0.33	7.86 ± 0.46	7.81 ± 0.41	7.96 ± 0.43	7.51 ± 0.28	8.20 ± 0.23	7.81 ± 0.41
2	**Conductivity**	-	437.56 ± 255.85	186.07 ± 35.25	177.92 ± 41.17	260.95 ± 183.52	361.67 ± 76.01	207.00 ± 48.77	181.38 ± 34.12	246.71 ± 95.00	329.35 ± 226.46	165.33 ± 129.65	205.77 ± 12.38	220.39 ± 162.47
3	**BOD**	5.0 Mg/l	3.47 ± 1.21	4.72 ± 4.64	3.10 ± 1.57	3.84 ± 3.06	3.32 ± 0.82	5.82 ± 7.02	3.00 ± 0.90	4.18 ± 4.46	3.07 ± 0.51	5.32 ± 5.54	3.00 ± 0.40	3.92 ± 3.54
4	**Nitrate (N)**	45 mg/l	1.07 ± 0.59	1.49 ± 0.79	3.40 ± 5.42	1.99 ± 3.11	0.97 ± 0.70	1.32 ± 0.59	3.43 ± 4.81	1.90 ± 2.83	1.31 ± 0.95	1.13 ± 0.41	1.84 ± 0.47	1.90 ± 2.81
5	**Ammonia**	1.5 mg/l	0.36 ± 0.20	0.48 ± 0.13	0.34 ± 0.17	0.41 ± 0.19	0.39 ± 0.20	0.47 ± 0.12	0.35 ± 0.19	0.42 ± 0.18	0.39 ± 0.22	0.50 ± 0.13	0.38 ± 0.13	0.43 ± 0.19
6	**Total Coliform**		105.00 ± 32.95	118.88 ± 42.17	138.75 ± 40.15	120.80 ± 40.41	103.75 ± 32.04	127.77 ± 50.60	126.25 ± 55.06	119.60 ± 46.24	103.75 ± 25.03	106.66 ± 39.77	97.50 ± 15.00	108.80 ± 32.03
7	**Faecal Coliform 100 ml**		4.00 ± 2.39	4.00 ± 1.68	5.714 ± 3.16	4.63 ± 2.62	4.00 ± 2.39	4.50 ± 2.06	5.42 ± 3.53	4.74 ± 2.80	4.00 ± 2.33	3.75 ± 1.69	2.66 ± 1.63	3.80 ± 1.90
8	**C.O.D.**	-	29.50 ± 16.82	28.40 ± 7.16	25.00 ± 15.08	27.69 ± 12.85	29.00 ± 14.30	28.00 ± 11.46	26.50 ± 10.23	27.85 ± 11.62	28.00 ± 14.34	45.33 ± 35.01	17.00 ± 5.03	31.68 ± 24.24
9	**TKN**		0.37 ± 0.26	0.45 ± 0.33	0.28 ± 0.19	0.38 ± 0.28	0.40 ± 0.26	0.44 ± 0.27	0.33 ± 0.25	0.40 ± 0.26	0.36 ± 0.25	0.43 ± 0.31	0.45 ± 0.12	0.37 ± 0.26
10	**TDS**	-	302.00 ± 193.52	126.30 ± 21.39	134.12 ± 26.32	182.77 ± 132.01	244.87 ± 102.46	137.40 ± 58.52	136.62 ± 25.38	170.23 ± 83.24	230.12 ± 176.03	106.80 ± 31.54	153.25 ± 23.20	154.15 ± 109.89
11	**Total Fixed Solids**	-	199.25 ± 184.85	66.10 ± 40.51	87.00 ± 40.17	113.50 ± 118.69	160.50 ± 114.92	81.50 ± 59.66	88.25 ± 40.90	107.88 ± 82.07	153.00 ± 160.07	57.50 ± 40.59	76.25 ± 54.66	96.04 ± 99.32
12	**T.S.S.**	-	16.87 ± 3.87	15.10 ± 4.43	19.13 ± 4.73	16.88 ± 4.52	16.75 ± 4.55	15.90 ± 4.67	20.50 ± 3.82	17.58 ± 4.67	16.63 ± 3.73	14.90 ± 4.45	17.25 ± 3.77	16.85 ± 4.76
13	**Turbidity**	-	0.52 ± 0.33	0.68 ± 0.16	0.41 ± 0.25	0.56 ± 0.31	0.52 ± 0.35	0.72 ± 0.24	0.47 ± 0.33	0.59 ± 0.35	0.42 ± 0.29	0.62 ± 0.12	0.16 ± 0.09	0.50 ± 0.28
14	**Hardness**	500 mg/l	101.75	84.00	92.50	92.08 ± 44.13	100.75	87.80	93.75	93.62 ± 36.53	102.75	78.88	92.00	88.48 ± 38.13

			± 64.28	± 38.44	± 27.03		± 42.13	± 34.58	± 36.68		± 35.40	± 44.71		
15	**Fluoride**	1.5 mg/l	BDL	BDL	1.45 ± 0.51	1.45 ± 0.28	BDL	BDL	1.46 ± 0.51	1.46 ± 0.29	BDL	BDL	BDL	BDL
16	**Boron**	-	NA	NA	NA	NA	NA	NA	NA	NA	BDL	BDL	BDL	NA
17	**Chloride**	600 mg/l	22.37 ± 10.211	16.15 ± 16.03	15.12 ± 7.23	17.75 ± 12.10	29.00 ± 19.73	13.25 ± 8.92	16.25 ± 7.28	19.02 ± 14.15	26.25 ± 24.01	12.95 ± 8.81	19.25 ± 7.36	17.40 ± 15.52
18	**Sulphate**	400 mg/l	20.29 ± 8.44	13.28 ± 5.98	21.37 ± 7.57	21.78 ± 21.55	35.30 ± 37.81	24.06 ± 14.68	20.37 ± 5.13	103.31 ± 399.93	28.74 ± 36.37	14.37 ± 15.79	19.00 ± 2.58	19.99 ± 22.50
19	**Total Alkalinity**	-	70.25 ± 8.43	89.20 ± 36.30	81.75 ± 13.06	81.08 ± 24.63	81.50 ± 14.95	72.40 ± 14.68	79.75 ± 12.00	77.46 ± 14.06	68.25 ± 20.29	74.80 ± 27.19	59.00 ± 1.83	71.54 ± 21.39
20	**P-alkalinity**	-	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NIL	BDL	BDL	BDL	NIL
21	**Sodium**	-	30.31 ± 20.50	43.80 ± 19.70	28.01 ± 11.30	34.97 ± 19.00	35.55 ± 20.64	54.03 ± 25.38	49.68 ± 71.55	47.47 ± 43.43	28.39 ± 19.78	43.61 ± 27.81	17.24 ± 13.53	37.45 ± 29.32
22	**Potassium**	-	4.14 ± 3.76	7.59 ± 7.58	5.61 ± 5.57	5.99 ± 6.02	5.61 ± 3.89	10.18 ± 13.12	11.47 ± 20.22	9.32 ± 13.73	4.05 ± 3.39	8.13 ± 12.74	2.55 ± 2.47	7.29 ± 9.56
23	**Calcium**	-	48.90 ± 56.56	25.15 ± 15.97	20.37 ± 7.48	30.99 ± 34.00	48.42 ± 40.86	26.76 ± 17.49	22.47 ± 10.22	32.11 ± 27.08	41.32 ± 32.05	25.55 ± 17.45	22.45 ± 15.03	28.62 ± 22.93
24	**Magnesium**	-	28.52 ± 25.82	14.54 ± 13.73	10.10 ± 3.89	17.48 ± 17.85	26.00 ± 21.49	14.66 ± 11.79	10.26 ± 5.95	16.80 ± 15.23	29.47 ± 24.33	10.17 ± 6.11	9.55 ± 4.20	15.93 ± 16.34
25	**Phosphate**	-	1.183 ± 0.94	1.28 ± 0.62	1.20 ± 0.35	1.23 ± 0.65	0.99 ± 0.70	1.37 ± 0.68	1.23 ± 0.34	1.21 ± 0.60	1.20 ± 0.88	1.34 ± 0.78	0.86 ± 0.17	1.24 ± 0.69
26	**D. oxygen**	4.0 mg/l	6.27 ± 0.91	6.95 ± 0.67	6.93 ± 0.43	6.74 ± 0.74	6.28 ± 0.91	6.63 ± 0.79	6.96 ± 0.26	6.63 ± 0.75	6.68 ± 0.56	6.82 ± 0.65	6.87 ± 0.9	6.86 ± 0.54

Data Source – Maharashtra Pollution control Board, ± indicates standard deviation from mean value

The river water analysis is carried out to show the general status of the rivers Warna and Krishna at various destinations in Sangli district. Majority of the water parameters are within the prescribed standards of A-II River. pH of all the sample range is neutral as well as there is very minute deviation in its range. There is no considerable variation in pH levels of the water samples throughout the three seasons. The parameters such as dissolved oxygen, fluorides, boron are within the limits and also show small deviation from its average reading. However, very small seasonal variations can be recorded from the present data set. The B.O.D. levels at all the stations are within the limits. There is a large amount of variation in the total coliform and fecal coliform number. The presence of coliforms indicates the fecal contamination. The levels of C.O.D., TKN, T.S.S., turbidity, potassium, ammonia and nitrates show variation from the average parameters readings. The nitrates levels show variation in three seasons. The nitrates levels of the sample near Islampur shows highest nitrate levels compared to other sites during summer season, further sources of nitrates need to be identified in this area. 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 gives rise to higher deviation from average reading.

Table no. 5.4 River Water Analysis from Kolhapur District (2011- 2013) with standard Deviation

	Parameter	A-II River std	Panchganga River water at Balinga U/S of Kolhapur Town				Panchganga River water at Balinga D/S of Kolhapur Town. (NH-4 Bridge)				Panchganga River water at Ichalkaranji Ghat 1311			
			Winter	Summer	Rainy	Average	Winter	Summer	Rainy	Average	Winter	Summer	Rainy	Average
1	**pH**	6.5 to 9.0	7.67 ± 0.67	7.54 ± 0.50	7.55 ± 0.58	7.60 ± 0.59	7.78 ± 0.40	7.19 ± 0.65	7.77 ± 0.54	7.51 ± 0.60	8.17 ± 0.48	7.38 ± 0.76	7.65 ± 0.41	7.64 ± 0.64
2	**Conductivity**	-	216.03 ± 134.69	388.07 ± 301.64	176.45 ± 75.39	265.72 ± 220.49	464.20 ± 243.40	490.34 ± 341.04	155.94 ± 59.10	359.19 ± 282.10	449.30 ± 281.04	585.65 ± 329.86	172.72 ± 58.70	445.10 ± 320.50
3	**BOD**	5.0 Mg/l	2.87 ± 0.90	5.23 ± 6.56	2.97 ± 0.37	3.83 ± 4.32	4.94 ± 2.58	7.77 ± 9.35	5.31 ± 2.25	5.88 ± 6.34	4.62 ± 2.10	8.13 ± 10.31	4.17 ± 2.02	5.80 ± 7.01
4	**Nitrate (N)**	45 mg/l	1.46 ± 0.93	1.08 ± 0.59	1.39 ± 0.44	1.28 ± 0.70	1.76 ± 1.21	1.46 ± 1.00	1.38 ± 0.59	1.40 ± 0.90	1.45 ± 0.89	1.57 ± 1.17	1.18 ± 0.64	1.39 ± 0.96
5	**Ammonia**	1.5 mg/l	0.46 ± 0.12	0.45 ± 0.18	3.41 ± 9.16	1.17 ± 4.01	0.51 ± 0.20	0.56 ± 0.13	0.48 ± 0.16	0.51 ± 0.17	0.46 ± 0.21	0.51 ± 0.16	0.39 ± 0.13	0.46 ± 0.19
6	**Total Coliform**		120.00 ± 17.32	121.66 ± 24.80	150.00 ± 34.64	128.28 ± 27.26	148.57 ± 1.42	153.33 ± 73.67	168.57 ± 47.40	158.40 ± 58.04	134.28 ± 48.70	188.88 ± 95.04	184.28 ± 57.98	178.80 ± 75.25
7	**Faecal Coliform 100 ml**		4.60 ± 2.33	4.66 ± 2.43	6.42 ± 3.25	5.21 ± 2.82	4.80 ± 3.08	6.11 ± 3.39	7.83 ± 4.49	6.68 ± 3.71	4.60 ± 4.58	8.11 ± 5.40	9.33 ± 5.29	8.36 ± 5.17
8	**C.O.D.**	-	27.38 ± 16.23	41.33 ± 26.164	21.14 ± 9.99	30.34 ± 20.94	30.28 ± 10.44	45.66 ± 18.71	41.71 ± 21.14	39.57 ± 18.33	35.42 ± 21.49	37.33 ± 19.98	32.57 ± 14.31	34.43 ± 20.02
9	**TKN**		0.46 ± 0.25	0.50 ± 0.27	0.28 ± 0.20	0.43 ± 0.25	0.60 ± 0.32	0.55 ± 0.30	0.40 ± 0.25	0.48 ± 0.28	0.60 ± 0.32	0.51 ± 0.28	0.31 ± 0.21	0.44 ± 0.28
10	**TDS**	-	236.76 ± 194.54	343.75 ± 320.33	124.71 ± 38.46	250.07 ± 243.23	350.57 ± 176.20	372.66 ± 290.64	119.00 ± 34.82	279.54 ± 230.32	312.14 ± 174.08	452.58 ± 292.05	132.57 ± 38.17	321.36 ± 247.80
11	**Total Fixed Solids**	-	148.76 ± 160.43	226.91 ± 293.91	74.57 ± 38.04	160.69 ± 214.38	238.57 ± 171.18	258.83 ± 276.15	71.00 ± 34.51	181.82 ± 209.56	215.14 ± 162.33	329.91 ± 283.56	80.85 ± 36.81	216.61 ± 226.80
12	**T.S.S.**	-	16.30 ± 4.71	16.16 ± 4.36	21.00 ± 4.89	17.38 ± 4.99	15.28 ± 7.01	17.08 ± 7.91	18.14 ± 5.08	17.07 ± 6.01	16.57 ± 4.67	20.00 ± 5.24	16.57 ± 3.64	17.89 ± 4.88
13	**Turbidity**	-	0.66	0.73	0.39	0.61	0.71	0.68	0.35	0.58	0.62	0.77	0.35	0.60

			± 0.35	± 0.13	± 0.27	± 0.31	± 0.36	± 0.07	± 0.25	± 0.30	± 0.36	± 0.17	± 0.25	± 0.34
14	**Hardness**	500 mg/l	137.69 ± 66.94	223.83 ± 246.55	97.71 ± 22.25	161.17 ± 169.15	161.42 ± 45.91	208.16 ± 211.85	98.28 ± 31.71	154.07 ± 145.96	141.14 ± 47.46	249.33 ± 227.31	100.85 ± 39.08	172.57 ± 163.82
15	**Fluoride**	1.5 mg/l	0.24 ± 0.06	BDL	0.60 ± 0.43	0.51 ± 0.23	0.14 ± 0.04	BDL	0.91 ± 0.55	0.65 ± 0.29	0.18 ± 0.05	BDL	1.44 ± 0.54	0.81 ± 0.27
16	**Boron**	-	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NA
17	**Chloride**	600 mg/l	37.91 ± 30.47	34.79 ± 39.55	24.64 ± 17.74	32.16 ± 25.78	52.50 ± 33.36	37.58 ± 28.43	24.14 ± 17.54	33.84 ± 25.99	45.42 ± 27.44	69.29 ± 82.47	26.71 ± 12.16	49.14 ± 58.29
18	**Sulphate**	400 mg/l	44.43 ± 58.38	28.57 ± 37.02	18.57 ± 7.27	30.73 ± 42.35	55.81 ± 62.88	33.36 ± 35.01	21.14 ± 8.04	39.29 ± 46.70	64.58 ± 50.86	62.20 ± 74.64	28.71 ± 13.97	50.84 ± 57.80
19	**Total Alkalinity**	-	109.46 ± 45.78	110.83 ± 45.00	75.42 ± 39.52	96.52 ± 41.47	98.71 ± 50.51	113.41 ± 51.14	65.71 ± 26.76	93.64 ± 44.10	84.00 ± 40.09	112.58 ± 48.32	62.14 ± 20.64	91.36 ± 43.64
20	**P-alkalinity**	-	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NIL
21	**Sodium**	-	37.93 ± 29.94	41.22 ± 28.53	27.19 ± 15.33	33.30 ± 22.38	44.78 ± 25.68	48.08 ± 26.36	29.15 ± 28.54	38.55 ± 25.95	47.64 ± 28.01	58.29 ± 15.19	34.10 ± 24.05	47.01 ± 24.04
22	**Potassium**	-	7.78 ± 11.16	7.84 ± 11.58	6.03 ± 7.09	6.24 ± 8.52	10.46 ± 8.08	7.41 ± 7.74	6.51 ± 10.24	6.57 ± 7.35	7.39 ± 5.19	6.78 ± 6.22	9.01 ± 11.65	7.09 ± 7.24
23	**Calcium**	-	59.25 ± 58.91	45.49 ± 36.74	20.26 ± 7.06	43.39 ± 43.85	87.76 ± 46.84	41.29 ± 34.59	20.85 ± 7.96	42.40 ± 36.44	67.26 ± 38.64	46.03 ± 28.36	23.28 ± 9.61	42.97 ± 31.56
24	**Magnesium**	-	32.79 ± 30.32	128.31 ± 262.91	11.42 ± 2.02	66.40 ± 173.99	48.89 ± 29.13	120.90 ± 224.38	11.19 ± 3.13	64.47 ± 152.30	46.99 ± 30.60	118.29 ± 163.03	10.33 ± 6.11	62.58 ± 116.21
25	**Phosphate**	-	0.94 ± 0.67	1.11 ± 0.40	1.18 ± 0.66	1.07 ± 0.59	0.97 ± 0.81	1.25 ± 0.58	1.07 ± 0.74	1.21 ± 0.69	1.16 ± 1.04	1.30 ± 0.59	1.37 ± 0.77	1.37 ± 0.83
26	**D. oxygen**	4.0 mg/l	6.26 ± 0.83	5.67 ± 1.71	7.03 ± 0.21	6.25 ± 1.29	6.14 ± 1.00	5.59 ± 1.41	6.46 ± 0.57	5.97 ± 1.17	5.89 ± 1.24	5.36 ± 1.68	6.78 ± 0.61	5.90 ± 1.43

	Parameter	A-II River std	Panchganga at River shirol near intake well				Krishna at Kurundwad				Krishna at Rajapur Weir			
			Winter	Summer	Rainy	Average	Winter	Summer	Rainy	Average	Winter	Summer	Rainy	Average
1	**pH**	6.5 to 9.0	7.81 ± 0.40	7.41 ± 0.60	7.67 ± 0.38	7.59 ± 0.51	8.12 ± 0.51	7.40 ± 0.57	7.62 ± 0.43	7.67 ± 0.59	8.16 ± 0.42	7.44 ± 0.62	7.58 ± 0.47	7.65 ± 0.56
2	**Conductivity**	-	541.32 ± 356.12	885.77 ± 425.62	178.02 ± 108.39	613.59 ± 450.98	583.20 ± 192.33	748.69 ± 341.97	170.32 ± 78.59	540.71 ± 342.11	783.37 ± 243.28	754.82 ± 148.76	179.64 ± 94.78	569.46 ± 300.95
3	**BOD**	5.0 Mg/l	4.68 ± 3.39	7.76 ± 10.82	3.80 ± 1.11	5.39 ± 7.29	4.08 ± 1.95	6.1166 ± 6.12	3.91 ± 0.88	4.75 ± 4.15	7.55 ± 4.67	8.72 ± 12.12	2.97 ± 0.76	5.57 ± 8.03
4	**Nitrate (N)**	45 mg/l	1.31 ± 54.57	1.85 ± 1.41	1.15 ± 0.30	8.43 ± 35.66	1.47 ± 0.90	1.61 ± 1.17	1.11 ± 0.35	1.39 ± 0.93	1.32 ± 0.94	1.24 ± 0.76	1.05 ± 0.29	1.21 ± 0.73
5	**Ammonia**	1.5 mg/l	0.52 ± 0.20	0.56 ± 0.18	0.37 ± 0.16	0.47 ± 0.19	0.42 ± 0.15	0.48 ± 0.19	0.37 ± 0.12	0.43 ± 0.13	0.50 ± 0.19	0.55 ± 0.19	0.34 ± 0.17	0.45 ± 0.20
6	**Total Coliform**		111.42 ± 53.78	155.55 ± 81.05	184.28 ± 63.47	161.20 ± 73.45	110.00 ± 28.70	151.11 ± 78.54	140.00 ± 43.96	140.80 ± 57.63	95.00 ± 25.74	145.00 ± 75.14	132.85 ± 48.20	132.50 ± 55.77
7	**Faecal Coliform 100 ml**		5.50 ± 4.96	7.50 ± 4.61	9.33 ± 5.56	8.05 ± 5.04	4.40 ± 2.81	6.55 ± 4.20	6.80 ± 3.76	6.43 ± 3.68	2.00 ± 2.95	7.14 ± 4.72	6.00 ± 3.68	6.05 ± 3.63
8	**C.O.D.**	-	25.71 ± 8.26	34.00 ± 22.40	26.28 ± 11.04	29.29 ± 16.30	29.14 ± 15.95	29.00 ± 10.93	32.00 ± 13.85	30.43 ± 13.91	33.00 ± 12.33	37.81 ± 24.55	19.42 ± 6.29	29.33 ± 18.66
9	**TKN**		0.62 ± 0.34	0.52 ± 0.34	0.31 ± 0.20	0.45 ± 0.29	0.51 ± 0.27	0.47 ± 0.28	0.34 ± 0.19	0.41 ± 0.24	0.65 ± 0.33	0.58 ± 0.35	0.31 ± 0.19	0.44 ± 0.28
10	**TDS**	-	469.14 ± 287.35	654.58 ± 305.32	121.57 ± 49.04	468.29 ± 333.85	383.85 ± 178.72	545.25 ± 331.55	120.7 ± 36.88	389.39 ± 290.80	592.50 ± 212.78	546.00 ± 202.82	126.42 ± 51.31	401.22 ± 247.10
11	**Total Fixed Solids**	-	314.28 ± 232.07	447.50 ± 311.30	68.57 ± 28.73	297.71 ± 278.01	235.42 ± 182.63	360.16 ± 314.80	77.14 ±47.79	242.61 ± 253.51	245.25 ± 222.38	367.27 ± 269.43	73.57 ± 32.72	223.56 ± 243.94

12	**T.S.S.**	-	17.42 ± 7.09	20.58 ± 9.30	19.00 ± 4.36	19.39 ± 6.76	32.28 ± 33.21	18.25 ± 6.31	18.14 ± 3.33	21.86 ± 22.10	212.75 ± 153.32	18.00 ± 6.63	18.14 ± 3.53	52.52 ± 107.39
13	**Turbidity**	-	0.76 ± 0.39	0.78 ± 0.13	0.37 ± 0.29	0.64 ± 0.35	0.72 ± 0.38	0.70 ± 0.13	0.38 ± 0.28	0.59 ± 0.33	0.87 ± 0.42	0.77 ± 0.15	0.35 ± 0.26	0.63 ± 0.37
14	**Hardness**	500 mg/l	157.71 ± 58.19	247.16 ± 194.69	98.57 ± 39.03	174.43 ± 145.30	138.00 ± 62.54	248.00 ± 216.52	83.71 ± 29.31	174.07 ± 159.67	191.50 ± 76.09	244.00 ± 193.28	98.57 ± 37.97	172.37 ± 144.22
15	**Fluoride**	1.5 mg/l	0.18 ± 0.05	BDL	1.42 ± 0.53	0.80 ± 0.27	0.17 ± 0.04	BDL	1.49 ± 0.56	0.83 ± 0.28	0.15 ± 0.04	BDL	1.44 ± 0.54	0.80 ± 0.28
16	**Boron**	-	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NA
17	**Chloride**	600 mg/l	61.92 ± 29.53	95.75 ± 89.08	19.22 ± 4.79	61.54 ± 67.53	49.50 ± 19.38	93.20 ± 122.70	29.14 ± 22.99	60.16 ± 85.08	84.62 ± 28.45	82.22 ± 86.55	24.00 ± 7.57	60.00 ± 61.33
18	**Sulphate**	400 mg/l	83.52 ± 42.28	77.06 ± 32.43	33.71 ± 34.57	66.10 ± 36.86	77.77 ± 42.97	73.10 ± 27.34	18.42 ± 6.05	57.74 ± 38.88	118.70 ± 46.60	75.03 ± 29.13	25.71 ± 16.38	61.42 ± 39.89
19	**Total Alkalinity**	-	94.00 ± 48.73	110.66 ± 46.69	70.42 ± 26.88	93.89 ± 47.37	87.85 ± 41.36	111.50 ± 45.56	57.71 ± 21.89	88.39 ± 41.49	105.00 ± 44.71	125.54 ± 54.75	60.28 ± 20.64	96.52 ± 47.04
20	**P-alkalinity**	-	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NIL
21	**Sodium**	-	54.28 ± 35.51	72.73 ± 29.19	24.29 ± 14.65	51.98 ± 34.23	46.58 ± 24.52	62.05 ± 22.14	22.56 ± 10.51	45.00 ± 25.78	63.03 ± 28.03	78.87 ± 14.81	31.56 ± 21.03	56.73 ± 29.19
22	**Potassium**	-	10.08 ± 9.19	9.18 ± 10.78	5.30 ± 3.95	7.29 ± 9.01	11.25 ± 8.66	8.65 ± 9.54	4.88 ± 3.24	6.65 ± 6.85	15.03 ± 9.59	10.03 ± 10.22	5.76 ± 3.38	7.64 ± 7.28
23	**Calcium**	-	74.06 ± 47.93	52.85 ± 34.83	24.70 ± 11.37	45.64 ± 39.07	62.47 ± 33.25	51.41 ± 29.95	20.80 ± 6.58	42.73 ± 29.16	104.30 ± 48.93	60.68 ± 46.08	20.73 ± 9.27	48.06 ± 42.47
24	**Magnesium**	-	59.62 ± 37.71	111.83 ± 199.54	8.94 ± 4.20	62.41 ± 135.74	50.43 ± 31.80	107.29 ± 204.04	9.10 ± 4.73	59.83 ± 137.85	47.70 ± 22.83	114.04 ± 180.07	11.33 ± 4.14	57.61 ± 121.78
25	**Phosphate**	-	0.75 ± 0.76	1.18 ± 0.49	1.17 ± 0.96	1.13 ± 060	0.76 ± 0.81	1.15 ± 0.44	1.00 ± 0.77	1.12 ± 0.68	0.53 ± 0.74	1.01 ± 0.41	1.10 ± 0.77	1.05 ± 0.65
26	**D. oxygen**	4.0 mg/l	6.13 ± 0.97	5.67 ± 1.75	6.87 ± 0.44	6.11 ± 2.00	6.16 ± 0.66	6.03 ± 1.35	6.95 ± 0.42	6.32 ± 1.04	5.80 ± 0.81	5.74 ± 1.50	7.07 ± 0.34	6.21 ± 1.19

Data Source – Maharashtra Pollution control Board, ± indicates standard deviation from mean value

The river water analysis is carried out to show the general status of the rivers Panchaganga and Krishna at various destinations in Kolhapur district. Majority of the water parameters are within the prescribed standards of A-II River. pH of all the sample range is neutral as well as there is very minute deviation in its range. The seasonal variations noted are very minute in case of pH. The levels of dissolved oxygen are good at all the stations in Kolhapur district as well as no considerable levels of variation is noted. The parameters such as fluorides, boron are within the limits and also show small deviation from its average reading. The B.O.D. levels at the stations of downstream of Kolhapur city show slightly raised levels which exceeds the limits. There is a large amount of variation in the total coliform and fecal coliform number. The presence of coliforms indicates the fecal contamination. 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 gives rise to higher deviation from average reading.

5.2 Krishna 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 Krishna and its tributaries 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 28 sampling sites were identified. During May 2014 from all the sites river water samples were collected. 15 parameters of water were tested. From five samples 17 parameters including heavy metals and pesticides were also tested. For the second round of sampling among the 28 samples 17 sampling sites were identified for sample collection. In the month of October 2014 17 identified samples and one more new sample was collected for analysis.

The following table show the details of sampling sites.

Table no 5.5 Details of Sampling Sites from Krishna River

Sr. No.	Station No.	Name
1	9	Kri-1. Dhom Downstream
2	10	Kri-2. Wai upstream near Menawali
3	11	Kri-3. Wai downstream near Songirwadi
4	12	Kri-4. Ozarde Upstream
5	13	Kri-5. Bhuinj Downstream
6	14	Kri-6. Near Limb
7	15	Kri-7. Sangam Mauli
8	16	Kri-8. Kanher Dam Downstream (Near Nele)
9	17	Kri-9. NH4 Bridge
10	18	Kri-10. After MIDC (Near Mahagaon)
11	19	Kri-11. Near Kameri (Rahimatpur)
12	20	Kri-12. NH4 Near Nagthane (River Urmod)
13	21	Kri-13. Near Umbraj (River Tarali)
14	22	Kri-14. Karad Old Bridge (Wooden Bridge)
15	23	Kri-15. Tembhu Downstream
16	24	Kri-16. Rethare Downstream (Kole)
17	25	Kri-13A. Bridge at Umbraj Masur Road
18	26	Kri-17. Takari Bridge
19	27	Kri-18. Near Ankalkhop
20	27 A	Kri-18 A Ganpati temple, Wai
	28	Kri-19. Kasabe Digraj Upstream
21	29	Kri-20. Sangli Upstream
22	30	Kri-21. Haripur Sangli Upstream
23	31	Kri-22. Kolhapur Sangli Road
24	32	Kri-23. Nrusinhawadi
25	33	Kri-24. Terwad (River Panchganga)
26	34	Kri-25. Rajapura well
27	35	Kri-26. Warnanagar Upstreams
28	36	Kri-27. NH4 (River Warana)

Table no 5.6 Krishna River Basin Water analysis from the Maharashtra (May 2014)

			Sample Site No.									
Sr. No.	**Parameters**	**Units**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
1	pH	-	7.04	6.69	6.65	7.02	7.24	7.04	6.85	6.3	6.74	7.02
2	Electrical Conductivity	µmhos/cm	95	260	360	410	460	350	340	190	350	380
3	Temperature	°C	25	27	25	29	29	28	28	30	28	27
4	Total Dissolved Solids	mg/l	67.4	185	255.6	290	325.6	247.5	240.4	134.9	249	270
5	Total Solids	mg/l	70.2	194.8	261.2	297.9	331	256.1	246.2	143.8	261.6	278.7
6	Turbidity	NTU	5.9	24.8	15.4	18.5	14.2	22.9	16.6	23.9	31.8	20.2
7	Dissolved Oxygen	mg/l	8.1	7.2	4.6	4.4	4.9	6.5	6.6	4.7	6.5	6
8	BOD 5 at 20°C	mg/l	Nil	2.2	6.1	8.8	7.8	1	Nil	9.1	0.6	2.4
9	COD	mg/l	Nil	65.6	9.6	12.8	11.2	1.6	Nil	14.4	1.6	4
10	Hardness	mg/l	48	144	160	204	208	168	168	120	180	176
11	Nitrates	mg/l	0.26	2.56	5.37	10	9.7	3.78	6.86	0.87	8.04	19.43
12	Phosphates	mg/l	0.097	0.16	0.99	0.47	0.31	0.38	0.81	0.29	1.3	0.78
13	Fluorides	mg/l	1.123	0.211	0.226	0.267	0.138	0.226	0.27	0.123	0.447	0.314
14	Oil and Grease	mg/l	Nil	Nil	Nil	-	Nil	Nil	Nil	Nil	Nil	Nil
15	Most Probable Number	100/ml	50	20	20	12	30	20	35	Nil	9	95
16	Heavy Metals											
a	Iron	mg/l			0.11							<0.001
b	Zinc	mg/l			<0.001							<0.001
c	Chromium	mg/l			<0.001							<0.001
d	Mercury	mg/l			<0.001							<0.001
17	Pesticides				N.D							N.D

			Sample No.								
Sr. No.	**Parameters**	**Units**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
1	pH	-	7.24	7.09	7.08	7.18	7.18	7.04	7.15	7.85	7.99
2	Electrical Conductivitiy	µmhos/cm	370	240	160	280	210	280	490	280	320
3	Temperature	°C	29	Nil	29	27	30	30	26	27	28
4	Total Dissolved Solids	mg/l	260.7	170	110.6	197.8	148	197.8	346	195.8	225.2
5	Total Solids	mg/l	268.2	175.3	115	205	153.2	207.7	351.2	201	229
6	Turbidity	NTU	19.3	14.9	12.1	17.3	12	25.4	11.1	13.4	10
7	Dissolved Oxygen	mg/l	5.2	5	4.7	6.1	5.1	2	4.8	4.1	5.8
8	BOD 5 at 20°C	mg/l	3.8	7.9	5.4	3.1	6.4	12	3.2	2	Nil
9	COD	mg/l	8.8	12	12	5.6	10.4	31.2	6.4	4	Nil
10	Hardness	mg/l	192	120	72	130	84	112	210	104	280
11	Nitrates	mg/l	6.7	1.39	2.07	2.65	0.59	1.59	4.61	1.31	1.02
12	Phosphates	mg/l	0.35	0.52	0.061	0.36	0.25	0.37	0.11	0.2	0.35
13	Fluorides	mg/l	0.153	0.035	0.182	0.04	0.079	0.27	0.211	0.52	0.388
14	Oil and Grease	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
15	Most Probable Number	100/ml	130	40	20	200	170	50	Nil	30	40
16	Heavy Metals										
a	Iron	mg/l				<0.001					
b	Zinc	mg/l				<0.001					
c	Chromium	mg/l				<0.001					
d	Mercury	mg/l				<0.001					
17	Pesticides					N.D					

			Sample No.								
Sr. No.	**Parameters**	**Units**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**
1	pH	-	8.05	7.86	8.03	7.92	7.81	8.19	7.87	7.1	7.07
2	Electrical Conductivity	µmhos/cm	380	430	480	300	310	460	240	130	110
3	Temperature	°C	28	26	29	28	26	27	26	28	27
4	Total Dissolved Solids	mg/l	265.8	303.3	340.8	213	220	320.6	170.4	92	78
5	Total Solids	mg/l	270.6	310.2	345.2	218.5	225.4	326.7	175.3	96.7	82.9
6	Turbidity	NTU	11.4	16	11.6	12.6	13.2	14.6	12.2	10.8	13.2
7	Dissolved Oxygen	mg/l	5.8	4.2	2.8	6.8	4.6	2.1	6.2	7.8	7.2
8	BOD 5 at 20°C	mg/l	Nil	2	4	Nil	2	1.2	0.4	Nil	Nil
9	COD	mg/l	Nil	4	7.2	0.8	6	2.4	1.6	0.8	2.4
10	Hardness	mg/l	136	152	156	104	104	156	100	128	56
11	Nitrates	mg/l	2.07	2.44	2.93	2.63	2.74	5.41	2.3	2	2.2
12	Phosphates	mg/l	0.27	0.2	0.025	0.21	0.15	0.28	0.2	0.09	0.097
13	Fluorides	mg/l	1.196	1.27	1.137	1.108	1.196	1.372	1.24	1.285	1.005
14	Oil and Grease	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
15	Most Probable Number	100/ml	100	80	200	80	110	300	80	Nil	10
16	Heavy Metals										
a	Iron	mg/l			<0.001				0.547		
b	Zinc	mg/l			<0.001				<0.001		
c	Chromium	mg/l			<0.001				0.021		
d	Mercury	mg/l			<0.001				<0.001		
17	Pesticides				N.D				N.D		

Table no 5.7 Krishna River Basin Water analysis from the Maharashtra (October 2014)

			Sample Site No.									
Sr. No.	**Parameters**	**Units**	**9**	**11**	**13**	**15**	**17**	**18**	**19**	**20**	**21**	**22**
1	pH	-	7.10	6.88	7.07	7.28	7.29	7.21	7.30	7.04	7.48	7.40
2	Electrical Conductivity	µmhos/cm	300	370	360	460	470	470	530	260	120	120
3	Temperature	°C	25	27	27	25	26	25	25	25	26	25
4	Total Dissolved Solids	mg/l	212	260	212	327	330	330	370	185	85	85
5	Total Solids	mg/l	214	262	215	330	333	332	372	188	90	95
6	Turbidity	NTU	0.6	0.6	1.2	1.1	1.2	0.6	1.3	2.1	3.8	7.1
7	Dissolved Oxygen	mg/l	7.8	7.2	6.1	5.8	6.6	7.0	5.2	7.2	7.4	7.8
8	BOD 5 at 20°C	mg/l	Nil	Nil	2	2	Nil	Nil	2	Nil	Nil	Nil
9	COD	mg/l	Nil	2	4.0	6	Nil	2	8	2	Nil	Nil
10	Hardness	mg/l	156	176	196	216	204	216	212	128	68	60
11	Nitrates	mg/l	1.06	0.84	0.88	0.76	0.54	0.32	0.24	0.22	0.84	1.00
12	Phosphates	mg/l	0.22	0.71	0.31	0.84	0.92	0.85	0.85	0.20	0.21	0.24
13	Fluorides	mg/l	0.20	0.30	0.18	0.40	0.18	0.10	0.53	0.27	0.17	0.21
14	Oil and Grease	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
15	Most Probable Number	100/ml	Nil	175	350	350	150	275	140	175	20	45

		Sample Site No.								
Sr. No.	**Parameters**	**Units**	**23**	**24**	**26**	**27**	**27 A**	**29**	**33**	**36**
1	pH	-	7.31	7.24	7.23	7.19	7.04	7.35	7.97	7.63
2	Electrical Conductivity	µmhos/cm	190	230	230	240	350	280	230	250
3	Temperature	°C	26	26	26	26	27	26	26	25
4	Total Dissolved Solids	mg/l	135	160	164	168	250	174	184	176
5	Total Solids	mg/l	145	172	170	170	255	186	188	179
6	Turbidity	NTU	7.5	6.5	2.4	1.9	1.2	2.1	1.9	1.8
7	Dissolved Oxygen	mg/l	7.4	7.2	5.2	7.2	5.0	6.9	6.1	6.8
8	BOD 5 at 20°C	mg/l	Nil	Nil	2	Nil	2	Nil	Nil	Nil
9	COD	mg/l	Nil	4	4	Nil	8	Nil	4	4
10	Hardness	mg/l	92	92	96	100	176	96	92	100
11	Nitrates	mg/l	0.48	0.80	0.66	0.70	1.02	0.80	0.76	0.78
12	Phosphates	mg/l	0.26	0.28	0.32	0.33	0.27	0.36	0.32	0.34
13	Fluorides	mg/l	0.31	0.83	0.68	0.83	0.78	0.82	0.78	0.82
14	Oil and Grease	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
15	Most Probable Number	100/ml	45	110	150	40	130	50	60	45

- Sample Site no 9 Krishna (Dhom Downstream) – the water sample from the upstream of Krishna does not seem to be contaminated. However, the parameters such as electrical conductivity, total dissolved solids, total solids and hardness were recorded with higher readings during October 2014 sampling in comparison to May 2014. This might be due to immediate sampling was carried out after rain. As these parameters are dependent on the ions in the water.

- Sample Site no10 Krishna 2 (Wai Upstream) – the water parameters such as electrical conductivity, total solids and COD were increased compared to upstream sample. There is partly effluent from MIDC of Wai along with effluent of food processing units and sewage from villages enters into the river. During October 2014 sampling this sample did not show any considerable changes in parameters carried out on the site.

- Sample Site no 11 Krishna 3 (Wai downstream near Songirwadi) the water sample shows high electrical conductivity, TS and hardness. The parameters such as electrical conductivity, total dissolved solids, total solids and hardness were recorded with higher readings during October 2014 sampling compared to May 2014; as these parameters are dependent on the ions in the water. The presence of MPN recorded during October 2014 which is an indicator of faecal contamination. The water samples also show presence of heavy metals such as iron, zinc, mercury and chromium. This may be because of disposal of domestic sewage from Wai town and agricultural runoff.

- Sample Site no 12 Krishna 4 (Ozarde Upstream) - the water sample shows high electrical conductivity, TS and COD. This may be because of disposal of domestic sewage from nearby villages, discharge of MIDC and agricultural runoff. During October 2014 sampling this sample did not show any considerable changes in the parameters performed on the site.

- Sample Site no 13 Krishna 5 (Bhuinj Downstream) the water sample shows high electrical conductivity, TS, TDS and COD during May 2014. This may be because of disposal of domestic sewage from nearby villages, discharge from MIDC and discharge from sugar industry. In October 2014 sampling the parameters such as electrical conductivity, total dissolved solids, total solids and hardness were recorded with higher readings than that of May 2014. Surprisingly the COD levels were lowered during the October sampling. This might be because of dilution after rainy season.

- Sample Site no 14 Krishna 6 (Near Limb) the water sample shows high electrical conductivity, hardness TS and TDS. This may be because of disposal of domestic sewage from nearby villages, discharge from MIDC and discharge from sugar industry. However, 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 15 Krishna 7 (Sangam Mauli) – in this stretch the domestic sewage of entire Satara city and effluent from part of Satara MIDC enters into the river water. Hence water from this site shows higher levels of electrical conductivity, hardness TS and TDS. During October 2014 sampling these parameters were recorded with higher readings than that of May 2014. This sample was also recorded with minute COD levels during October 2014 which was totally absent during May 2014.

- Sample Site no 16 Krishna 8 Kanher Dam downstream (near Nele) - The sampling site was not influenced by domestic sewage. The parameters show that the water was clear and there was negligible contamination on the site. However, during October 2014 sampling this sample did not show any considerable changes in parameters performed on the site.

- Sample Site no 17 Krishna 9 NH4 Bridge – in this stretch the domestic sewage from neighbouring villages enters into the river water. Hence water from this site shows higher levels of electrical conductivity, hardness TS, TDS and fluorides in May 2014. Except fluorides other parameters such as electrical conductivity, hardness TS, TDS were increased during October 2014 sampling. The presence of MPN is an indicator of faecal contamination.

- Sample Site no 18 Krishna 10 After MIDC (near Mahagaon) the water sample shows high electrical conductivity, TS and hardness during both the sampling sessions. However, the levels of these parameters were higher in October 2014 as compare to May 2014 levels. The water samples also show presence of heavy metals such as iron, zinc, mercury and chromium. This may be because of disposal of effluent form Satara MIDC area. The presence of MPN is an indicator of faecal contamination.

- Sample Site no 19 Krishna 11 Near Kameri (Rahimatpur) - in this stretch the domestic sewage of Satara city enters into the river water. Hence water from this site shows higher levels of electrical conductivity, hardness TS, TDS and higher MPN compared to other sites. The presence of MPN is an indicator of faecal contamination. There is considerable rise in the levels of parameters such as electrical conductivity, hardness TS, TDS during October 2014 than May 2014.

- Sample Site no 20 Krishna 12 NH4 near Nagthane (river Urmod) - in this stretch the effluent from Ajinkyatara Sugar Industry, Satara and domestic sewage from nearby villages and city enters into the river water. A slight increase was recorded in the levels of parameters such as electrical conductivity, hardness TS, TDS during October 2014 compared to May 2014 and MPN was considerably high during October 2014.

- Sample Site no 21 Krishna 13 Near Umbraj (river Tarali) - the water sample shows lowered dissolved oxygen along with higher electrical conductivity. This may be because of sewage and effluent from Umbraj

and its vicinity. Similar to the sample no 20 there is slight increase was recorded in the levels of parameters such as electrical conductivity, hardness TS, TDS during October 2014 compared to May 2014 and MPN was considerably high during October 2014.

- Sample Site no 22 Krishna 14 Karad old bridge (Wooden bridge) – the water sample shows high electrical conductivity, TS and hardness in May 2014. The water samples also show presence of heavy metals such as iron, zinc, mercury and chromium. This may be because of disposal of effluent form Tasawade MIDC, Sahyadri Factory and domestic sewage from nearby area. Surprisingly the levels of electrical conductivity, TS and hardness were decreased during October 2014. This may be because of dilution of water due to rain.

- Sample Site no 23 Krishna 15 Tembhu Downstream (Karad Tasgaon Road) – the water quality of river is influenced by discharge of effluent from Rethare industry and domestic sewage. Similar to that of site no 22 the levels of electrical conductivity, TS and hardness were slightly decreased during October 2014. This may be because of dilution of water due to rain.

- Sample Site no 24 Krishna 16 Rethare Downstream (Kole) - the water quality of river is influenced by discharge of effluent from industrial area and domestic sewage of Rethare. The lowest dissolved oxygen levels were recorded on the site. The levels of electrical conductivity, TS and hardness were slightly decreased during October 2014. This may be because of dilution of water due to rain and high water level of river.

- Sample Site no 25 Krishna 13 A Bridge at Umbraj Masur road) - the water sample shows lowered dissolved oxygen along with higher electrical conductivity. This may be because of sewage and effluent from Umbraj and its vicinity. During October 2014 sampling this sample did not show

any considerable changes in parameters performed on the site. Hence, further analysis were not performed.

- Sample Site no 26 Krishna 17 Takari Bridge - the water sample shows lowered dissolved oxygen along with higher electrical conductivity. This may be because of sewage and effluent from villages in the vicinity and effluent disposal of Takari Sugar Factory. However, the levels of electrical conductivity, TS and hardness were slightly decreased during October 2014. This may be because of dilution of water due to rain and high water level of river.

- Sample Site no 27 Krishna 18 Near Ankalkhop – the site is at the downstream of Walva and a sugar factory is located in the vicinity show impact on the water quality of river. However, the levels of electrical conductivity, TS and hardness were slightly decreased during October 2014. This may be because of dilution of water due to rain and high water level of river.

- Sample Site no 27 A Ganapati temple, Wai – sampling on the site was carried out during October 2014. By observing the anthropogenic activities in the vicinity. The site shows high levels of electrical conductivity, TDS and TS. Little COD was also recorded. Presence of MPN indicated the fecal contamination in the water.

- Sample Site no 28 Krishna 19 Kasabe Digraj Upstream – there is a sugar factory located in the vicinity, domestic sewage from villages and industrial discharge from nearby area show impact on the water quality of river. Especially increase in electrical conductivity and TS, TDS. However, during October 2014 sampling this sample did not show any considerable changes in parameters performed on the site.

- Sample Site no 29 Krishna 20 Sangli Upstream - there is a sugar factory located in the vicinity, domestic sewage from villages and industrial

discharge from nearby area shows impact on the water quality of river. Especially increase in electrical conductivity and TS, TDS as well as lowering of DO levels in May 2014. However, the levels of electrical conductivity, TS and hardness were slightly decreased during October 2014. This may be because of dilution of water due to rain and high water level of river.

- Sample Site no 30 Krishna 21 Haripur Sangli upstream - the water sample shows alkaline pH, high electrical conductivity, TS and hardness. The water samples also show presence of heavy metals such as iron, zinc, mercury and chromium. This may be because of disposal of effluent and domestic sewage from Sangli area. During October 2014 sampling this sample did not show any considerable changes in parameters performed on the site. Hence, further analysis was not performed.

- Sample Site no 31 Krishna 22 Kolhapur Sangli Bridge - the water sample shows alkaline pH, high electrical conductivity, TS and hardness due to townships on the banks of river. During October 2014 sampling this sample did not show any considerable changes in parameters performed on the site. Hence, further analysis was not performed.

- Sample Site no 32 Krishna 23 Nrusinhwadi – the water sample shows lowered level of Dissolve oxygen, high electrical conductivity, TS and hardness along with fluoride content. The water from Krishna River also gets influenced due to confluence of river Panchaganga. During October 2014 sampling this sample did not show any considerable changes in parameters performed on the site. Hence, further analysis was not performed.
- Sample Site no 33 Krishna 24 Terwad (River Panchaganga) – the water sample shows lowered dissolved oxygen level and higher electrical conductivity, TS, TDS and hardness in May 2014. The river Panchaganga carries sewage from villages as well as 2 Municipal Corporations, effluent from MIDCs and sugar industries. However, the levels of electrical conductivity, TS and hardness were slightly decreased during October

2014. This may be because of dilution of water due to rain and high water level of river. The presence of K. T. weirs is also an influential factor on water quality.

- Sample Site no 34 Krishna 25 Rajapur Well - - the water sample shows alkaline pH, high electrical conductivity, TS and hardness. The water samples also show presence of heavy metals such as iron, zinc, mercury and chromium. During October 2014 sampling this sample did not show any considerable changes in parameters performed on the site. Hence, further analysis were not performed.

- Sample Site no 35 Krishna 26 Warananagar Upstream – the water sample is clear and with negligible pollutants in it. During October 2014 sampling this sample did not show any considerable changes in parameters performed on the site. Hence, further analyses were not performed.

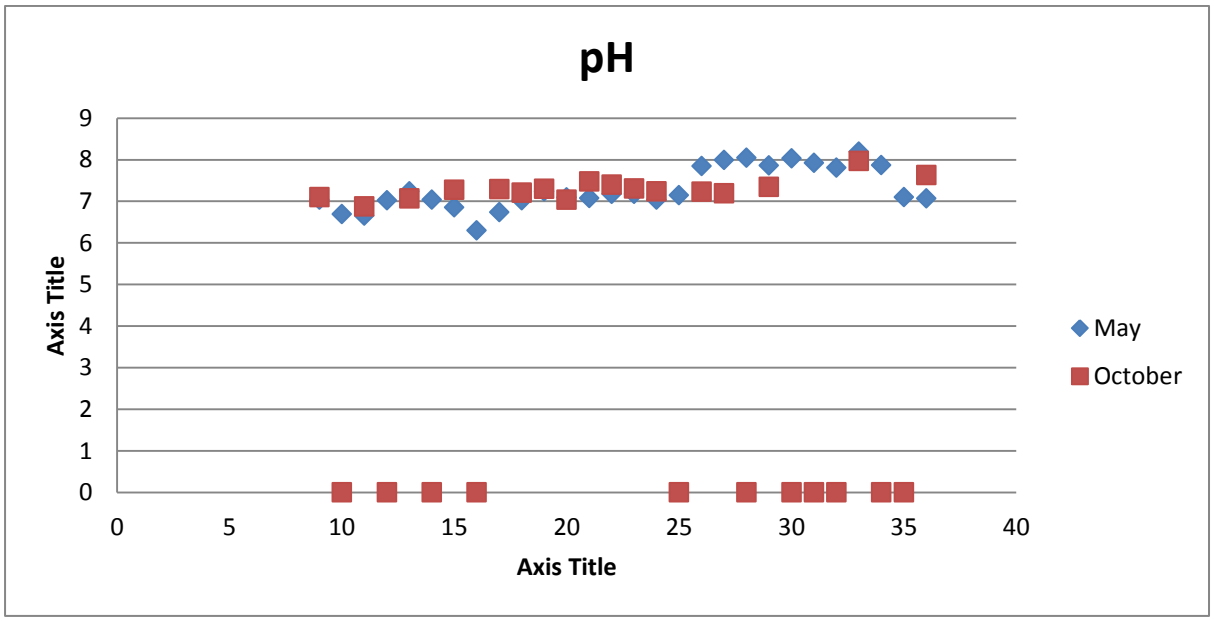
- Sample Site no 36 NH4 Bridge (River Warana) – slightly higher levels of some parameters were noted than upstream due to discharge of sewage from neighbourhood villages. . The increase in the levels of parameters such as electrical conductivity, hardness TS, TDS was recorded during October 2014 compared to May 2014 and MPN was slightly high during October 2014.

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 at 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 as compared to May 2014. Increase in the levels of readings of parameters at upstream could have taken place due to higher levels of water in the river due to high degree of slope at upstream which increases the rate of siltation during rain; heavy discharge from dams. The levels of readings could have decreased at downstream because of meandering of river; reduced degree of slope; sandy river bed; aquatic vegetation and 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:

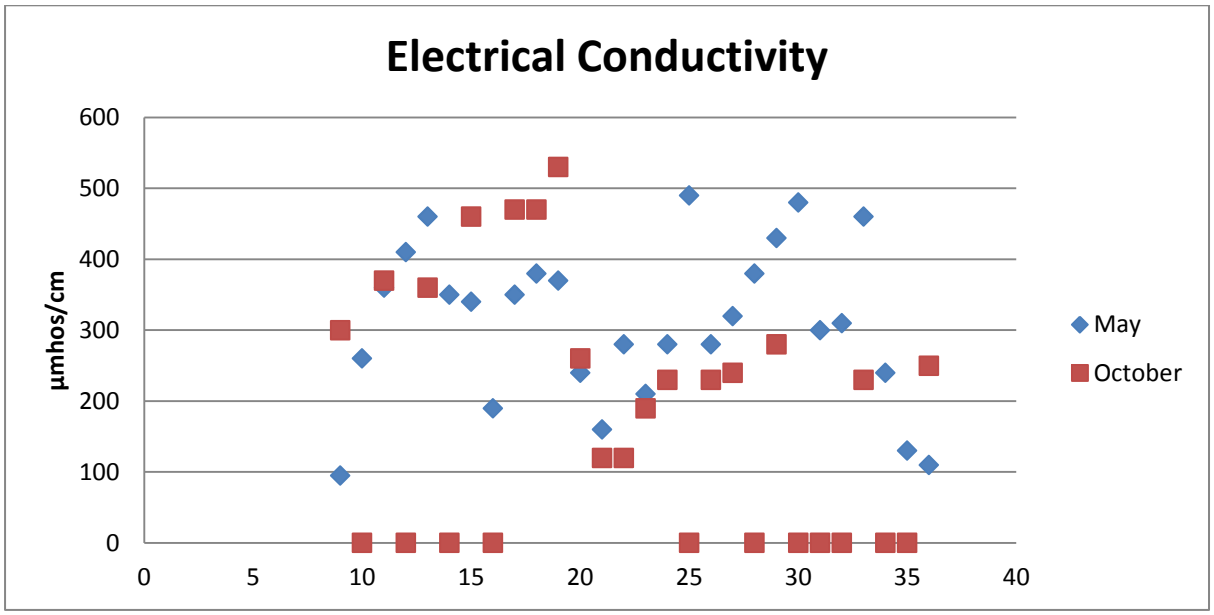
The sudden drops to zero levels in all the graphs during October month are recorded because at these stations further investigations were avoided. On site testing and other observations did not show any considerable pollution levels at these sites.

Fig. 5.1 Water parameter pH



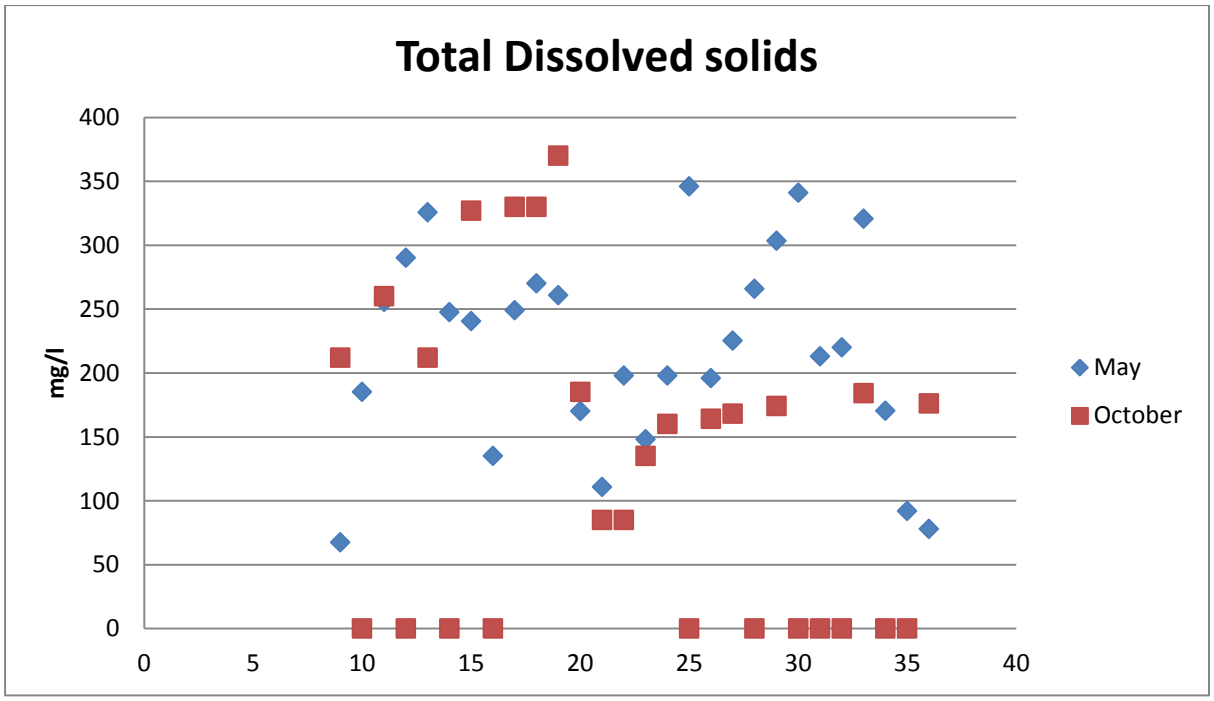
The pH levels of the samples at all the 36 stations lay between the range of 6 to 8 which is a neutral pH range. Slight variation was noted during two sampling periods. The downstream water samples show slightly higher range of pH than that of upstream samples.

Fig. 5.2 Water parameter electrical conductivity



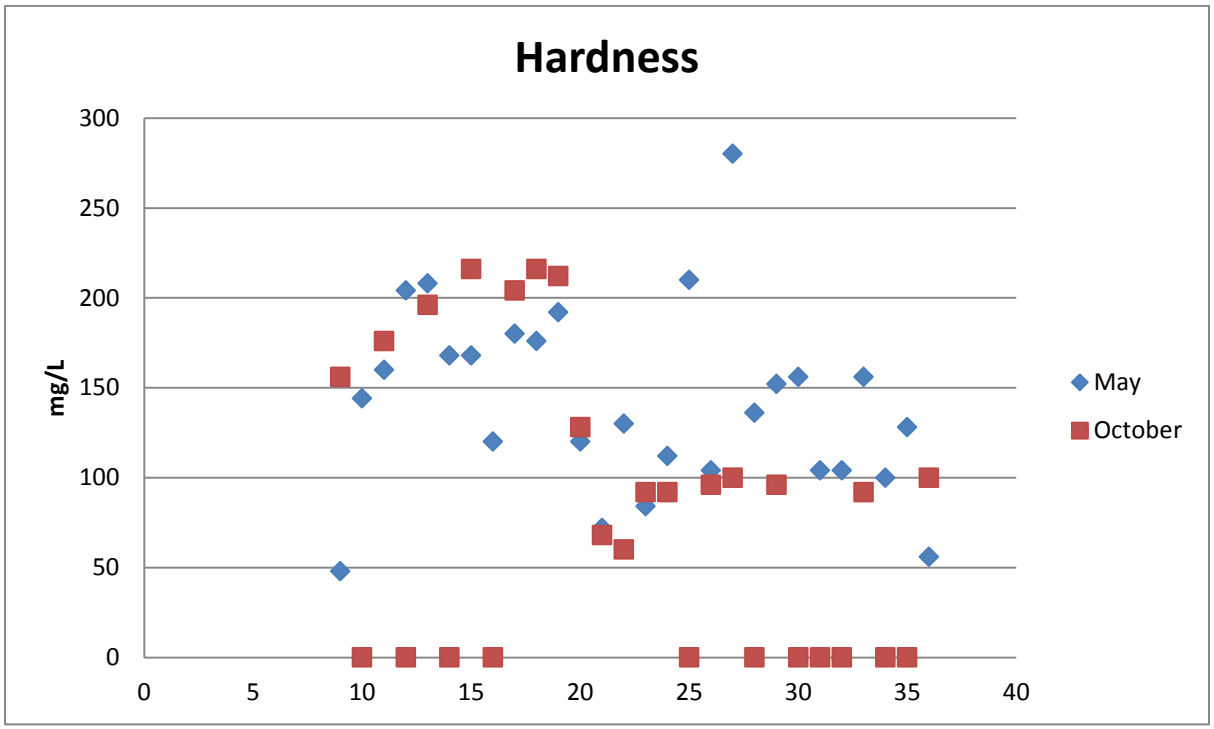
The electrical Conductivity of the water is dependent on the ions in the water. It ranges between 100 µmhos/cm to 500 µmhos/cm. At upstream of the river the electrical conductivity readings were higher during October 2014 while at the downstream it was decreased. This decrease in the levels of readings could be due to higher levels of water in the river due to rain as well as the Kolhapur type of weirs.

Fig. 5.3 Water parameter Total Dissolved Solids



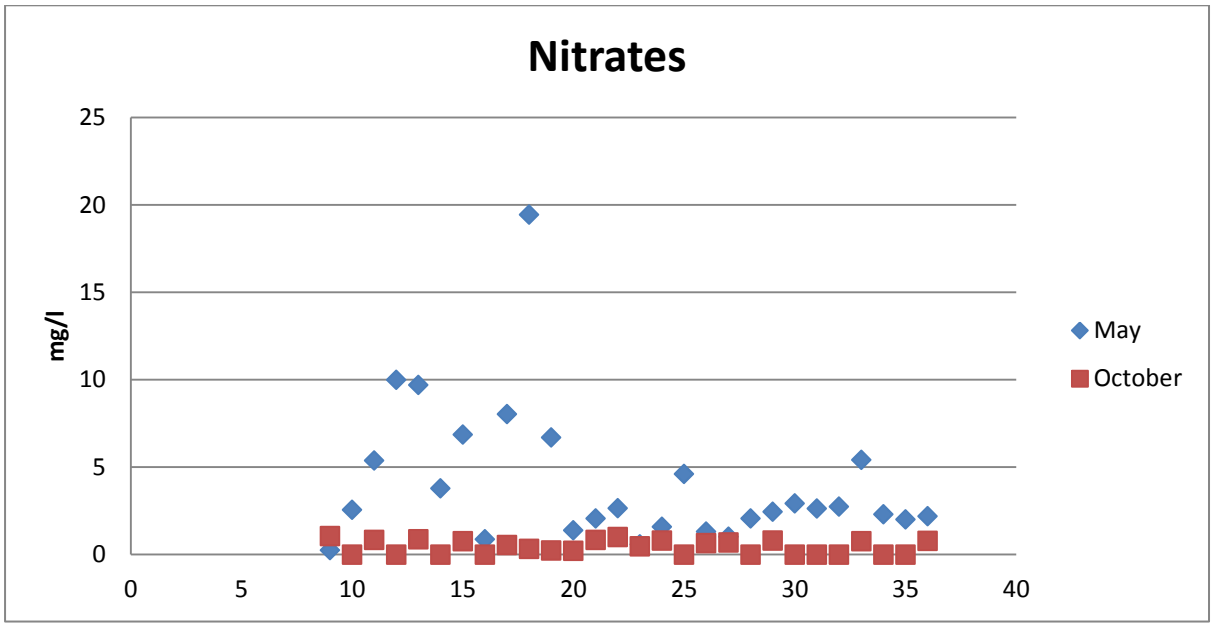
The TDS of the water is dependent on the ions in the water. It ranges between 50 mg/L to 400mg/L. At upstream of the river the TDS readings were higher during October 2014 while at the downstream it was lower. This pattern was similar to that of electrical conductivity as both the parameters are interdependent. 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



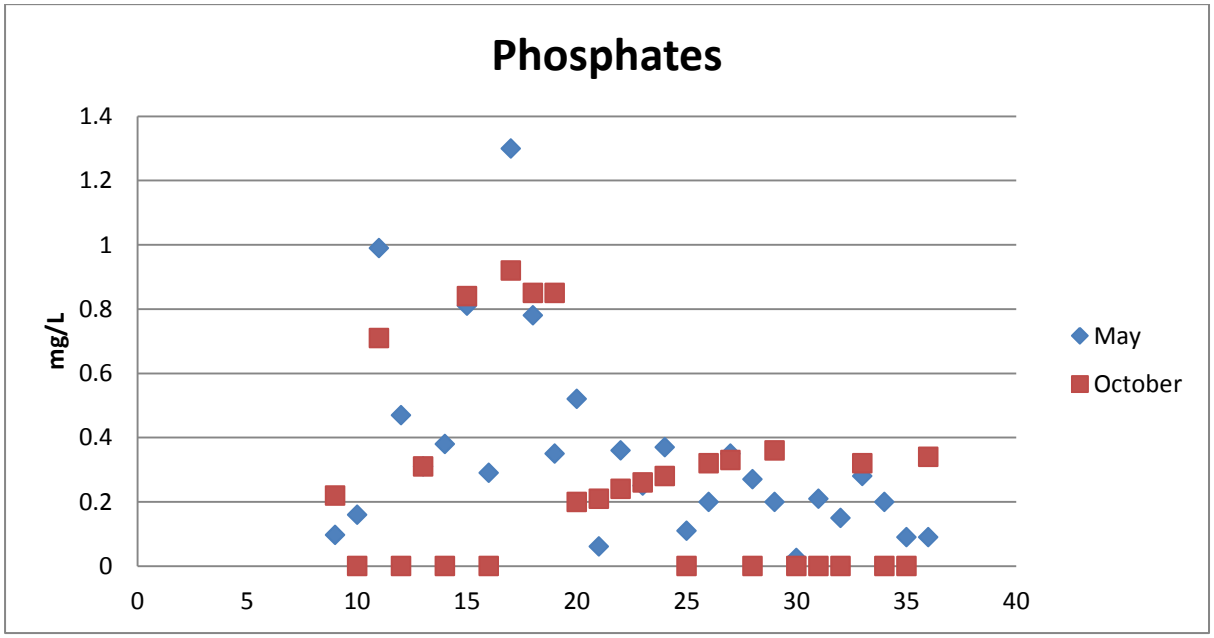
The hardness of the river water lies in the rage of 50 mg/L to 300 mg/L. The levels of hardness are fluctuating in upstream and downstream during May 2014. However, the levels of hardness are higher at upstream during October 2014. Higher levels of water in the river due to rain as well as the Kolhapur type of weirs during late. Along with this discharge of non-point source pollutant also play important role in these fluctuations.

Fig. 5.5 Water parameter Nitrates



The nitrate levels in the water are less than 10 mg/L. Only at one sampling station it was recorded upto 20mg/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 1.40 mg/L. Only at few sampling station in upstream these were 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. The presence of heavy metals is of a serious concern which needs a further investigation. There are number of obstacles in the river such as K. T. weirs, bridges, sand mining units, etc. which break the continuous flow of the rivers and convert rivers into chain of pools. The industries, sugar industries, distilleries are also majorly contributing in river water pollution. The urban and rural centres on the banks of the river release their domestic sewage into the river. Hospitals 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. Sand mining units are causing deepening of river bed and removal of fertile soil for brick making is causing changing the river bank. On the banks of river during the low water levels cultivation practices are reported. Animal waste from animal husbandry also causes a considerable amount of pollution which has always remained overlooked. This needs to be identify in detail. Moreover the anthropogenic activities such as washing of animals, vehicles, cloths and bathing are also contributing to 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. Frequently occurring fish kills in the rivers is an indicator of river water pollution in the river patches. Hence it is essential to see the possible polluting agents along with the river water analysis.

5.3 Industrial and domestic sewage nala sample analysis –

None of the industries directly discharge their effluent in the river. However, there are industries within the distance of 1.5 km from river whose effluent treatment is not proper. Considering this fact and some other sources of pollution such as domestic nalas and hospitals, samples from various industries and locations were collected during the study period.

Samples were collected from 24 sites and 13 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. Among them 14 samples were from industrial outlet, 8 were domestic sewage nalas and remaining 2 were hospital discharge outlets. Their sampling codes are as follows:

Table no. 5.8 Details of sampling locations and industries

Sr. No.	Code	Name of the Location/ Industry
1	1	Sahyadri starch Industry (water after R. O. treatment)
2	2	Sahyadri starch Industry (Treated effluent)
3	3	Rameshwar Dairy (ETP sample)
4	4	Chitale dairy (ETP sample)
5	5	Santosh Milk Industry
6	6	Hindustan
7	7	Roayl Food Stuff Pvt. Ltd., MIDC, Karad
8	8	Prabhune
9	9	Royal food Leachate
10	10	Bansi Industry
11	11	Rajarambapu Patil Sahakari Krishna Milk
12	12	Satyasai, Pratibha, Prerana (ETP)
13	13	Malas Foods
14	14	Garware Wall Ropes Ltd, MIDC, Wai

Table no. 5.9 Details of sampling locations of domestic sewage nalas

Sr. No.	Code	Name of the Location/ Industry
1	15	Tilawani Nala
2	16	Yadrav road kala nala
3	17	Chinchwad boundry nala
4	18	Miraj Nala
5	19	Haripur nala
6	20	Sheri nala (Mixing through Pipeline)
7	21	Ashta domestic Nala
8	22	Islampur domestic nala
9	23	Karad City 1
10	24	Karad City 2
11	25	Satara city 1
12	26	Satara city 2
13	27	Satara city 3
14	28	Nala at Wai
15	29	Nala at Umbraj

Table no. 5.10 Details of Biomedical liquid waste nalas

Sr. No.	Code	Name of the Location/ Industry
1	30	Sahyadri Speciality Hospital, Karad
2	31	Krishna Hospital Medical & Research Centre, Karad

Table no 5.11 Water analysis of samples from industries and domestic sewage nalas

Sr. No.	Sample code	pH	T.S. Mg/L	TDS Mg/L	TSS Mg/L	Cl Mg/L	SO4 Mg/L	COD Mg/L	BOD Mg/L	O&G Mg/L	Fe Mg/L	Zn Mg/L	Cr Mg/L	Hg Mg/L
1.	1	6.40	80	80	00	20	08	00	00	00	BDL	BDL	BDL	BDL
2.	2	6.90	1900	1870	30	540	438	64	22	00	BDL	BDL	BDL	BDL
3.	3	5.97	3260	1820	1440	350	218	1500	420	12	0.11	BDL	BDL	BDL
4.	4	7.54	1580	1536	44	145	112	300	112	2	BDL	BDL	BDL	BDL
5.	5	6.56	1800	1780	20	400	112	224	80	00	BDL	2	BDL	BDL
6.	6	7.55	340	320	20	30	30	80	26	00	BDL	BDL	BDL	BDL
7.	7	4.01	7720	6820	900	10	200	16300	3210	2	2.12	0.5	BDL	BDL
8.	8	3.63	5534	4934	600	10	812	2714	1800	00	1.28	0.11	BDL	BDL
9.	9	3.61	232420	231520	900	2120	2880	117000	50418	112	2.38	0.21	BDL	BDL
10.	10	5.30	6900	6070	830	620	280	3684	1230	42	0.18	BDL	BDL	BDL
11.	11	7.63	1760	1732	28	50	28	40	22	00	BDL	BDL	BDL	BDL
12.	12	10.32	1360	1142	218	312	218	1320	412	00	0.17	BDL	BDL	BDL
13.	13	4.40	1080	1040	40	15	112	780	278	00	BDL	BDL	BDL	BDL
14.	14	7.00	1680	1640	40	85	27	80	30	00	BDL	BDL	BDL	BDL

The industrial effluent samples were collected from food processing industries, dairies, starch industries. Effluent treatment plants were present in all the industries but were no working with their full efficiency. All these industries were within the distance of 1.5 km from river Krishna. However not a single industry was observed to release its effluent directly into the river water. Among the industries sample no 1 shows very low levels of parameters as the water was collected from reverse osmosis treatment unit. pH from sample no 7, 8, 9, 10 and 13 are acidic in nature while sample no 12 has very high alkaline pH. All the parameters from sample no 9 i.e. food industry leachate shows highest values among all the samples. Sample no 7, 8, 9 and 10 were recorded with the presence of heavy metals such as Fe and Zn. The analysis of effluent shows only sample 6 collected from Hindustan industry was within the standards. The COD and BOD levels were under control. The COD and BOD levels of sample no 2, 6, 11 and 14 were lowest among rest of the industries. However total solids, total dissolve solids and total suspended solids were on higher side for all the samples. Presence of heavy metals in the treated effluent was of a serious concern.

Table no 5.12 Water analysis of samples from domestic sewage nalas

Sr. No.	Sample code	pH	T.S. Mg/L	TDS Mg/L	TSS Mg/L	Cl Mg/L	SO4 Mg/L	COD Mg/L	BOD Mg/L	O&G Mg/L
1	15	8.92	3440	2240	1200	20	180	2380	890	5
2	16	6.68	1480	1180	300	15	40	713	220	4
3	17	7.10	1900	1878	22	245	18	88	20	00
4	18	6.61	920	187	3	15	20	212	70	00
5	19	6.93	600	520	80	160	8	120	48	00
6	20	7.06	600	511	89	160	8	64	22	00
7	21	6.90	720	685	35	180	12	184	62	00
8	22	7.10	1680	1600	80	130	28	56	24	00
9	23	6.93	630	520	110	140	7	60	35	00
10	24	7.06	568	411	75	160	8	64	22	00
11	25	6.50	1508	1280	300	80	25	260	150	4
12	26	6.80	1900	1700	220	300	58	150	80	00
13	27	6.46	920	187	3	15	20	180	70	00
14	28	7.08	700	520	80	160	16	120	48	00
15	29	6.61	920	650	150	150	25	210	70	00

Domestic sewage samples were collected from 8 nalas. These nalas were flowing from Sangli and Miraj area carrying domestic sewage to river. All the nalas have pH neutral to slightly acidic in nature. They were having higher levels of total solids, total dissolve solids and total suspended solids. COD and BOD levels of these nalas were very high except Miraj nala. None of the nala was detected with heavy metals. Chlorides and sulphate levels were higher in sample no 17 i.e. Chinchwad nala.

Table no 5.13 Water analysis of Biomedical liquid waste nalas

Sr. No.	Sample code	pH	T.S. Mg/L	TDS Mg/L	TSS Mg/L	Cl Mg/L	SO4 Mg/L	COD Mg/L	BOD Mg/L	O&G Mg/L
23.	30	6.79	1520	1500	20	220	18	128	40	00
24	31	6.79	200	170	30	100	62	18	10	00

Sample no 23 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. Some of the small villages are Vyahali, Sultanpur,

Pandharechiwadi, Sherlarwadi, Chandwadi, Nagewadi, saigaon, Fadtarwadi, Vitthalwadi, etc.

- **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. Small villages and municipal councils include bhuinj, Jambh, Limb, Kadegaon, Malgaon, Borgaon, ankalkhop, shirdhon, Kurundwad, Chipri, Takali, Masur, Narwad, Sainik takli, Wategaon, etc.

- **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. Major towns and cities in the basin include Shirol, Kasabe digraj, Miraj- sangli- Kupwad, Mhaishal, ashta,Uran Islampur, Kasegaon, Palus, wai city, Satatra city, etc. where sewage treatment as mentioned above is need to be incorporated.

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. Approximately 150 – 180 trucks per day are used in Kolhapur district, 120 and 150 trucks respectively in the districts of Sangli and Satara. 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.

- The equipment in most of the industries has become old and obsolete. Most of the processing units, equipment, pipelines are non-functional and also have developed leakages leading to accidents in an increasing order. All such units have to be subjected to safety and utility inspection and changes should be made wherever necessary. 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 MIDCs. 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 were observed at Wai, Buinj, Satara, Umraj, walwa, sangli, Karad, Patan, Debewadi, Limb, etc. At Karad and Kolhapur as a result of increased awareness levels due to efforts of social environmental organisations and MPCB, it was found that the idols are immersed in water bodies which are no longer in use.

- 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.

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.
- Trenches made for reclamation of saline soil are collecting high salt containing water. Such water further end into the river which is unscientific and may lead towards serious environmental problem. A detailed study should be conducted for reclamation method which may avoid river pollution and further enviornmetal problems.

6.6 Other important 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. Environmental Impact Assessment of existing and sand mining should be carried out in the river basin for further policy decisions.
- 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.

Annexure – I

List of places and population upto 3 kms to left and right side of Krishna River in Maharashtra

Left side	Population	Right side	Population
Dhom dam to Sangam Mauli			
Eksar	2379	Warkhadwadi	1120
Wyahali	594	Pandewadi	1100
Pasarni	5049	Bhogaon	679
Kolan	216	Menawali	2015
Siddhanathwadi	662	Wai rural	2643
Songirwadi Rural	4455	Wai city	36025
Shendurjane	1082	Sultanpur	721
Sultanpur	721	Shelarwadi	443
Pandharechiwadi	521	Bawdhan	10002
Anpatwadi	1932	Darewadi	742
Ozarde	5608	Kadegaon	1091
Pande	1716	Purna Vyahali	625
Bhuinj	11364	Asale	2668
Kadamwadi	1392	Panchwad	3087
		Amrutwadi	1388
NH 4			
Chindhawali	2153	Sarjapur	1072
Jamb	2512	Kalambhe	1452
Chandwadi	519	Prabhuchiwadi	415
Khadki	1339	Saigaon	526
Bhivadi	94	Kharshitwadi	1760
Nikamwadi	830	Raigaon	1187
Kisanvirnagar	925	Mahamulkarwadi	519
Mardhe	1990	Limb	7851
Gove	47	Kondhaval	527
Rautwadi	461	Nagewadi	737
Malgaon	3859	Basappachiwadi	1041

Vangal	1428	Arale	2222
Shivthar	3992	Wadhe	2649
Arphal	2640	Wasole	619
Vaduth	3236	Patkhal	4063
Aasgaon	336	Khed	2854
Borkhal	1973	Satara city	120079
saigaon	1634		
Khavali	560		
Kshetra Mahuli	4234		
Sangam Mahuli	1980		
Sangam Mahuli- (Priti Sangam)			
Triput	1487	Pirwadi	2048
Jarewadi	641	Chahur	543
Lhasurne	3496	Jaitapur	1152
Tadawale,Koregaon	2820	Kindwadi	1762
Mangalpur	999	Degaon	5100
Sultanwadi	874	Rajewadi	469
Eksal	2379	Chincher Vandan	2655
Godsewadi	700	Dhangar Wadi	339
Kathapur	2464	Gojegoan	1078
Shirambe	2120	Braramhanwadi	504
Dughi	1287	Tasgaon	2204
Nigadi t.satara	2798	Jadhav Wadi	780
Katewadi	361	Mulik Wadi	1070
Sasurve	2199	Jihe	1845
Apshinge	2588	Fadtarwadi	768
Dhamner	2657	Angapur targaon	1901
Rahimatpur	18584	Angapur vandan	3926
Borgaon Takale	2543	Varne	4190
Surli	2027	Nigadi Vandan	697
Pimpri t. medha	236	Dhondewadi	411
Kiroli	2561	Kameri	2226

Wathar Kiroli	5174	Fatyapur	1536
Gujarwadi (N.V.)	322	Deshmukhnagar	402
Targaon t targaon	1901	Limbachi Wadi	740
Mohitewadi	1323	Jawalwadi	1246
Sathewadi	491	Nandgaon	1148
Rikibadarwadi	877	Landewadi	444
Dakewadi Kalgaon	777	Venegaon	2384
Tukaichiwadi	757	Khodad	1164
Chinchani	265	Atit	6038
Belwadi	658	Parle	2115
Kacharewadi	467	Bhayarhi Wadi	340
Navin Kavathe	1078	Korti	2316
Wanyachiwadi	892	Umbraj	14431
Vadoli Bhikeshwar	1849	Shiwade	1632
Masur	7966	Varade	1243
Konegaon	1983	Tasawade	1793
Malewadi	715	Belevade Haveli	450
Riswad	1593	Talbid	4357
Shahpur	1711	Karad City	4357
Koparde Haveli	6298	Malkapur	22392
Virvade	3715	Koyananagar	2628
Vidyanagar	1351	Varunji	5452
Babarmachi	1454	Gote	3747
Tembhu	3255	Mudhe	600
Wadgaon Haveli	6460	Khodshi	3336
Kodoli	3412	Vahagaon	653
Kaletake	1347	Kapil	1805
Dushere	2409	Jakhinwadi	3351
Munawale	271	Dhondewadi	646
Kille Machindra Gadh	3569	Narayanwadi	1701
Rethere BK	1590	Kale	9493

Rethere	11853	Junjarwadi	494
Kole	4577	Wathar kiroli	5174
Yedemachindra	6323	Chatlgulemala	832
Bhavaninagar	5030	Kalawade	4256
Bichud	3809	Belawde budruk	1117
Shirate	1285	Ond	4067
Takari	3088	Kasegaon	12401
Dudhari	3928	Wategaon	8838
Ghogaon	2157	Tambave	4838
Gaundwadi	2407	Dhotrewadi	759
Kundal	1025	Yewalewadi	1225
Dudhondi	3056	Kedarwadi	1144
Share Dudhondi	6663	Nerli	2132
Kirloskarwadi	310	Bahe	189
Palus	22690	Hubalwadi	2246
Sawantpur	18296	Kapuskhed	4630
Pundi Tarf Walva	6372	Uran Islampur	58830
Nagarale	3705	Farnewadi	707
Shirgaon	2029	Borgaon	3131
Burli	867	Banewadi	780
Gondilwadi	12892	Satapewadi	666
Aamanapur	2332	Masuchiwadi	2846
Shivajinagar	1868	Junekhed	2468
Vithalwadi	771	Navekhed	3419
Tasgav Sugar	1174	Walwa	21029
Tavdarwadi	2394	Ahirwadi	800
Julewadi	1648	Padavalwadi	2141
Burungwadi	2853	Nagthane	7704
Nimani	2588	Santgaon	7704
Hajarwadi	1142	Ankalkhop	10724
Khandobachiwadi	2076	Mardawadi	1759
Malwadi	1205	Ashta	33536

Bhilawadi	1784	Karandwadi	3121
Vasagade	9622	Tung	5716
Khatav	5070	Krishnagar	5716
Chopdewadi	1452	Sheri Kavathe	1048
Sukhwadi	1291	Kavathe Piran	9438
Braontianal	1291	Kasbe digraj	12163
Nandre	2624	Old Kavateshwar	12163
Navaraswadi	726	Samdoli	8196
Monje Digraj	4455	Samdoli	8196
Bisur	8096	**(kop)**Danoli	12874
Karnal	5138	Kothali	8972
Padmale	3237	Umalwad	5035
Budhgaon	3237	Jaysingpur	8654
Bamnoli	3809	Chipari	7096
Miraj/SangliiKupwad	502697	Shirol	24512
Takali	5798	Nandai	1517
Balwad	5450	Kurundwad	5860
Dhavali	2860	Shirdhon	2113
Badag	2860	Terwad	5380
Narwad	6282	Herwad	6698
Mhaisal	13809	Gurudatta Sugar	7444
Lakshmiwadi	1181	Takali	5798
Lokarewadi	713	June Danwad	5454
Kagwad	71	Dattawad	9311
Alas	1083	Sainik Takali	5450
Mangavati	7224		
Total	**382226**	**Total**	**641088**
	Grand Total	**909455**	

Executive Summary

of

Comprehensive Study Report on Krishna River Stretch

(Dhom dam to Rathare weir, Satara, Rethare wier to Rajaram Bandhara, Shirol, Sangli)

Submitted by

MITRA

(Mass Initiative for Truth Research & Action)

2014

Summary

The Krishna 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 Dhom dam to Rethare weir, Satara and Rethare weir to Rajapur Bandhara, Shirol, Sangli. The Krishna River originates in Mahabaleshwar in the Western Ghats. It is one of the major rivers in Maharashtra. The river basin in Maharashtra extends from lat $18^0$03' N to long $73^0$34' E covering 69,425 Km^2 area which contributes about 26.81% of total area of Krishna River basin. The length of Krishna river in Maharashtra is 342.02 Km. It is one of the major water source, which supports 2536 major cities, towns and villages along with a population of 68,94,862. The Krishna river stretch covers area from 21 talukas of the three districts namely, Satara, Sangli and Kolhapur.

- Origin of Krishna River – Mahabaleshwar, Satara
- Total extend of Krishna river basin - 258,948 Km^2
- Extend of Krishna river basin Maharashtra - 69,425 km^2
- Expanse of Krishna river in Maharashtra – Satara, Sangli and Kolhapur Districts
- No of tributaries and sub-tributaries of Krishna river in Maharashtra – 24

- **Details of Krishna river, its tributaries and sub-tributaries**
  - No of dams – 19
  - No of K. T. weirs – 157
  - Total length of rivers – 2378.19 Km
  - Total length of A1 rivers – 365.85 Km
  - Total length of A2 rivers – 1939.76 Km
  - Area under irrigation – 314367 Ha
  - Total power generation – 186.344 MW/ Yr
  - Gross water storage – 6122.7 Mm^3

- Live water storage – 6157.88 Mm^3
- Water used for irrigation – 2521.28 Mm^3
- Water used for domestic use – 637.32 Mm^3
- Water used for industries – 76.11 Mm^3

(TOR 1)

- **Population of districts and Domestic Sewage generation in Krishna River Basin in Maharashtra**

District	Taluka	No. of Town/ Village	Population	Domestic sewage (Lit/ day)
03	21	2536	68,94,862	689486200

Average sewage generation by a person is 100 Lit per day

Details of Agriculture in the Krishna 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)
03	21	604310	376616	7128500	8109426

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

Districts	Foreign Hybrid Cows and oxen	Indian Hybrid Cows and oxen	Buffalos	Total	Waste water generated (Lit/ Day)
03	263546	259739	1102596	1625881	81294050

Average sewage generation by an animal is 50 Lit per day

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

District	Land under cultivation (ha)	Sale of Fertilisers MT	Per hectare use MT
03	1021979	583784	1.75

(TOR – 2)

Details of Industries in the Krishna river Basin in Maharashtra

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

Category of Industries	Category	Water Consumption (CMD)	Industrial Effluent (CMD)	Domestic Effluent (CMD)	Total Effluent (CMD)
Red	2212	198839.262	103401.555	15271.242	118672.797
Orange	1843	13555.58	2318.09	4135.925	6454.015
Green	7839	11475.051	1670.4	6196.203	7903.056
Total	11894	223869.893	107390.045	25603.37	133581.976

- **Water consumption and effluent generation by sugar industries in Krishna River Basin in Maharashtra**

No of Sugar Industries	Sanctioned crushing capacity (MT/D)	Industrial water consumption (CMD)	Domestic water consumption (CMD)	Industrial Effluent (CMD)	Domestic Effluent (CMD)	Total effluent generated (CMD)
34	53250	8325	1785	6170	1375	7545

- **Water consumption and effluent generation by Distilleries in Krishna River Basin in Maharashtra**

No of Distillery	Industrial water consumption (CMD)	Domestic water consumption (CMD)	Industrial Effluent (CMD)	Domestic Effluent (CMD)	Total effluent generated (CMD)
19	9314	199.45	6775	155.18	6930.18

(TOR – 2 & 3)

- **Details of solid waste generation and its treatment**

Sr. no.	Waste Management Details	SATARA	SANGLI	KOLHAPUR
a)	**Hazardous Waste (HW)**			
1	No. of Hazardous Waste generating units	179	65	205
3	Quantity of H.W. generated (MT/Month)	97.791	164.473	770

8	Units joined to common facilities	65	31	134
9	Quantity of waste treated at common facility (MT/Month)	97.791	2.61	725
b)	**Bio-Medical Waste (BMW)**			
1	No. of Health Care Establishments (HCEs)	1118	1364	1773
3	Quantity of BMW Generated (MT/day)	1.21438	0.885	1.75
4	Quantity of BMW treated (MT/day)	1.21438	0.885	1.75
5	HCEs with own treatment & disposal facilities	1	73	84
c)	**Municipal Solid Waste (MSW) Management**			
1	No of local bodies	9	6	10
2	Quantity of Solid waste Generated in (MT/Month)	125.5	6870	9450
4	Local bodies having their own treatment & disposal facilities.	3	4	4

Recommendations

River water management –

The concerened governmental agencies should maintain minimum water 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.

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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.

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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

- 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 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.
- Environmental Impact Assessment of existing and sand mining should be carried out in the river basin for further policy decisions.
- 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.

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 Krishna River Basin

Sr. no.	Particulars	Quantity			Short Term Measures	Long Term Measures	Preference
		Actual	Total	%			
1	**Domestic Liquid Waste**						
i	Satara Municipal Corporation (120079)	12 MLD		6.11	Arrest, Disinfection, reuse for agriculture	STP, Reuse for Agriculture	1
ii	Sangli Miraj Municipal Corporation (502697)	50.27 MLD		25.59			1
iii	Kolhapur Municipal Corporation (500000)	97 MLD		49.39			1
iv	Villages (> 10,000 population) (364846)	36.48 MLD		18.57			2
v	Villages (1000 – 10000 population) (617655)	0.62 MLD		0.32			3
vi	Villages (< 1000 population) (40813)	0.04 MLD		0.02			3
2	**Industrial Effluent**						
i	MIDC from Satara District	3246.39 CMD	147306.20 CMD	2.20	Reduce, Reuse for agriculture	ETP, CETP, Reuse for Agriculture/ HRTS	2
ii	Non MIDC industries from Satara District	9056.97 CMD		6.14			3
iii	MIDC from Sangli District	7363.32 CMD		5.00			2
iv	Non MIDC industries from Sangli District	2122.59 CMD		1.44			2
v	Five Star MIDC from Kolhapur District	24215.88 CMD		16.43			1
vi	Ichalkaranji MIDC from Kolhapur	22383.36 CMD		15.19			1

vii	Other MIDCs from Kolhapur District	15633.48		10.61			1
viii	Non MIDC industries from Kolhapur District	48809.01 CMD		33.13			3
ix	Sugar Industries	7545 CMD		5.12			2
x	Distillaries	6930.18 CMD		4.70	Compost	Reverse Osmosis	2
3	**Solid Waste**						
i	Municipal Solid Waste	16445.5 MT/day	17482	94.07	Reduce, Reuse, Segregation, Compost,	Proper treatment	1
ii	Biomedical Solid Waste	3.84938 MT/day		0.02	Segreagation, Decentralisation	Proper treatment	1
iii	Hazardous Waste	1032.264 MT/day		5.90	---	Ranjangaon HW plant	1
4	**Other**						
i	Religious	---			Ban on immersion in natural water sources	Establishment of Visarjan Kund, Raksha Kund	1
ii	Ganesh Idol Immerssion	---					
iii	Brick Making	--			Immediate restrict the activity	Approval after EIA	1
iv	Sand Mining	--			Immediate restrict the activity	Approval after EIA	1

Krishna River Basin in Maharashtra

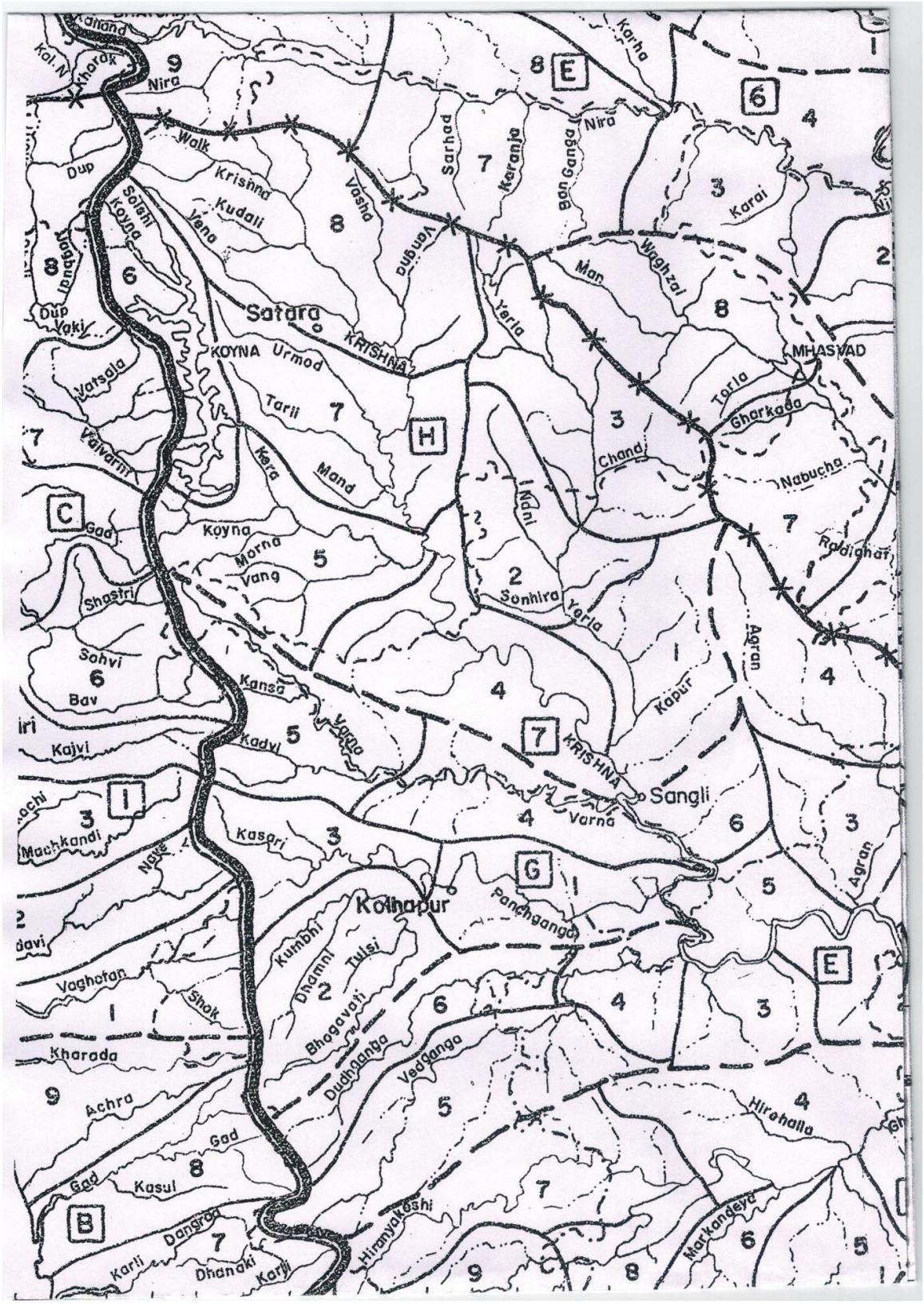

Photo Plate – Hospital Waste Status

Photo no 1

Photo no 2

Photo no 3

Photo no 4

Photo no 5

Photo no 6

Photo no 1 – North east corner of Krishna Hospital Karad premises where liquid waste is stored open land which further directly flows towards river

Photo no 2 and 3 – Phyto remediation plant at Krishna Hospital Karad which not working in tis full efficiency; liquid waste passes through plant and agricultural land towards nalla which further flows towards river.

Photo no 4 – BMW dispersed in hospital premises

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

Photo Plate – Industries and MIDC Status

Photo no 1

Photo no 2

Photo no 3

Photo no 4

Photo no 5

Photo no 6

Photo no 7

Photo no 1 – Non-functional ETP at Royal foods Industry

Photo no 2 – Effluent directly flowing towards river from Royal foods Industry Tasawde MIDC

Photo no 3 & 4 – Prabhune engineering plating Industry – ETP is not in working condition. Hazardous waste is directly disposed on the land in premises

Photo no 5 – Leachate from Royal foods Industry passing through land, after rain may flow towards river

Photo no 6 & 7 – santosh dairy, Tasawade MIDC – STP is nonfunctional, waste water directly disposed on the land and gutters

Photo Plate – Industries Status

Photo no 1

Photo no 2

Photo no 3

Photo no 4

Photo no 5

Photo no 6

Photo no 1 – Untreated effluent from Mala's food industry is discharged on agricultural land

Photo no 2 & 3 – Garware Bestreach Industry ETP is non-functional. Effluent is discharged in natural drains

Photo no 4 – Non-functioning ETP of Mapro industry, effluent is discharged on agricultural land

Photo no 5 & 6 – Non-functioning ETP of Gokul Milk processing Industry

Photo Plate – Status of Solid Waste

Photo no 1

Photo no 2

Photo no 3

Photo no 4

Photo no 5

Photo no 6

Photo no 1 – Burning of solid Waste in Karad city

Photo no 2 – Disposal of solid waste on the Krishna river bank in high flood line area at Karad city

Photo no 3 – Disposal of solid waste on the Krishna river bank at Bhuinj village

Photo no 4 – Shendri at foot hill of Ajinkyatara - Solid waste dumping site of Satara city, burning of solid waste

Photo no 5 – Disposal of incineration ash and untreated biomedical waste at Waste dumping site of Sangli, Miraj, Kupwad,

Photo no 6 – Disposal of night soil from septic tanks

Photo Plate – Status of Solid Waste

Photo no 1

Photo no 2

Photo no 3

Photo no 4

Photo no 5

Photo no 6

Photo no 1 - Waste dumping site of Sangli, Miraj, Kupwad

Photo no 2 – BMW and slaughter house waste disposal at sangli, Miraj, Kupwad waste dumping site

Photo no 3 – Non-functioning slaughter house waste treatment plant

Photo no 4 – solid Waste disposal at Kera river, Patan

Photo no 5 – MSW disposal site at Kolhapur

Photo no 6 – MSW disposal in Panchaganga river

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 – Tradition of disposal of milk drawn from freshly delivered cattle into the river

Photo no 3 – Fishing Activity at river

Photo no 4 – Rituals after cremation of dead-body at river

Photo no 5 – Crematorium at satara on the bank of river from where cremation ash is disposed at the river Krishna

Photo no 6 – Disposal of cremation ash in the river Panchaganga

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 – bathing activities at Krishna river

Photo no 2 – Bathing and washing activities at river Panchaganga

Photo no 3 & 4 – Washing activities on the river ghats

Photo no 5 & 6 – washing of heavy vehicles in the river bed

Photo Plate – Status of Effluent Carrying Nallas

Photo no 1

Photo no 2

Photo no 3

Photo no 4

Photo no 5

Photo no 6

Photo no 1 – Unscientific disposal of effluent of Sahyadri SSK on the land

Photo no 2 – Effluent from ETP flowing towards river

Photo no 3 – Filling of effluent in the tanker

Photo no 4 – Effluent flowing towards river

Photo no 5 – Discharge of effluent from tankers on the agricultural lands

Photo no 6 – Satara MIDC nalla flowing towards river Krishna

Photo Plate – Status of Effluent Disposal

Photo no 1

Photo no 2

Photo no 3

Photo no 4

Photo no 5

Photo no 6

Photo no 1 – Effluent storage in Kaccha lagoon of Rajarambapu distillery, effluent flowing towards river from non-lined lagoons

Photo no 2 – Disposal of ash from Rajarambapu distillery

Photo no 3 – Nalla carrying effluent from Ajinkyatara sugar industry and distillery towards river

Photo no 4 – Leakages in effluent carrying pipe at Narade sugar factory

Photo no 5 – Disposal of effluent through leakages in effluent carrying pipes

Photo no 6 – Unscientific storage of effluent in non-lined oxidation plants

Photo Plate – Status of Sewage Carrying Nallas

Photo no 1

Photo no 2

Photo no 3

Photo no 4

Photo no 5

Photo no 6

Photo no 1 – Disposal of domestic sewage near board intimating not to dispose off sewage in stream

Photo no 2 – Naturally occurring phyto – remediation on the village sewage carrying nalla

Photo no 3 – Nalla carrying sewage to Krishna river at Miraj

Photo no 4 – Domestic sewage carrying nalla at Umbraj village

Photo no 5 – Sewage carrying nalla from Satara city flowing towards Venna river

Photo no 6 – Sewage carrying nalla from Wai city

Photo Plate – Status of Sewage Carrying Nallas

Photo no 1

Photo no 2

Photo no 3

Photo no 4

Photo no 5

Photo no 6

Photo no 1 & 2 - Sewage carrying nalla from Wai city

Photo no 3 – Sewage disposal into river at Koregaon

Photo no 4 & 5 – Sewage Carrying nallas at villages flowing towards river

Photo no 6 – Patchy growth of echornia and algae in river bed

Photo Plate – Activities Agricultural fields having Impact on River

Photo no 1

Photo no 2

Photo no 3

Photo no 4

Photo no 5

Photo no 6

Photo no 1 & 2 – Left over chemical pesticide containers are washed off in the agricultural runoff stream

Photo no 3 & 4 – Drip irrigation and plastic mulching at saline soil field

Photo no 5 – Trenches for reclamation of saline soil

Photo no 6 – Water collected from trenches is further disposed off in to the river

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 – Sand deposits at sand mining units in Krishna river

Photo no 2 – Sand mining units in Yerla river

Photo no 3 – K. T. weir on the river with open barracks

Photo no 4 – Pipes and pumps installed in river for pumping water for irrigation purpose. There is no monitoring at water pumping

Photo no 5 – Non flowing dry bed of Yerala river with scanty growth of shrubs and water weeds

Photo no 6 – Brick kilns in Kera river bed along with growth of water hysinth in the river bed