# ACTION PLAN FOR RESTORATION OF

# POLLUTED STRETCH OF RIVER KATHAJODI AND RIVER SERUA

**FOR POLLUTED RIVER STRETCHES OF**

**1. KATHAJODI ( CUTTACK TO URALI)**

**2. SERUA ( KHANDAETA TO SANKHATRASA)**

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**CHAPTER-I**

# INTRODUCTION

## 1.0 Kathajodiriver

Kathajodi River, a major distributary of Mahanadi river in Odisha, branches off from the river at Naraj at the upstream of Cuttack city. Kathajodiriver is immediately bifurcatednearNaranpur village into Kuakhai river and Kathajodi river. The southern branch Kuakhai river flows along the capital city of Odisha, Bhubaneswar, whereas, the northern branch, Kathajodi river flows along Cuttack city. At the downstream of Cuttack city, the river is again bifurcated into the right branch, Seruariver and left branch, Kathajodi river. After flowing for a distance of 17 Km, both the rivers again merge and later named as river Devi, which is further bifurcated at Gobindpur, the right branch is known as the Devi and the left branch as the Biluakhai. The major percentage of water originally carried by Kathajodiriverhas been diverted into the Devi and ultimately drains into the Bay of Bengal.

Kathajodiriver water is used for various in-stream activities along its course. However, the river is polluted by both point and non-point sources.The major source of pollution of the river is due to discharge of domestic wastewater into the river. Cuttack city is the only urban local body located along the course of flow of Kathajodiriver. A large portion of the wastewater of Cuttack city find its way into the river thereby degrading the water quality of the river. The condition deteriorates further due to lack of sufficient dilution capacity of the river during lean period. Keeping in view the large rural population dependent upon the river at its downstream, it is of significance to restore its water quality.

The flow of water in the river is controlled through the Naraj barrage. The river remains almost in dry state during January to June in many parts of its stretch and under flooded conditions during July-October. During the non-monsoon period (October to June), the river flow reduced significantly and some of the stretches of the riverbecome almost dry.

Discharge of untreated domestic wastewater of Cuttack city into the river has deteriorated the water quality of Kathajodi river which is further aggravated due to insignificant flow of water in the river.

## 1.1 Cuttack city

Cuttack, the former capital city of Odisha state, is headquarter of the Cuttack district. It is the major hub for trading and business in and around the city. The topography of the city lies between $20^0$ 29'North Latitude and $85^0$ 52' East Longitude. The city is surrounded by the Mahanadi River and Kathajodiriver. The general topography of Cuttack city is gentle slope from west to east occupying the delta plains of the Mahanadi river in the east and hilly terrain on the west. Satellite map of Cuttack city is given in Fig.1.

Maximum elevation is 28 meter inthe north and minimum elevation is 20 meter in south east. The central part of the city is low with anelevation of 17 meter. Major canal, known as Taldanda Canal starts from JobraAnicut on the Mahanadi river, runs in southeast direction bisecting the city. The western and southern part of the city is divided by the canal.

The population of the city, as per the Census 2011, is 606,007(Census of India, 2011). which is 23.14% of the population of Cuttack district and 1.45% of the population of Odisha state. The municipal area comprises of an area of 192.5 sq.km. The gross population density of the ci

ty is 7,769 persons per sq.km. Slum population is 223,619, which is 36.9% of the total population Floating population of city is around 30,000 to 40,000 per day.

**Fig. 1 Satellite map of Cuttack city**

## 1.2 Water Supply

The Cuttack municipal area has 59 numbers of wards. Drinking water sources of Cuttack Municipal area includes surface sources (rivers) andground water sources. However, presently the majority of water demand of Cuttack city is being fulfilled through 192 numbers of production wells. Daily water demand in the city is 103.12 MLD.

## 1.3 Waste water generation

The wastewater generation is82.5 MLD (80 percent of water supply) from the city.There is no systematic seweragesystem in the city. The domestic waste water along with storm water are being discharged to Kathajodi river, Mahanadi river, Taladanda canal and in some places are collected in ponds.

Open surface drains exist in some portion of the town to discharge the storm and wastewater. These drains not only receive sewage from majority of residents but also septic tank effluent containing excreta and rain water runoff. Storm water drain known as drain No 1 runs from west to east direction and discharges into Kathajodiriver while another drain runs from west to east direction and discharges into Mahanadi River.Besides, there are a number of small drains which are intercepted and diverted to the existing two major drains. Drainage map of Cuttack city is shown in Fig. 2.

**(a) Drains leading to Kathajodiriver**

Wastewater is being discharged to the Kathajodi river at the following three points.

(i) The Drain No. 1 runs for a length of about 10.47 km. It originates at Srivihar Colony(Hanuman Temple) near Tulasipur which isto the north west of the city and ultimately outfalls into river Kathajodi near Mattagajpurat the city's south east end. Beyond the Mattagajpur sluice, water flows for about 2.25km parallel to Kathajodiriver inside the flood plain before joining the stream. This reach is not having defined drain section. At the origin of the main drain No. 1 a tributary drain also joins the main drain about a km upstream of Srivihar colony. The main drain has been diverted at Samrat Cinema Hall and major portion of the domestic waste water is being directly discharged to Kathajodiriver near Khannagar (Fig. 3).

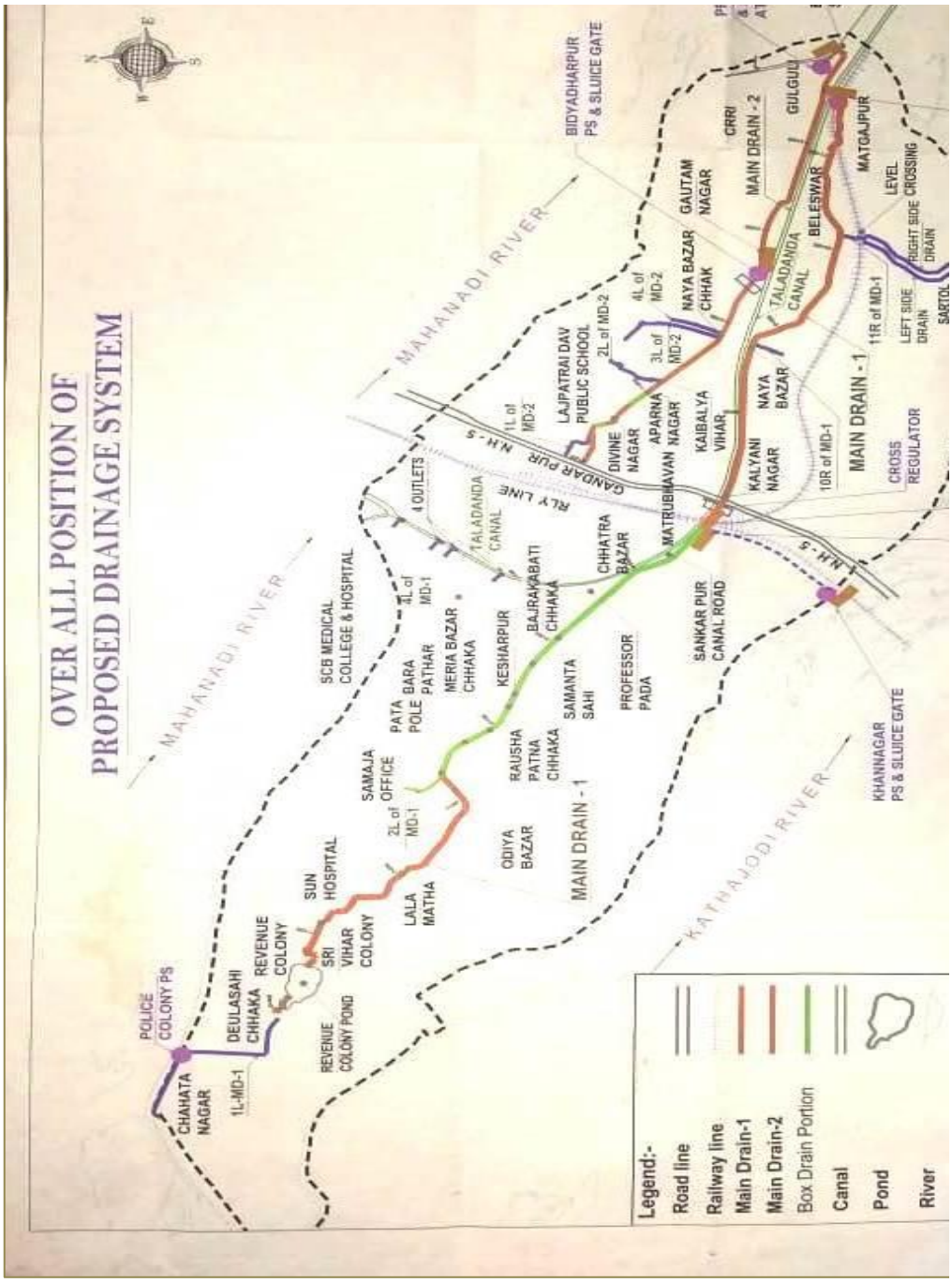


**Fig. 2 Drainage map of Cuttack city (Existing as well as proposed)**

(ii) Bidanasi area of Cuttack city is a planned area and have sewerage system. The wastewater from all the sectors of CDA and Bidanasi area are being discharged to Kathajodiriver near Ajay-BinayInstitute of Technology (ABIT) (Fig. 4). However, the discharge to the river is controlled through a sluice gate.

(iii) A 33 MLD Sewage Treatment Plant (STP) is located in Mattagajpur consisting of the stabilization pond system. It treats the wastewater received through main drain No. 1 and discharges the treated water to Kathajodiriver. During the non-operational period of the STP, the untreated waste water is also disposed to Kathajodi River (Fig. 5).

**Fig. 3 Wastewater discharge to Kathajodiriver atKhannnagar**

**Fig. 4 Wastewater discharge to Kathajodiriver nearABIT**

**Fig. 5 Wastewater discharge to Kathajodiriver atMattagajpur**

**(b) Drains leading to Mahanadi river**

The main drain No. 2 originates from eastern part of Cuttack Railway Station near the railway track. Itruns from OMP square to bank of Mahanadi riverbeyond C.R.R.I. campus and thereafter inside the flood plain before joining the river. Guluguli sluice on Mahanadi right embankment, just on the eastern boundary of C.R.R.I, controls water flow of river Mahanadi and prevents back flow into the city. The drainage area of main drain No. 2 at Guluguli sluice is 565 hectares. No definite drain section is maintained in the reach inside the C.R.R.I campus.

As most of the industries in Cuttack city are located in Jagatpur Industrial Estate, the treated wastewater from these area find their way to Mahanadi river.

**(c) Drains leading to Taladanda canal**

A part of untreated domestic wastewater of Cuttack city is also being discharged to Taladanda canal. The canal origins from Mahanadi river at Jobra and passes through the Cuttack city before it finally culminates at Paradeep in Jagatsinghpur district.

## CHAPTER-II

# POLLUTION OF KATHAJODI RIVER

The State Pollution Control Board, Odisha regularly monitors the water quality of Kathajodiriver at the upstream and downstream locations of Cuttack city. At the downstream of Cuttack city the river bifurcates into Kathajodiriver and Serua river. Due to gradient, the major flow of the river is through Seruariver. After traversing for a distance for approximately 17 Km, both the river merge. Water quality is also being measured at Sankhatrasa (Cuttack Further Downstream) on Serua river, Mattagajpur (Cuttack Further Downstream) on Kathajodiriver. Water quality monitoring studies during last decades has revealed that the polluted stretch of Kathajodiriveris along the Cuttack city.

## 2.1 The Project

Keeping in view the polluted stretch of Kathajodi river, Central Pollution Control Board has sanctioned a project proposal on “Comprehensive Study on Polluted Stretch of River Kathajodi downstream of Cuttack” in the year 2013 for estimation of pollution load reaching the river and to prepare action plan indicating key areas for short term as well as long term measures forimprovement and restoration of water quality in the polluted stretch of the river.

## 2.2 Industrial sources of river water pollution

There are two industrial areas in the city. Madhupatna Industrial Estate is located near Kathajodiriver, whereas the Jagatpur Industrial estate is located near Mahanadi river. Major industries in Cuttack city are located in Jagatpur Industrial Estate. The treated industrial wastewater after meeting the disposal standards laid down by the State Pollution Control Board, Odisha are either recycled or discharged to Mahanadi river. There is practically no industrial wastewater discharge in Madhupatna Industrial Estate to Kathajodiriver.

## 2.3 Domestic sources of river water pollution

Discharge of untreated wastewater is the major cause of pollution of Kathajodiriver. Rising density of population in the vicinity of the bank of the river, poor sanitation practices of the residents, dumping of municipal solid waste along the banks, lack of proper treatment facilities of domestic wastewater are the main causes of pollution along this stretch of the river.

There are three identified sources of domestic wastewater pollution on the river Kathajodi along the Cuttack stretch. These are (i) drain near ABIT, (ii) drain near Khannagar (iii) drain at Mattagajpur. Since the bed of Kathajodiriver during lean period is almost dry, the discharges of these drainsexcepting the Khannagar drain, flow through sand bed for almost 500 meter distance before directly mixing with the river water.

## 2.4 Wastewater Quality

Wastewater quality of these three drains have been monitored by the Boardfor the following physic-chemical and bacteriological parameters.

pH, biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), total phosphate, ammonical nitrogen, total nitrogen, cyanide (CN), hexavalent and total chromium (Cr), mercury (Hg), copper (Cu), lead (Pb), zinc (Zn), cadmium (Cd), nickel (Ni), cobalt (Co), total coliform (TC) and fecal coliform (FC).

To assess the impact of these wastewater drains on theKathajodi river water quality, theBoard is also monitoring the water quality of Kathajodi river at the following locations.

(i) Cuttack U/s at Narajon Kathajodiriver

(ii) Cuttack D/s at Urali on Kathajodiriver

(iii) Sankhatrasa on Seruariver

(iv) Mattagajpur on Kathajodiriver

(v) Kamasasan after confluence of Serua and Kathajodiriver

The monitoring locations are shown in Fig.6.

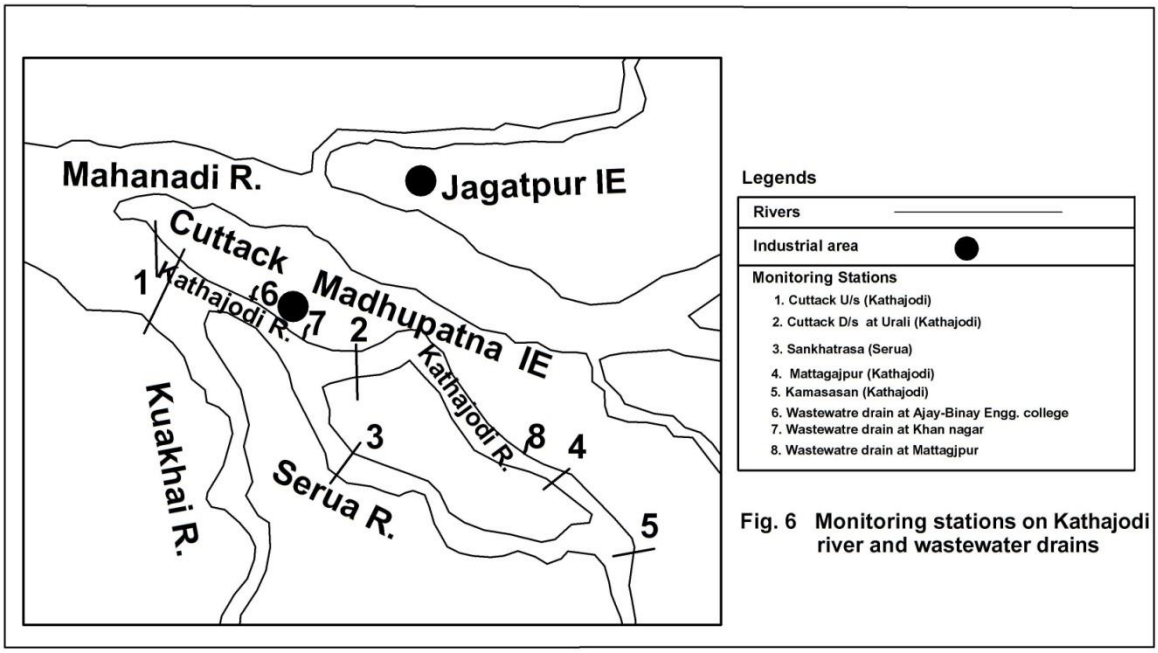


**Fig. 6 Monitoring stations on Kathajodi river and wastewater drains**

## 2.5 Water Quality of Kathajodiriver

River water quality has been monitored for the following parameters.

(a) *Physical parameters*: pH, Alkalinity, Total suspended solids (TSS)

(b) *Indicators of Organic pollution*: Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Free ammonia – Nitrogen, Ammonical (Ammonium + ammonia) – Nitrogen, Total Kjeldahl Nitrogen (TKN)

(c) *Bacteriological parameters*: Total Coliform (TC) and Fecal Coliform (FC)

(d) *Mineral constituents*: Electrical Conductivity (EC), Total Dissolved Solids (TDS), Boron, Sodium Absorption Ratio (SAR), Total Hardness (TH), Chloride, Sulphate, Fluoride.

(e) *Nutrients*: Nitrate (Nitrate + Nitrite) – Nitrogen, Phosphate – Phosphorous

(f) *Metals* :Chromium (Cr) (total and hexavalent), Iron (Fe), Nickel (Ni), Copper (Cu), Zinc (Zn), Cadmium (Cd), Mercury (Hg), Lead (Pb)

## CHAPTER-III

# Water and Wastewater Quality

Quality of the three major wastewater drains outfall into Kathajodi river and their impact on the water quality of the Kathajodiriverhave been discussed in following pages.

Wastewater quality of the three drains during the period February, 2014-December, 2017 are discussed in this report.

Water quality of Kathajodi river at five locations during the period February, 2014-December, 2017 have been discussed in the following pages. As the water quality monitoring at Kamasasanhas been initiated from May, 2017, data for this station are given for the period May, 2017-December, 2017.

### 3.0 Water Quality of drains

The quality as well as quantity of wastewater is responsible for the degradation of the receiving water bodies. The potential deleterious effects of wastewater on the quality of receiving water bodies are manifold and depend on volume of the discharge as well as on composition of the wastewater and flow available in the receiving water bodies. The wastewater quality are compared with the critical values stipulated by Ministry of Environment and Forests and Climate Change (MoEF& CC) (General standards for discharge of environmental pollutants : Part- A Effluents) (Annexure-1) to assess its suitability for acceptance in receiving water bodies.

### 3.1 Wastewater of Cuttack citythrough sluice gate at ABIT

The physico-chemical characteristic of wastewater with respect to pH, BOD, COD and TSS, from CDA-Bidanasi area discharged to Kathajodi river through the sluice gate near Ajay-Binay Engineering college during the period 2014-2017 is given in Table-1.

**Table-1Wastewater quality near ABIT with respect to pH, BOD, COD and TSS**

| Parameter | Annual average (Range of values) | | | | Discharge standard |
|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | |
| pH | 7.2 (7.0-7.4) | 7.3 (6.9-8.1) | 7.1 (6.8-7.4) | 6.9 (6.8-7.2) | 5.5-9.0 |
| TSS, mg/l | 41 (18-83) | 37 (15-73) | 111 (25-492) | 59 (16-169) | 100 |
| BOD, mg/l | 55 (21-80) | 47 (23-77) | 69 (30-133) | 64 (14-111) | 30 |
| COD, mg/l | 138 (91-195) | 137 (69-218) | 185 (80-377) | 135 (50-193) | 250 |

pH values range from 6.8 to 8.1 which are within the prescribed limit for pH for discharge of effluents into inland surface water, that is, 5.5-9.0.

TSS values exhibit a wide fluctuation with maximum values being observed in rainy season (June-September). During lean period, TSS values remain within the prescribed limit for TSS,that is, 100 mg/l.

The organic waste load measured in terms of BOD shows an annual average value of 47-69 mg/l during the study period, which is beyond the prescribed limit of BOD,that is, 30 mg/l.Monthly variation of BOD values is depicted in Fig.7 . Excepting few occasions, BOD values in the wastewater drain exceeded the permissible limit.

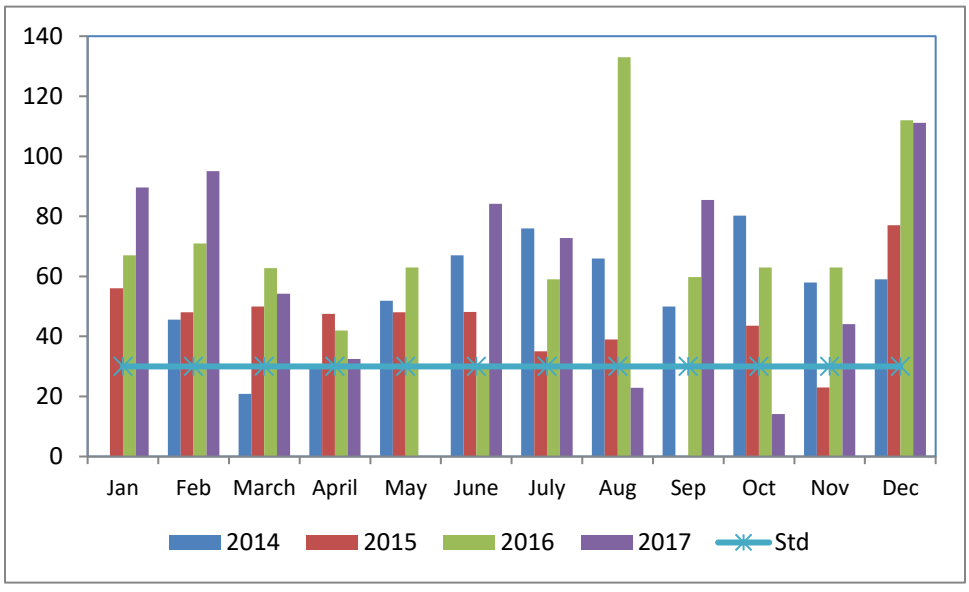


**Fig.7 Monthly variation of BOD values in wastewater of Cuttack city through sluice gate at ABIT**

Annual average valuesCOD varies within 135-185 mg/l during the study period, which remains within the prescribed limit of COD, that is, 250 mg/l. Monthly variation of COD values has been only exceeded during the rainy season of 2016.

Annual average and range values of total dissolved phosphates, ammonical nitrogen, total nitrogen, total coliform and fecal coliformin the wastewater drain during the years 2016 and 2017 are given in Table-2. As revealed from the data, the month-wise variation in total dissolved phosphates, ammonical nitrogen andtotal nitrogen concentrations in the drain shows wide fluctuation.

Both total coliform and fecal coliform bacteria population in the wastewater are found to be extremely high during 2016 and 2017.

**Table-2 Wastewater quality near ABIT with respect to $PO_4^{3-}$-P, $NH_3$-N, Total N, TC and FC**

| Parameter | Annual average (Range of values) | | Discharge standard |
|---|---|---|---|
| | 2016 | 2017 | |
| **Total dissolved $PO_4^{3-}$-P, mg/l** | 4.148 (0.810-9.090) | 11.964 (2.521-26.015) | 5.0 |
| **$NH_3$-N, mg/l** | 16.987 (7.840-29.400) | 17.540 (2.688-48.200) | 50 |
| **Total Nitrogen, mg/l** | 63.471 (26.640-115.502) | 49.738 (11.200-95.200) | - |
| **TC, MPN/100 ml** | 1600000 (160000-1600000) | 814546 (160000-1600000) | - |
| **FC, MPN/100 ml** | 1464000 (920000-1600000) | 814546 (160000-1600000) | - |

Results of heavy metals and cyanide measured in the wastewater during 2014 is given in Table-3. Except iron, all other heavy metals and cyanide concentrations are observed to be within the permissible limit. As there is no industrial source of pollution, heavy metal concentrations in the wastewater are found to be much lower than the permissible limit.

**Table-3 Wastewater quality near ABIT with respect to heavy metals and Cyanide during 2014**

| Parameter | $Cr^{+6}$, mg/l | T.Cr , mg/l | Pb, mg/l | Cu, mg/l | Zn, mg/l | Cd, mg/l | Fe , mg/l | Mn , mg/l | Ni, mg/l | Hg, mg/l | CN, mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Annual average (Range of values)** | 0.016 (0.003-0.032) | 0.048 (0.020-0.126) | 0.003 (0.001-0.004) | 0.002 (0.002-0.002) | 0.002 (0.001-0.003) | 0.001 (0.001-0.001) | 3.474 (3.068-3.879) | 0.027 (0.018-0.035) | 0.016 0.013-0.018) | 0.00045 (0.00038-0.00052) | 0.0128 (0.0069-0.0190) |
| **Discharge standard** | 0.1 | 2.0 | 0.1 | 3.0 | 5.0 | 2.0 | 3.0 | 2.0 | - | 0.01 | 0.2 |

### 3.2 Wastewater of Cuttack citythrough sluice gate at Khannagar

The physico-chemical characteristic of wastewater drain with respect to the parameters pH, BOD, COD and TSS, discharged to Kathajodi river through the sluice gate near Khannagar during the period 2014-2017 is given in Table-4.

**Table-4 Wastewater quality at Khannagar with respect to pH, BOD, COD and TSS**

| Parameter | Annual average (Range of values) | | | | Discharge standard |
|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | |
| **pH** | 7.3 (7.0-7.5) | 7.3 (7.0-8.0) | 7.1 (6.8-7.4) | 7.0 (6.8-7.2) | 5.5-9.0 |
| **TSS, mg/l** | 74 (27-150) | 71 (23-203) | 137 (26-657) | 50 (32-83) | 100 |
| **BOD, mg/l** | 55 (39-84) | 43 (9-72) | 48 (15-93) | 44 (26-80) | 30 |
| **COD, mg/l** | 124 (92-163) | 120 (18-189) | 137 (39-333) | 99 (65-158) | 250 |

pH values range from 6.8 to 8.0 which are within the prescribed limit for pH for discharge of effluents into inland surface water.

TSS values exhibit a wide fluctuation with maximum values being observed in rainy season (June-September). During lean period, TSS values remain within the prescribed limit for TSS (100 mg/l).

Annual average values of BOD ranges within 43-55 mg/l during the study period, which is beyond the prescribed limit of BOD (30 mg/l) Month-wise variation of BOD values is depicted in Fig. 8 . As revealed from the figure, excepting few occasions, BOD values in the wastewater drain exceeded the permissible limit.

Annual average valuesCOD varies within 99-137 mg/l during the study period, which remains within the prescribed limit of COD (250 mg/l). Monthly variation of COD values has been only exceeded during the rainy season of 2016.

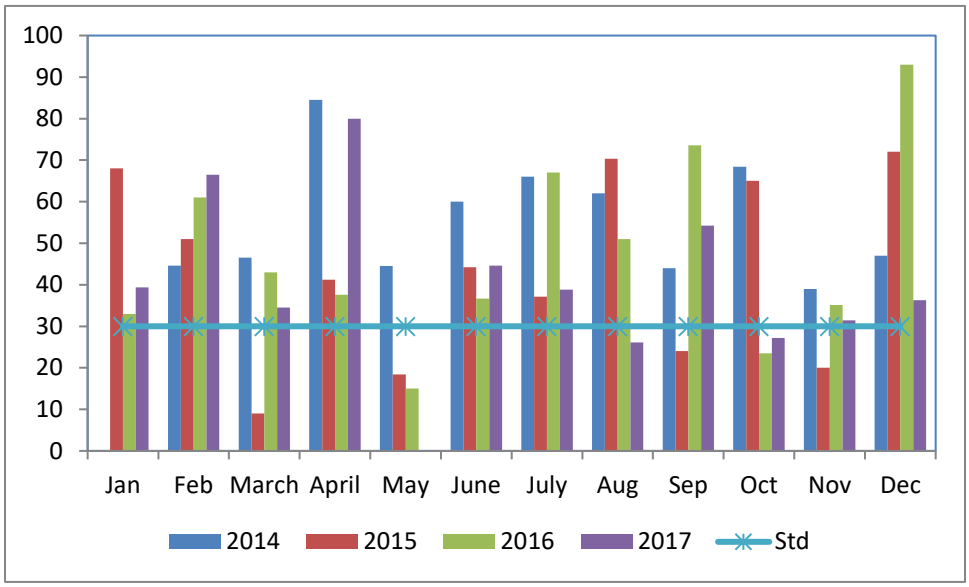


**Fig. 8 Monthly variation of BOD values in wastewater of Cuttack city through sluice gate at Khannagar**

Annual average and range values of total dissolved phosphates, ammonical nitrogen, total nitrogen, total coliform and fecal coliform in the wastewater drain during the years 2016 and 2017 are given in Table-5. As revealed from the data, the month-wise variation in total dissolved phosphates, ammonical nitrogen and total nitrogen concentrations in the drain shows wide fluctuation.

Both total coliform and fecal coliform bacteria population in the wastewater are found to be extremely high during 2016 and 2017.

**Table-5 Wastewater quality at Khannagar with respect to $PO_4^{3-}$-P, $NH_3$-N, Total N, TC and FC**

| Parameter | Annual average (Range of values) | | Discharge standard |
|---|---|---|---|
| | 2016 | 2017 | |
| **Total dissolved $PO_4^{3-}$-P, mg/l** | 4.966 (0.850-19.830) | 17.456 (1.370-66.500) | 5.0 |
| **$NH_3$-N, mg/l** | 12.767 (4.480-20.200) | 10.706 (2.240-22.900) | 50 |
| **Total -N , mg/l** | 33.625 (16.513-62.39) | 37.418 (4.480-84.000) | - |
| **TC, MPN/100 ml** | 1600000 (1600000-1600000) | 683636 (160000-1600000) | - |
| **FC, MPN/100 ml** | 1388000 (540000-1600000) | 683636 (160000-1600000) | - |

Results of heavy metals and cyanide measured in the wastewater drain during 2014 is given in Table-6. Except iron, all other heavy metals and cyanide concentrations are observed to be within the permissible limit. As there is no industrial source of pollution, heavy metal concentrations in the waste water are found to be much lower than the permissible limit.

**Table-6 Wastewater quality with respect to heavy metals and Cyanide during 2014**

| Parameter | $Cr^{+6}$, mg/l | T.Cr , mg/l | Pb, mg/l | Cu, mg/l | Zn, mg/l | Cd, mg/l | Fe , mg/l | Mn , mg/l | Ni, mg/l | Hg, mg/l | CN, mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Annual average (Range of values)** | 0.016 (0.005 - 0.032) | 0.052 (0.020 - 0.119) | 0.003 (<0.001 -0.008) | 0.002 (<0.001 -0.005) | 0.003 (0.003 - 0.004) | 0.001 (<0.001 -0.001) | 3.324 (3.189 - 3.458) | 0.018 (0.014 - 0.021) | 0.017 (0.012 - 0.022) | 0.00035 (0.00032 - 0.00038) | 0.0165 (0.0066 - 0.0375) |
| **Discharge standard** | 0.1 | 2.0 | 0.1 | 3.0 | 5.0 | 2.0 | 3.0 | 2.0 | - | 0.01 | 0.2 |

### 3.3 Wastewater of Cuttack city at Mattagajpur

The physico-chemical characteristic of wastewater drain with respect to the parameters pH, BOD, COD and TSS, discharged to Kathajodi river through the drain at Mattagajpur during the period 2014-2017 is given in Table-7. This drain carries the outlet discharge of STP at Mattagajpur as well as untreated domestic wastewater of main drain No.1. During non-functioning period of STP and rainy season, the untreated wastewater is discharged to Kathajodiriver through this drain.

**Table-7 Wastewater quality at Mattagajpurwith respect to pH, BOD, COD and TSS**

| Parameter | Annual average (Range of values) | | | | Discharge standard |
|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | |
| pH | 7.4 (6.8-7.9) | 7.4 (7.2-7.6) | 7.2 (7.2-7.3) | 7.1 (6.5-7.8) | 5.5-9.0 |
| TSS, mg/l | 18 (8-38) | 32 (10-144) | 14 (12-15) | 24 (4-67) | 100 |
| BOD, mg/l | 17 (10-28) | 9.3 (2.4-15.3) | 7.7 (4.7-10.7) | 11.4 (2.8-28.4) | 30 |
| COD, mg/l | 37 (20-72) | 32 (11-57) | 34 (25-42) | 38.1 (22.6-76.6) | 250 |

pH of the wastewater ranges from 6.5 to 7.9 which are within the prescribed limit for pH for discharge of effluents into inland surface water.

TSS values vary within 8 – 67 mg/l with a single observation of 144 mg/l during April, 2015.

Annual average values of BOD ranges within 9.3-11.4 mg/l during the study period, which remains always within the prescribed limit of BOD (30 mg/l) Month-wise variation of BOD values is depicted in Fig. 9. As revealed from the figure,the monthly BOD values also remained within the permissible limit. The missing data of BOD during some months in the figure is due to the fact that there is no available outflow in this drain during these periods.

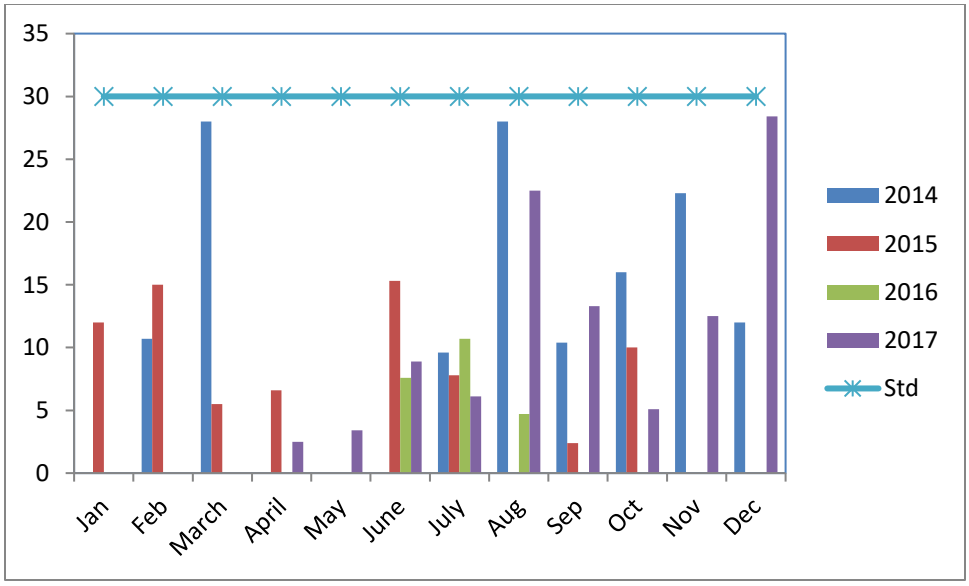


**Fig. 9 Monthly variation of BOD values in wastewater of Cuttack city at Mattagajpur**

Annual average valuesCOD varies within 32-38 mg/l during the study period, which remains within the prescribed limit of COD (250 mg/l). Monthly variation of COD values during this period has been observed to be within 11-76.6 mg/l

Annual average and range values of total dissolved phosphates, ammonical nitrogen, total nitrogen, total coliform and fecal coliform in the wastewater drain during the years 2016 and 2017 are given in Table-8. As revealed from the data, the month-wise variation in total dissolved phosphates, ammonical nitrogen and total nitrogen concentrations in the drain shows wide fluctuation.

Both total coliform and fecal coliform bacteria population in the wastewater are found to be extremely high during 2016 and 2017.

Results of heavy metals and cyanide measured in the wastewater drain during 2014 is given in Table-9. As the result reveals, all heavy metals and cyanide concentrations remain be within the permissible limit. As there is no industrial source of pollution, heavy metal concentrations in the waste water are found to be much lower than the permissible limit.

**Table-8 Wastewater quality with respect to $PO4^{3-}$-P, $NH_3$-N, Total N, TC and FC**

| Parameter | Annual average (Range of values) | | Discharge standard |
|---|---|---|---|
| | 2016 | 2017 | |
| **Total dissolved $PO_4^{3-}$-P, mg/l** | 2.058 (1.680-2.435) | 2.930 (1.002-7.731) | 5.0 |
| **$NH_3$-N, mg/l** | 6.020 (5.880-6.160) | 4.074 (1.008-19.6) | 50 |
| **Total -N , mg/l** | 22.460 (15.789-26.228) | 13.377 (2.6888-47.6) | - |
| **TC, MPN/100 ml** | 730000 (540000-920000) | 62286 (17000-130000) | - |
| **FC, MPN/100 ml** | 445000 (350000-540000) | 27414 (7900-49000) | - |

**Table-9 Wastewater quality with respect to heavy metals and Cyanide during 2014**

| Parameter | $Cr^{+6}$, mg/l | T.Cr , mg/l | Pb, mg/l | Cu, mg/l | Zn, mg/l | Cd, mg/l | Fe , mg/l | Mn , mg/l | Ni, mg/l | Hg, mg/l | CN, mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Annual average (Range of values)** | 0.010 (0.002-0.015) | 0.041 (0.015-0.076) | 0.003 (0.003-0.003) | 0.002 (0.001-0.002) | 0.002 (<0.001-0.004) | 0.001 (<0.001-0.001) | 2.552 (2.158-2.946) | 0.013 (0.011-0.014) | 0.012 (0.008-0.015) | 0.00048 (0.00006 - 0.00089) | 0.0066 (0.0011-0.0110) |
| **Discharge standard** | 0.1 | 2.0 | 0.1 | 3.0 | 5.0 | 2.0 | 3.0 | 2.0 | - | 0.01 | 0.2 |

### 3.4 Impact of the wastewater discharge on Kathajodi river water quality

The major criteria parameters to assess the impact of domestic wastewater discharge into a river body are pH, DO, BOD, COD, TSS, Total coliform and fecal coliform. Annual average and range values of these parameters during the period 2014-2017 at four monitoring stations are given in Table-10. Water quality of the river at Cuttack FFD/s at Kamasasan is only given for the year 2017. The data are compared with the tolerance limit prescribed for Class C inland surface water bodies by Bureau of Indian Standards (IS : 2296-1982) (Annexure-2).

**Table-10 Kathajodi River water quality with respect to pH, DO, BOD, COD and TSS, TC and FC**

| Year | pH | DO , mg/l | BOD , mg/l | COD , mg/l | TSS, mg/l | TC, MPN/100 ml | FC, MPN/100 ml |
|---|---|---|---|---|---|---|---|
| **Cuttack U/s** | | | | | | | |
| 2014 | 8.0 (7.6-8.4) | 7.6 (6.6-9.6) | 1.2 (0.6-1.6) | 11.5 (6.5-18.2) | 81 (3-267) | 5600 (1300-16000) | 1378 (490-3500) |
| 2015 | 8.1 (7.2-8.4) | 7.7 (6.5-8.5) | 1.2 (0.5-1.8) | 9.9 (6.1-15.8) | 25 (4-68) | 3627 (130-16000) | 1460 (45-5400) |
| 2016 | 8.0 (7.5-8.4) | 7.7 (6.5-8.9) | 1.2 (0.6-2.1) | 10.1 (6.0-12.9) | 29 (4-154) | 2490 (490-9200) | 1028 (140-5400) |
| 2017 | 8.0 (7.2-8.4) | 7.6 (6.8-9.9) | 0.8 (0.5-1.4) | 9.3 (5.0-11.0) | 42 (4-124) | 1223 (40-3300) | 423 (20-2100) |
| **Cuttack D/s** | | | | | | | |
| 2014 | 7.8 (7.1-8.4) | 7.1 (6.0-8.6) | 3.7 (2.1-5.6) | 26.3 (16.4-40.0) | 85 (16-310) | 98818 (28000-160000) | 57600 (13000-160000) |
| 2015 | 8.2 (7.4-8.4) | 7.1 (6.0-7.9) | 3.3 (2.1-4.7) | 21.1 (16.6-24.4) | 22 (3-66) | 27108 (3300-54000) | 14873 (780-35000) |
| 2016 | 7.8 (6.7-8.4) | 7.1 (4.5-8.9) | 3.5 (1.7-5.8) | 23.5 (16.1-30.3) | 39 (17-139) | 76500 (7000-160000) | 58492 (4900-160000) |
| 2017 | 7.9 (7.0-8.4) | 6.7 (5.4-9.8) | 3.2 (1.3-5.4) | 23.2 (10.7-38.0) | 37 (4-90) | 68000 (1100-160000) | 61840 (180-160000) |
| **Cuttack FD/s at Mattagajpur** | | | | | | | |
| 2014 | 7.8 | 6.9 | 8.4 | 42.2 | 85 | 94273 | 66889 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | (7.0- 9.1) | (4.6-10.8) | (1.6-19.3) | (12.1-76.6) | (30-226) | (35000-160000) | (17000-160000) |
| 2015 | 7.3 (5.4-8.0) | 5.5 (1.3-14.2) | 9.7 (5.4-17.0) | 55.7 (24.8-127.1) | 27 (7-62) | 58583 (11000-160000) | 28725 (4900-92000) |
| 2016 | 7.8 (7.4-8.4) | 7.9 (1.2-14.3) | 7.9 (1.8-17.4) | 43.1 (16.1-84.3) | 43 (5-114) | 78250 (7000-160000) | 62650 (2100-160000) |
| 2017 | 7.8 (7.0-8.5) | 6.0 (3.3-14.1) | 6.3 (1.2-11.2) | 42.4 (12.2-99.6) | 89 (2-262) | 11673 (780-35000) | 5727 (20-17000) |
| **Sankhatrasa (Cuttack FD/s)** | | | | | | | |
| 2014 | 7.9 (7.3- 8.4) | 7.1 (2.0-14.2) | 2.7 (1.3- 4.2) | 20.4 (10.2-36.0) | 40 (9-144) | 32164 (5400 –92000) | 14982 (1700-54000) |
| 2015 | 8.0 (7.2-8.4) | 7.6 (6.8-8.8) | 2.1 (1.3-3.7) | 14.4 (9.6-20.7) | 26 (5-76) | 26599 (490-92000) | 14227 (130-54000) |
| 2016 | 7.6 (6.9-8.4) | 6.6 (4.9-9.0) | 2.8 (1.4-4.8) | 19.5 (11.3-31.3) | 54 (3-243) | 50233 (4900-160000) | 36175 (2300-160000) |
| 2017 | 7.9 (7.3-8.4) | 6.3 (4.4-7.7) | 2.3 (0.6-4.4) | 16.7 (6.7-30.8) | 46 (8-122) | 75478 (130-160000) | 65682 (78-160000) |
| **Cuttack FFD/s at Kamasasan** | | | | | | | |
| 2017 | 7.9 (7.4-8.4) | 6.9 (6.3-7.7) | 1.6 (0.9-2.5) | 12.9 (9.2-8.4) | 50 (4-126) | 6671 (<1.8-16000) | 4206 (<1.8-16000) |
| **Tolerance limit for Class C rivers** | **6.5-8.5** | **4.0, minimum** | **3.0, maximum** | **-** | **-** | **5000, max** | **Should not be more than 40% of TC values** |

As revealed from the data, pH at all stations remained within the tolerance limit , that is, 6.5-8.5, excepting one occasion at Cuttack FD/s (Mattagajpur).

Dissolved oxygen content at Cuttack U/s varied within 6.5-9.6 mg/l. High values of DO are due to the eutrophication condition and collection of water samples during day time. At the downstream station, DO varied within 4.5-9.8 mg/l during the study period. At the further downstream stations, DO values are sometimes observed to be below the tolerance limit of 4.0 mg/l which may be attributed to the deteriorating condition of river water. The depletion of DO values is much more pronounced in Cuttack FD/s station at Mattagajpur (Kathajodi river) rather than at Sankhatrasa (Serua river). However, at Kamasasan (downstream of confluence of Kathajodi are Serua rivers, DO level in river water remained within the permissible limit.

The annual average value of BOD varied from 3.2-3.7 mg/l during the study period, whereas the monthly BOD values varied from 1.3 – 5.8 mg/l. Similarly, at Mattagajpur, annual average value of BOD varied from 6.3-9.7 mg/l with the monthly BOD values varying 1.2-19.0 mg/l. However, at Sankhatrasa, though the monthly BOD values varied from 0.6-4.2 mg/l, the annual BOD values remained within the tolerance limit of 3.0 mg/l (minimum). At Kamasasan, the BOD values always remained within the tolerance limit. Frequency of deviation of monthly BOD values from the tolerance limit at the five monitoring stations during the period of study is shown in Fig. 10 .

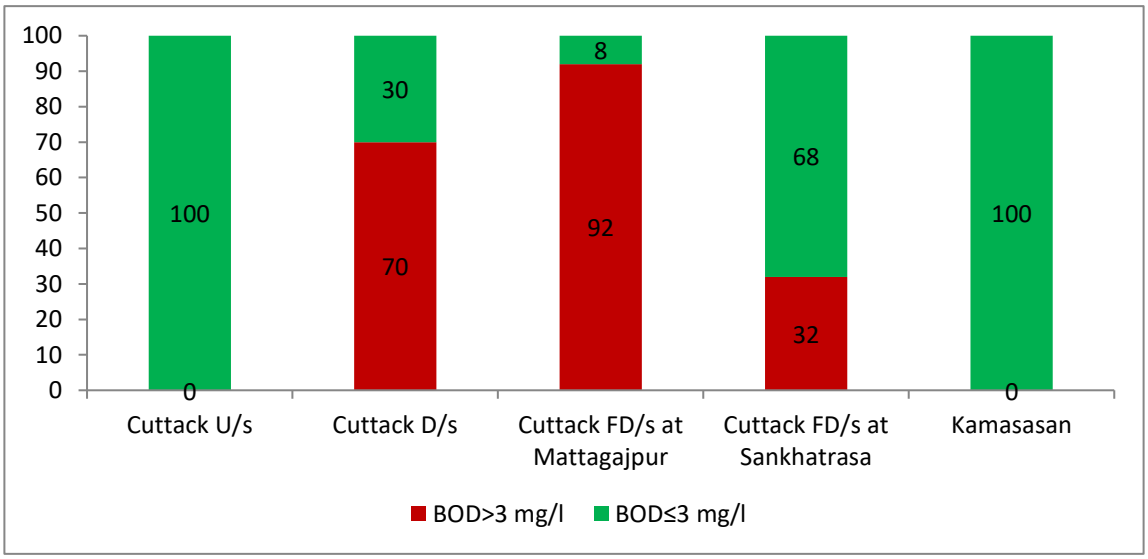


**Fig. 10 Frequ Cuttack**

It is evidenced from the figure that BOD remained above the tolerance limit most of the time at Mattagajpur, 70% of time at Cuttack D/s and 32% of time at Sankhatrasa. The BOD level at Mattagajpur is also comparatively higher than at these two stations due to lack of flow in the river for dilution purpose.

The total suspended solids in river water exhibits a wide range of fluctuation, with the maximum being during rainy season due to mixing of turbid surface run-off water. During the study period, the annual average of TSS values at Cuttack U/s was within 25-81 mg/l, at Cuttack D/s within 22-85 mg/l, at Mattagajpur within 27-89 mg/l, at Sankhatrasa within 26-54 mg/l and at Kamasasan was 50 mg/l.

During the entire period of study, COD values at Mattagajpur are comparatively higher than those at other stations. Maximum COD value at Mattagajpur was observed within the range 76.6-127.1 mg/l. Wide fluctuations in both COD and BOD values at Mattagajpur in comparison to Cuttack D/s and Sankhatrasa is because of improper functioning of the STP located at Mattagajpur. During non-functioning period of STP, the wastewater of main drain No.1 is diverted directly through the drain to be discharged into the river.

Water quality of the river at Cuttack D/s is mainly influenced by the discharge of wastewater at Khannagar. As the major flow of the river is through Seruariver, deterioration of water quality at Sankhatrasa is also observed which is evidenced by the BOD, COD, TC and FC values.

The coliform population in the water is significantly high at the downstream stations and exceeds the tolerance limit (maximum 5000 MPN/ 100 ml for total coliform). The frequency of deviation of TC value at the five monitoring station during the period of study is shown in Fig 11.

The non-conformance of TC values at Cuttack U/s is due to in-stream activities by the local people.

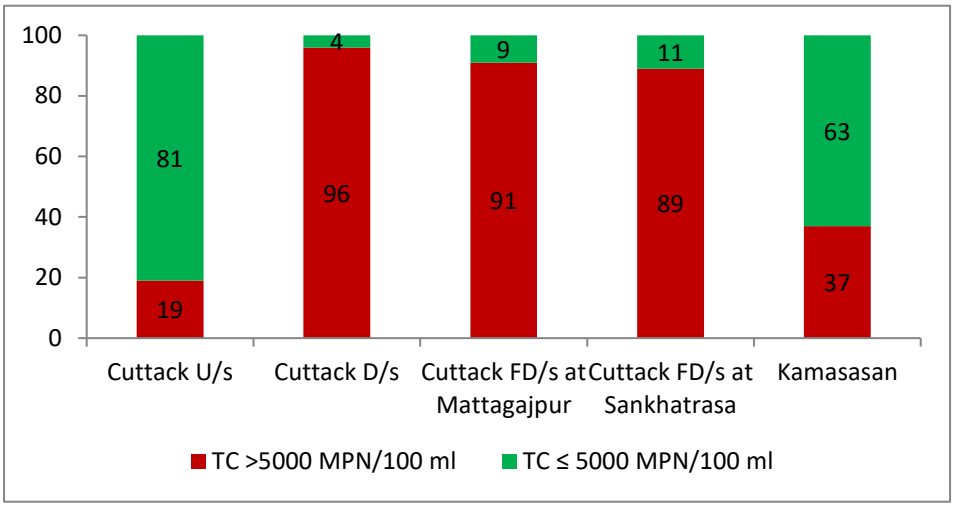


**Fig. 11 Frequency of deviation of monthly TC values in Kathajodi river along Cuttack stretch from the tolerance limit during 2014-2017**

The fecal coliform values most of the time has been observed to exceed 40% of the corresponding TC values, therefore not conforming to the stipulated criteria for FC. Further, fecal coliform values at the downstream stations mostly exceed the tolerance limit of 2500 MPN/100 ml for Bathing water prescribed under E (P) Rule, 1986 (Annexure-3).

River water quality at these five stations with respect to nitrogen content (in the form of nitrate, ammonical nitrogen and total Kjeldahl nitrogen), dissolved phosphate and boron are presented in Table-11 .

Annual average of nitrate content at Cuttack U/s varied from 2.317 mg/l to 3.04 mg/l. Increase in nitrate content has been observed at the downstream stations after the discharge of domestic wastewater into the river body. Fig. 12 shows the annual variation of nitrate content in the river at the five monitoring stations during the period of study. However, the nitrate content in river at these locations remained within the tolerance limit of 45 mg/l.

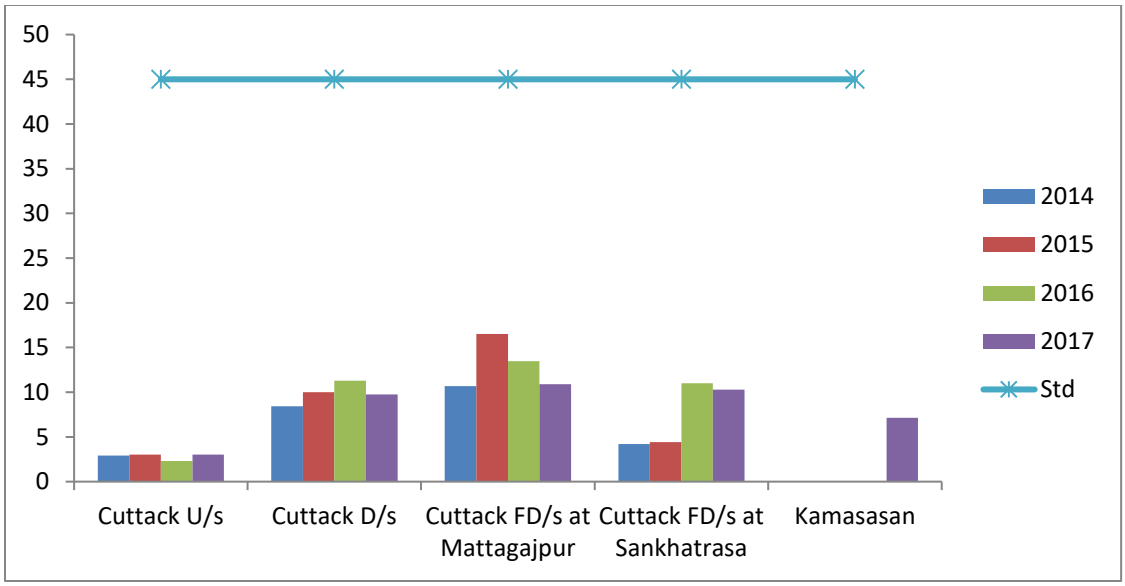


**Fig. 12Annual variation of Nitrate content in Kathajodi river along Cuttack stretch during 2014-2017**

Similar observation has been made with the ammonical nitrogen, total Kjeldahl nitrogen and phosphate concentration. However, there has not been any tolerance limit prescribed for these there parameters in IS : 2296-1982 for comparison purpose.

No significant impact of wastewater discharge on boron concentration in the river water at these monitoring stations have been observed.

River water quality at these five monitoring stations with respect to conductivity, sodium absorption ration, total hardness, total alkalinity, chloride, sulphate and fluoride content are presented in Table -12.

Annual average of conductivity values at Cuttack U/s increased from the range 180-189 micromhos/cm to the range at 241-279 micromhos/cm at Cuttack D/s and to 319-429 micromhos/cm at Mattagajpur. At Sankhatrasa, it varied between 212-297 micromhos/cm.However, the conductivity value always remained much below the tolerance limit for irrigation water (2250 micromhos/cm).

Similarly, sodium absorption ratio, a cumulative representation of sodium, calcium and magnesium content also exhibit increased values at the downstream stations in comparison to the upstream stations. However, the value always remained within the tolerance limit for irrigation water (26). A similar pattern is observed for other parameters like total hardness, total

alkalinity, chloride, sulphate. However, no significant effect on fluoride concentration has been observed.

River water quality with respect to the heavy metal contents at these five monitoring stations during the period of study are presented in Table -13. All the metal contents are observed to be present in much lower concentration in comparison to the tolerance limit for Class-C.

From the above studies, it is observed that the water quality of Kathajodiriver has been deteriorated along the Cuttack stretch due to wastewater discharge of Cuttack city. However, the river has rejuvenated itself at Kamasasan as there is no other wastewater discharge within this stretch.

**Table-11Kathajodi River water quality along Cuttack stretch with respect to Nitrogen content and Phosphate and Boron**

| Year | $NO_3$, mg/l | $NH_4$-N, mg/l | TKN, mg/l | $PO_4^{3-}$-P , mg/l | Boron, mg/l |
|---|---|---|---|---|---|
| **Cuttack U/s** | | | | | |
| 2014 | 2.929 (0.226-7.465) | 0.097 (0.056-0.168) | 1.02 (0.28-1.68) | 0.035 (0.012-0.073) | 0.045 (0.003-0.163) |
| 2015 | 3.04 (0.186-6.492) | 0.079 (0.056-0.168) | 1.12 (0.84-1.40) | 0.074 (0.019-0.229) | 0.031 (0.010-0.077) |
| 2016 | 2.317 (0.639-9.625) | 0.089 (0.056-0.224) | 1.35 (0.84-1.96) | 0.091 (0.025-0.220) | 0.043 (0.003-0.197) |
| 2017 | 3.009 (1.031-7.694) | 0.179 (0.056-0.900) | 1.82 (0.56-4.76) | 0.109 (0.002-0.527) | 0.040 (0.007-0.112) |
| **Cuttack D/s** | | | | | |
| 2014 | 8.424 (0.851-44.852) | 0.122 (0.056-0.336) | 1.16 (0.28-1.84) | 0.116 (0.006-0.833) | 0.101 (0.003-0.407) |
| 2015 | 10.01 (0.522-30.467) | 0.079 (0.056-0.112) | 1.33 (1.12-1.68) | 0.190 (0.027-0.590) | 0.058 (0.022-0.133) |
| 2016 | 11.29 (1.038-32.608) | 2.086 (0.056-8.624) | 3.95 (0.84-13.72) | 0.250 (0.024-1.168) | 0.061 (0.006-0.260) |
| 2017 | 9.763 (0.542-33.887) | 1.186 (0.056-5.880) | 3.73 (1.40-8.40) | 0.315 (0.002-0.984) | 0.076 (0.005-0.218) |
| **Cuttack FD/s at Mattagajpur** | | | | | |
| 2014 | 10.699 (2.167-22.909) | 1.232 (0.056-10.360) | 3.08 (0.56-15.4) | 0.183 (0.017-0.910) | 0.164 (0.002-1.157) |
| 2015 | 16.529 (1.186-36.552) | 4.952 (0.056-16.296) | 9.10 (2.52-25.76) | 0.327 (0.038-1.305) | 0.087 (0.010-0.170) |
| 2016 | 13.491 (4.740-28.879) | 3.831 (0.056-16.240) | 5.93 (1.68-17.04) | 0.382 (0.082-0.913) | 0.063 (0.003-0.291) |
| 2017 | 10.882 (1.617-28.099) | 1.525 (0.056-4.648) | 5.88 (0.56-11.76) | 0.346 (0.081-1.020) | 0.108 (0.004-0.367) |
| **Cuttack FD/s at Sankhatrasa** | | | | | |
| 2014 | 4.223 (0.859-13.215) | 0.168 (0.112-0.392) | 1.17 (0.28-1.96) | 0.096 (0.025-0.350) | 0.079 (0.002-0.253) |
| 2015 | 4.412 (1.599-7.867) | 0.138 (0.035-0.504) | 1.38 (1.12-1.68) | 0.153 (0.015-0.731) | 0.030 (0.003-0.126) |
| 2016 | 11.009 (2.548-30.637) | 1.849 (0.056-6.216) | 4.07 (1.12-11.48) | 0.351 (0.059-1.445) | 0.064 (0.003-0.225) |
| 2017 | 10.282 (1.495-35.269) | 1.577 (0.050-7.560) | 4.06 (0.28-11.76) | 0.429 (0.065-1.250) | 0.084 (0.023-0.225) |
| **Cuttack FFD/s at Kamasasan** | | | | | |
| 2017 | 7.147 (2.913-13.959) | 0.272 (0.056-0.780) | 2.380 (0.560-6.720) | 0.200 (0.007-0.460) | 0.133 (0.005-0.639) |
| **Tolerance limit for Class C rivers** | 45 | - | - | - | - |

**Table-12Kathajodi River water quality with respect to Inorganic metallic constituents**

| Year | EC, micromhos/cm | SAR | TH, as $CaCO_3$, mg/l | T.Alk as $CaCO_3$, mg/l | Cl, mg/l | $SO_4$, mg/l | F, mg/l |
|---|---|---|---|---|---|---|---|
| **Cuttack U/s** | | | | | | | |
| 2014 | 185 (136-280) | 0.47 (0.32-1.13) | 64 (42-84) | 69 (44-92) | 11.9 (7.8-29.4) | 6.83 (2.98-10.69) | 0.343 (0.256-0.469) |
| 2015 | 185 (144-218) | 0.37 (0.25-0.49) | 70 (56-90) | 72 (58-84) | 9.9 (6.9-11.7) | 10.6 (5.0-17.0) | 0.384 (0.266-0.604) |
| 2016 | 189 (154-238) | 0.39 (0.25-0.60) | 69 (52-104) | 72 (56-100) | 11.6 (7.8-16.6) | 8.5 (2.5-15.5) | 0.364 (0.260-0.510) |
| 2017 | 180 (138-229) | 0.34 (0.22-0.64) | 69 (52-88) | 71 (52-104) | 10.6 (8.0-22.0) | 9.1 (4.8-19.7) | 0.359 (0.220-0.510) |
| **Cuttack D/s** | | | | | | | |
| 2014 | 248 (150-420) | 0.68 (0.31-1.38) | 79 (52-116) | 78 (48-126) | 18.3 (6.9-39.1) | 11.26 (6.71-22.98) | 0.292 (0.205-0.442) |
| 2015 | 241 (193-309) | 0.47 (0.31-0.65) | 94 (68-128) | 89 (68-132) | 13.4 (8.8-20.6) | 15.9 (9.7-25.5) | 0.407 (0.262-0.543) |
| 2016 | 271 (162-361) | 0.63 (0.25-1.16) | 88 (64-108) | 93 (60-112) | 22.6 (7.8-43.1) | 13.2 (5.3-26.1) | 0.341 (0.180-0.520) |
| 2017 | 279 (174-419) | 0.60 (0.22-1.10) | 96 (68-128) | 98 (64-168) | 21.6 (6.0-42.0) | 14.3 (8.4-23.8) | 0.298 (0.142-0.564) |
| **Cuttack FD/s at Mattagajpur** | | | | | | | |
| 2014 | 319 (142-539) | 0.99 (0.29-2.24) | 92 (46-134) | 91 (48-124) | 28.6 (6.9-64.6) | 19.77 (4.23-37.3) | 0.283 (0.178-0.464) |
| 2015 | 510 (352-652) | 1.70 (1.13-2.31) | 146 (100-232) | 141 (116-200) | 55.0 (37.2-70.5) | 41.5 (7.6-125.6) | 0.416 (0.300-0.555) |
| 2016 | 429 (169-618) | 1.18 (0.35-1.85) | 115 (58-160) | 129 (60-192) | 45.7 (10.8-74.4) | 18.1 (2.6-41.4) | 0.320 (0.190-0.470) |
| 2017 | 392 (267-516) | 1.05 (0.22-1.52) | 118 (84-140) | 122 (92-148) | 41 (10-64) | 19.8 (10.9-35.4) | 0.282 (0.200-0.433) |
| **Sankhatrasa (Cuttack FD/s)** | | | | | | | |
| 2014 | 212 (142-326) | 0.49 (0.30-0.77) | 74 (46-110) | 79 (48-134) | 12.7 (6.9-23.5) | 7.24 (4.98-9.95) | 0.320 (0.243-0.464) |
| 2015 | 225 (192-281) | 0.53 (0.25-0.89) | 80 (66-96) | 79 (60-92) | 14.4 (7.8-23.5) | 13.2 (4.5-26.4) | 0.389 (0.252-0.585) |
| 2016 | 285 (152-395) | 0.74 (0.26-1.63) | 87 (62-102) | 94 (64-116) | 25.8 (7.8-58.7) | 12.6 (3.6-21.1) | 0.322 (0.190-0.450) |
| 2017 | 297 (170-444) | 0.67 (0.21-1.40) | 93 (68-128) | 101 (68-136) | 25.2 (6.0-47.0) | 11.8 (7.1-19.0) | 0.270 (0.174-0.380) |
| **Kathajodi FFD/s at Kamasasan** | | | | | | | |
| 2017 | 229 (165-360) | 0.45 (0.22-0.86) | 81 (64-102) | 84 (52-118) | 14.7 (7.0-29.0) | 11.5 (7.6-18.5) | 0.277 (0.220-0.431) |
| **Tolerance limit for Class C rivers** | **-** | **-** | **-** | **-** | **600** | **400** | **1.5** |

**Table-13Kathajodi River water quality with respect to heavy metals**

| Year | Cr(VI), mg/l | T. Cr, mg/l | Fe, mg/l | Ni, mg/l | Cu, mg/l | Zn , mg/l | Cd, mg/l | Hg, mg/l | Pb, mg/l |
|---|---|---|---|---|---|---|---|---|---|
| **Cuttack U/s** | | | | | | | | | |
| 2014 | 0.012 (<0.002-0.023) | 0.035 (0.006-0.075) | 3.147 (0.087-9.155) | 0.011 (0.002-0.020) | 0.005 (0.004-0.007) | 0.008 (0.007-0.009) | 0.0007 (0.0006-0.0007) | 0.00036 (<0.00006-0.00120) | 0.004 (0.002-0.007) |
| 2015 | 0.014 (<0.002-0.033) | 0.047 (0.013-0.099) | 1.914 (0.170-5.890) | 0.013 (0.003-0.024) | 0.005 (0.002-0.010) | 0.014 (0.001-0.023) | 0.0021 (0.0004-0.0060) | 0.00033 (0.00006-0.00089) | 0.011 (0.002-0.028) |
| 2016 | 0.005 (<0.002-0.017) | 0.022 (0.012-0.042) | 0.603 (0.070-1.430) | 0.008 (0.003-0.021) | 0.003 (0.001-0.006) | 0.009 (0.001-0.014) | 0.0006 (0.0003-0.0009) | 0.00011 (<0.00006-0.00051) | 0.006 (0.004-0.011) |
| 2017 | 0.007 | 0.019 | 1.44 | 0.003 | 0.003 | 0.005 | 0.0017 | <0.00006 | 0.004 |
| **Cuttack D/s** | | | | | | | | | |
| 2014 | 0.018(<0.002-0.050) | 0.057 (0.003-0.121) | 3.023 (0.230-8.339) | 0.013 (0.013-0.014) | 0.007 (0.006-0.009) | 0.015 (0.007-0.024) | 0.0011 (0.0008-0.0014) | 0.00050 (<0.00006-0.00101) | 0.010(0.006-0.014) |
| 2015 | 0.012 (<0.002-0.036) | 0.048 (0.021-0.094) | 2.366 (<0.005-6.990) | 0.017 (0.009-0.027) | 0.006 (<0.001-0.015) | 0.010 (0.001-0.017) | 0.0032 (0.0001-0.0061) | 0.00035 (0.00013-0.00089) | 0.011 (0.007-0.016) |
| 2016 | 0.013 (<0.002-0.028) | 0.042 (0.015-0.071) | 0.755 (0.100-2.470) | 0.012 (0.006-0.028) | 0.004 (0.002-0.007) | 0.026 (0.010-0.093) | 0.0010 (0.0005-0.0018) | 0.00034 (0.00019-0.00082) | 0.011 (0.006-0.021) |
| 2017 | 0.013 | 0.032 | 3.76 | 0.004 | 0.003 | 0.005 | 0.0032 | 0.00025 | 0.009 |
| **Cuttack FD/s at Mattagajpur** | | | | | | | | | |
| 2014 | 0.015 (<0.002-0.035) | 0.044 (<0.002-0.145) | 3.001 (0.301-8.874) | 0.009 (0.006-0.013) | 0.017 (0.005-0.029) | 0.030 (0.003-0.056) | 0.0011 (0.0010-0.0012) | 0.00033 (<0.00006-0.00095) | 0.008 (0.005-0.011) |
| 2015 | 0.013 (<0.002-0.038) | 0.060 (0.016-0.114) | 2.384 (0.367-6.290) | 0.020 (0.008-0.048) | 0.011 (0.002-0.022) | 0.013 (0.003-0.028) | 0.0034 (0.0013-0.0072) | 0.00053 (0.00013-0.00095) | 0.013 (0.009-0.024) |
| 2016 | 0.016 (<0.002-0.033) | 0.049 (0.018-0.076) | 0.983 (0.050-4.410) | 0.013 (0.003-0.034) | 0.006 (0.001-0.010) | 0.034 (0.014-0.085) | 0.0010 (0.0004-0.0023) | 0.00028 (<0.00006-0.00071) | 0.014 (0.003-0.031) |
| 2017 | 0.008 | 0.024 | 2.31 | 0.006 | 0.005 | 0.012 | 0.0029 | 0.00032 | 0.010 |
| **Sankhatrasa (Cuttack FD/s)** | | | | | | | | | |
| 2014 | 0.015 (<0.002-0.061) | 0.042 (<0.002-0.148) | 1.844 (0.041-8.874) | 0.012 (0.007-0.017) | 0.004 (0.004-0.005) | 0.014 (0.004-0.024) | 0.0007 (0.0005-0.0009) | 0.00030 (<0.00006-0.00070) | 0.010 (0.004-0.015) |
| 2015 | 0.010 (<0.002-0.033) | 0.037 (0.005-0.076) | 2.736 (0.150-6.960) | 0.013 (0.007-0.026) | 0.005 (0.001-0.012) | 0.010 (0.001-0.028) | 0.0032 (0.0009-0.0072) | 0.00025 (<0.00006-0.00057) | 0.010 (0.002-0.019) |
| 2016 | 0.012 (<0.002-0.031) | 0.032 (0.013-0.069) | 0.958 (0.080-3.290) | 0.008 (0.003-0.019) | 0.004 (0.001-0.009) | 0.010 (0.001-0.017) | 0.0007 (0.0004-0.0011) | 0.00022 (<0.00006-0.00082) | 0.008 (0.004-0.018) |
| 2017 | 0.017 | 0.035 | 3.66 | 0.002 | 0.005 | 0.014 | 0.022 | 0.00019 | 0.009 |
| **Kathajodi FFD/s at Kamasasan** | | | | | | | | | |
| 2017 | 0.003 | 0.011 | 0.450 | 0.004 | 0.002 | 0.011 | 0.0014 | <0.00006 | 0.007 |
| **Tolerance limit for Class C rivers** | **0.05** | **-** | **50** | **-** | **1.5** | **15** | **0.01** | **-** | **0.1** |

## 3.5 Categorization of Kathajodi river along Cuttack stretch

The critical parameters for maintenance of water quality with respect to public health are organic matter and coliform group of bacteria. Thus the organic matter in terms of Biochemical Oxygen Demand is the most critical parameter representing municipal sewage pollution. The organized water supplies with high organic matter in surface water may cause formation of chlorinated compounds during the disinfection process using chlorine. The presence of high organic matter from municipal origin also account for higher number of coliform group of bacteria including fecal coliforms. Therefore the need for water quality management in river is broadly concentrated on control of organic matter (in terms of BOD) by providing infrastructure for sewage treatment as first priority. Based on BOD concentrations, CPCB has categorised the river stretches under five priorities. Monitoring locations with BOD concentration exceeding 30 mg/l has been categorized as Priority-I. Monitoring locations with BOD concentrations in the range 20-30 mg/l, 10-20 mg/l, 6-10 mg/l and 3-6 mg/l are categorized as Priority-II, Priority-III, Priority-IV and Priority-V respectively.

Based on the water quality studies during the period 2014-2017, water quality of Kathajodiriver along Cuttack stretch may be categorized as follows.

| **Monitoring station** | **Priority category** | **Maximum BOD (mg/l) range during the period 2014-2017** |
|---|---|---|
| Cuttack D/s | Priority V | 4.7-5.6 |
| Cuttack FD/s at Mattagajpur | Priority III | 11.2-19.3 |
| Cuttack FD/s at Sankhatrasa (Serua river, distributary of Kathajodi river) | Priority V | 3.7-4.8 |

## CHAPTER-IV

# ACTION PLAN FOR RESTORATION OF POLLUTED RIVER STRETCH

## 4.0 Requirement of Action Plan for Restoration of River Water Quality

Studies in the foregoing sections have revealed that the stretch of Kathajodiriver along the Cuttack city is polluted due to the discharge of domestic wastewater at three locations. The quality of wastewater discharged near ABIT and Khannagar are more or less similar. However, the impact of former is less in comparison to the later one. In the former case, the waste water passes through a large stretch of sand bed before mixing with the river water as the river bed is alomost dry during the lean period. At Khan nagar, the wastewater directly mixes with the river water thereby degrading its quality. As the major flow of the river is through Seruariver, a distributary of Kathajodi river, the deterioration of water quality is also observed at Sankhatrasa and falls under priority category V.

The STP at Mattagajpur with 33 MLD capacity had been installed in the year 2001 with the projected population upto 2010. In the mean time, the population has been increased manifold with the simultaneous increase in wastewater generation load. Further, though the BOD value of the wastewater drain falling on Kathajodi river at Mattagajpur remains mostly within the discharge limit of 30 mg/l, due to lack of sufficient flow in the river at this location the wastewater could not be diluted. Therefore, the BOD value in the river at this location observed to be in the range of 11-19 mg/l and falls under priority category II. The coliform bacterial population in the river at all the monitoring location observed to exceed the tolerance limit thereby posing threat to human health.

River restoration is necessary where river systems have degraded to the point where they can no longer provide the services required of them. Growing concern for maintenance of water quality in Kathajodiriveralong Cuttack stretch has been discussed at several forums including the legislative assembly of the Odisha Government. Also the Hon'ble High Court of Odisha has taken cognizance of this issue of pollution due to discharge of untreated sewage of Cuttack city and urged to take necessary restoration plans.

Therefore there is an urgent need to prepare strategic action plans for restoration of the polluted river stretch with the following objectives.

- to improve aesthetics of the area along the river bed and its embankment
- to treat the wastewater outfall into the river

- to maintain sufficient flow in the river during lean period
- to restore the quality of the river to meet its designated best use
- to establish institutional arrangements with the mandated and accountability for restoration, and to coordinate between the stakeholders.

River restoration requires that policies, strategies andplans be developed with a clear understanding of long-termdevelopment and conservation objectives and priorities.

## 4.1 Action Plans Suggested

1. The city should have a well- planned sewerage system and a separate storm water drain system with appropriate management and maintenance
2. Proper functioning of sluice gate at Khannagar to prevent the discharge of wastewater into the river during lean period.
3. As the CDA-Bidanasi area is a planned city having the sewerage system, STP of 10 MLD capacity already established in this area should be made functional to treat the wastewater prior to discharge into the river at ABIT.
4. Proper functioning of the STP at Mattagajpur.
5. Siltation of the river bed has to be avoided by prohibiting dumping of solid waste along the river bank.
6. The CutatckMunicipal Corporation can undertake the river front beautification activities and rainwater harvesting project along the stretch of the river. Rainwater harvesting can help in attaining the minimum flow in the river water for scouring the sediments and dilution water availability.
7. SulabhShauchalays should be created in the slums and urban fringe areas to avoid open defecation practices by the local inhabitants.
8. Explore possibility to create storages in the water shed of River for release of water during non-monsoon period.

   (Action to be taken by : Cuttack Municipal Commission)

9. Since a large patch of Agricultural land exists near Mattagajpur area, provision may be made for reusing the treated wastewater of the STP atMattagajpur for irrigation purpose instead of discharging into the river.

   (Action to be taken by : Irrigation Department)

10. The Gram Panchayats of the villages on the bank of the river has to pass a resolution not to allow sewage / sullage from their respective villages to enter the river. Further they should also provide community sanitation facilities in villages to avoid open defecation. Awareness programmes should be made in this regard.

(Action to be taken by : Village Gram Panchayat)

10. Review the consent conditions of Cuttack Municipal Corporations in compliance to Water (PCP) Act,1976 and Municipal Solid Waste (Handling and Management) Rule, 2016.

10. Review the consent conditions of the STP in compliance to the outlet water quality requirement such as. discharge of BOD not more than 30 mg/l and Suspended solids not more than 100 mg/l.

(Action to be taken by : State Pollution Control Board, Odisha)

## 4.2 Actions already initiated

Odisha Water Supply and Sewerage Board (OWSSB) with financial assistance from Japan International Cooperation Agency (JICA) has initiated implementation of the project "Integrated sewerage and drainage system in Cuttack City", which involves followings.

- Construction of a 16 MLD capacity STP at Matagajpur to treat waste water based on Activated Sludge process prior to discharge into Kathajodiriver.
- The existing 33 MLD STP waste stabilization pond constructed to treat drain water at Mattagajpur will be modified to treat 18 MLD wastewater before discharging to the river.
- A 36 MLD capacity STP based on Activated sludge process at CDA-Bidanasi area has been made operational with effect from 26.11.2018.
- Construction of 12 numbers of Low cost sanitation units to prevent open defecation practices of the local communities,
- Improvements of existing major and minor drains and channels,
- Reconstruction/widening of major drains for enhanced hydraulic capacity,
- Construction of new sub-drains connecting to the main drains

Map of Cuttack Sewerage scheme proposed under this project is shown in Fig. 13. The Cuttack city has been divided into three sewerage districts depending on the contour map (Fig.14). Schematic diagram of STPs to be constructed in the Sewerage District-I and Sewerage District-II are shown in Fig. 14 and 15 respectively. Both the STP are based on Activated sludge process treatment. Unit process interface of the STP is shown in Fig. 16. Schematic process flow diagram of the STP is shown in Fig. 17.

Under AMRUT prgoramme, a Septage Treatment Plant is under construction for treatment of septage generated in the city which will reduce pollution of river Kathajodi.

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