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Forecasting and Prediction of Class of Water Quality in River Mahanadi, Odisha

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Abstract: In the present research program, the status of pollution of water of a major river namely Mahanadi of Odishahas been analyzed. In the selected study area, the River Mahanadi is receiving a considerable amount of industrial wastes and witnessing a considerable amount of human and agricultural activities**.**Nineteen samples were collected along the entire stretches of the river basin during the period from January-2000 toDecember-2017 on the first working day of every month. In the selected research area, the River is receiving the domestic, industrial, and municipal waste waters/effluents all along its course [1]. Various physico-chemical parameters like pH, Nitrate (NO_3), Total Dissolved Solids (TDS), Boron, Alkalinity, Calcium, Magnesium, Turbidity, Chloride Cl^-) , Sulphate (SO_4^{2-}), Fluoride(F^-) and Iron(Fe) etc. were analysed. The present study indicates that the water quality of Mahanadi River is well within tolerance limit taking the physico-chemical parameters into considerations.
It is realized from the study thatthe main pollutant of water in Mahanadi is the sewerage systems influenced by urban and industrial growths in Sambalpur, Bbsr (D/s) and Cuttack town.The study puts an alarm for utilizing Mahanadi water in Cuttack D/s, Paradeep, Bbsr D/s and Choudwar at these zones for intense agricultural activities and industrial purposes. Also it focuses in order to provide better survival of flora and fauna of the system the pollution should be checked at the source i.e. at Cuttack d/s and Choudwar.

Keywords: Mahanadi River, Physico-chemical parameters, pH, TDS, Alkalinity, Tolerance limit.

I. INTRODUCTION

Water, a prime natural resource, is a basic need for sustenance of human civilization. Sustainable management of water resources is an essential requirement for the growth of the state's economy and wellbeing of the population. As per National water policy, 2002, water resources development and management will have to be planned for a hydrological unit such as drainage basin as a whole or for a sub-basin for sustainable use incorporating quantity and quality aspects as well as environmental considerations [2].

Water quality monitoring is an integral part of the water resource management plans. Monitoring comprises all activities to obtain" information" with respect to the water system. Its scope is also related to the types of water use i.e. in stream use or abstractive use and nature of the source such as surface water (rivers, lakes), ground water or sea water.

The requirements for utilizing available water resources (Surface and ground) in a judicious and equitable as well as sound economic manner are outlined in the State Water Policy. Clause 7 of water Policy-2007 for the state Odisha emphasizes upon monitoring of both surface and ground water quality and sharing of information among the data users group [3].

The State of Odisha is located in the southeastern part of India, between 17°31´ and 22°27´N Latitude and 81°27´ and 87°30´E Longitude with a population of 36.7 million (2001 census). The annual overall availability of surface water in Odisha is about 85.89 billion cubic meters. The state has 11% of the water resources of the country. The per capita availability of water in 2001 was 2259 cubic meters. With increasing population and the consequential increase in demand for food and water and with the growth in mining and industrial activities, the demand for water from various sectors in next twenty years will have significant impact on the per capita availability of water [4]. Further, the degradation in quality of water resources by direct and indirect human interference such as discharge of untreated/ partially treated industrial and municipal waste water will make the resource scarce [5]. It is therefore imperative to manage this resource as rationally and efficiently as possible to make it sustainable.

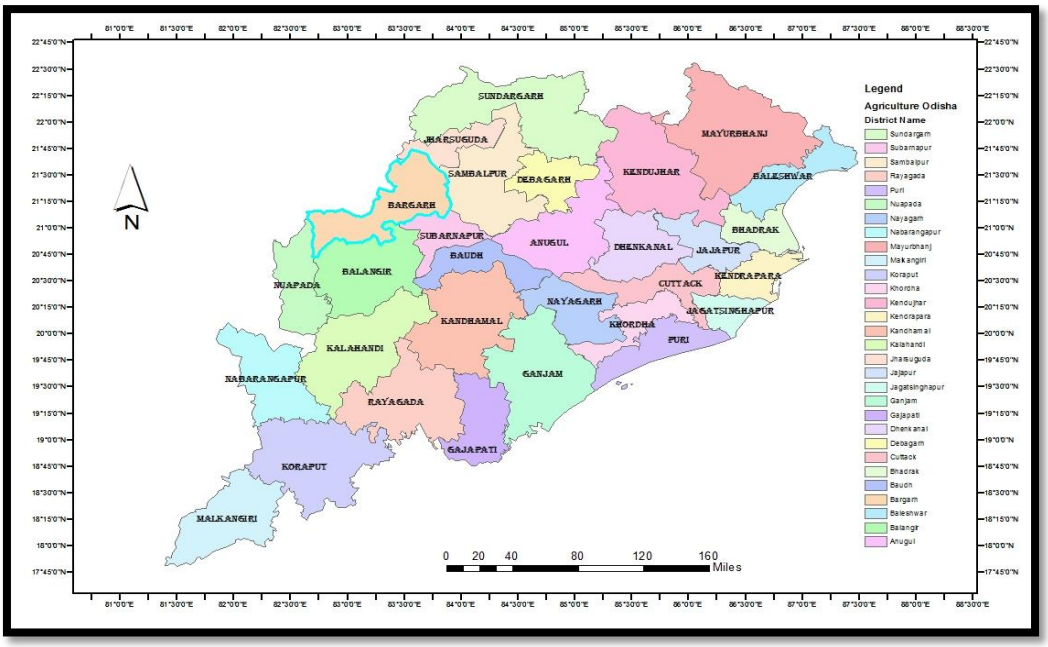
State Pollution Control Board, Odisha monitors the water quality of nine rivers of Odisha under National Water Quality Monitoring Programmes(NWMP) of Central Pollution Control Board (CPCB). CPCB is an apex body in the field of water quality management in India and provides technical and financial support for water quality monitoring programmes conducted by State Pollution Control Boards [6].

II. STUDY AREA AND DATA COLLECTION

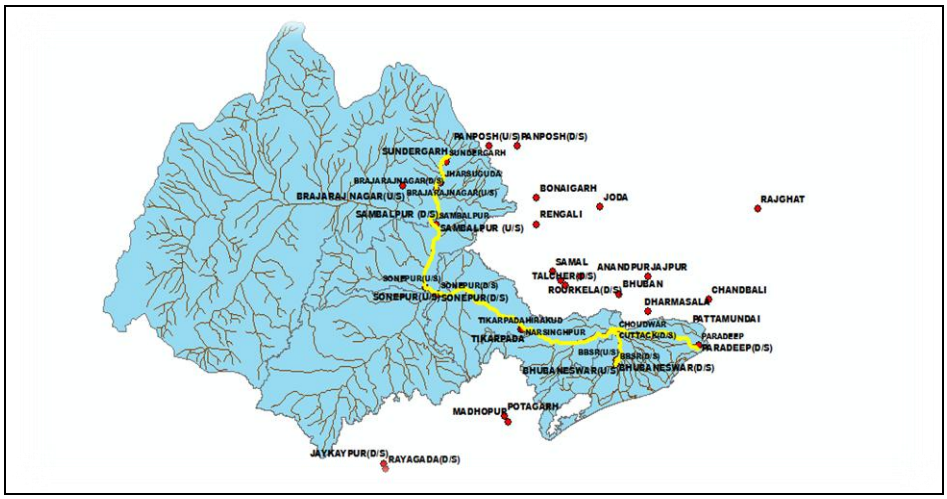
STUDY SITE

River Mahanadi rises from a small pool located at about 6 km from Pharsiya village in the Amarkantak hills of Bastar Plateau, which lies to the extreme south east of Raipur district of Chattisgarh State. Out of its total length of 851 km, it covers 494 km in Odisha state. Ib, Ong, Tel, Hariharjore and Jeera are the main tributaries and Kathojodi, Kuakhai , Devi and Birupa are the major distributaries of Mahanadi in Odisha. The multipurpose Hirakud Dam over the Mahanadi at sambalpur is nearly 400 km from the mouth and is located exactly at the midpoint of the trunk stream. The river Ib joins Mahanadi near Bagra and enters into the Hirakud reservoir from the left. From Sambalpur, the river flows southwards till it joins with Ong and Tel. Tel is the biggest tributary of Mahanadi at sonepur from where again the river flows eastwards to join the Bay of Bengal. Before entering into the coastal plain and forming the delta, the river traverses through the Eastern Ghats cutting across a 60 km long " Satkosia Gorge" overlooked by precipitous hills and lush green tropical forests [7]. Finally the river emerges out of the Eastern Ghats near Naraj about 10 km to the west of cuttack city. The deltaic action starts near Naraj where the river first divides into two major distributaries i.e. the Mahanadi on the north and the kathojodi on the south. Traversing through the districts of cuttack and puri from west to east through a large no of distributaries, it has developed an extensive delta.

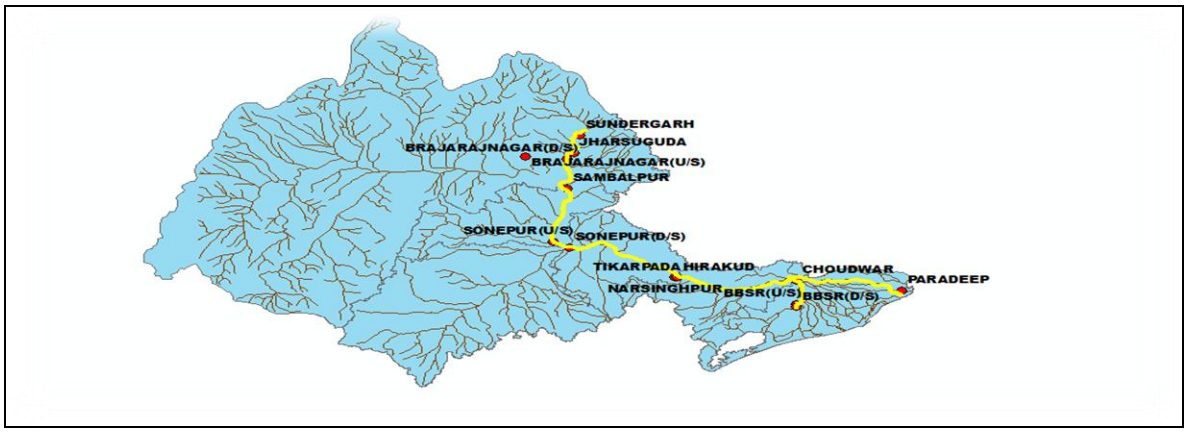
The below **(figure 1, 2, 3, 4, 5, 6)** showing monitoring stations of Mahanadi basin by the application of GIS Software.



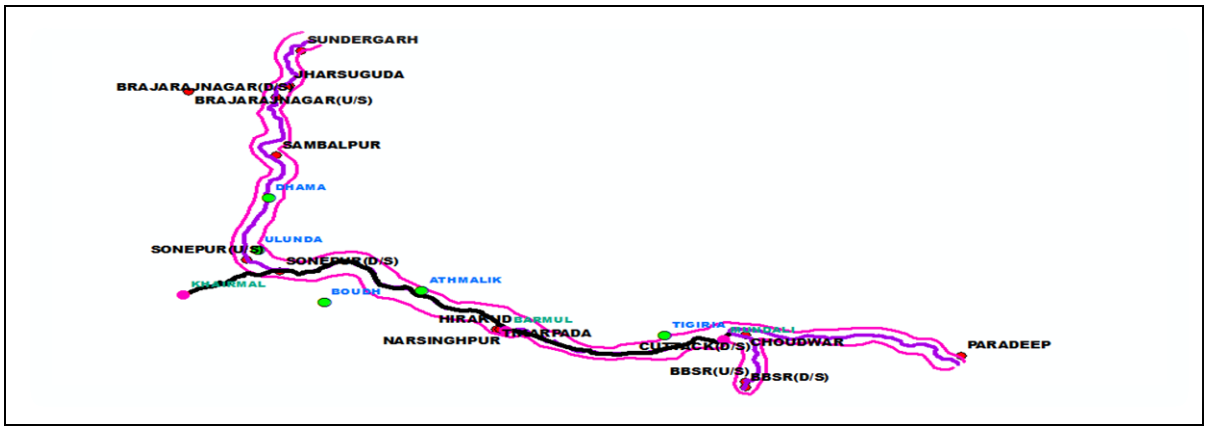
(Figure1. Districts of Odisha showing monitoring stations of Mahanadi Basin)



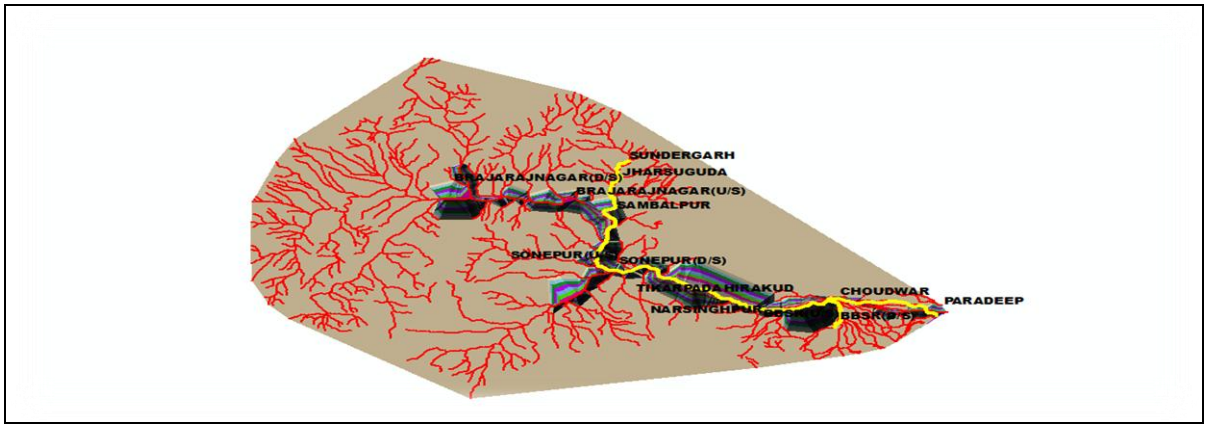
(Figure2.Plotting of monitoring stations on river map of Odisha)



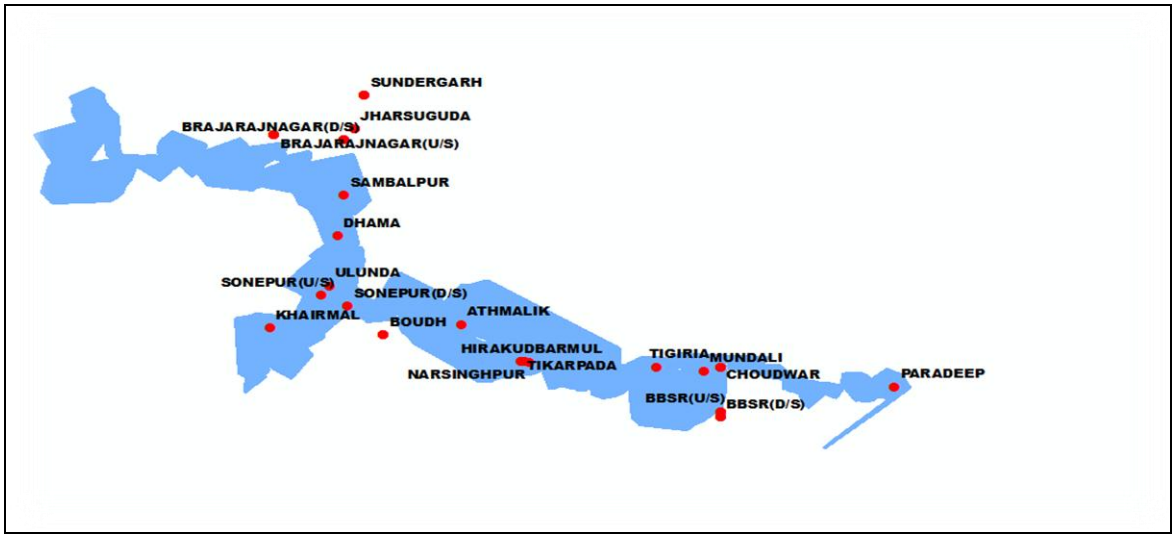
(Figure3. Mahanadi basin showing monitoring stations taken for research)



(Figure4. Mahanadi basin showing flow path accompanied with monitoring stations)



(Figure5.Tin of Mahanadi river basin accompanied with monitoring stations)



(Figure6.Tin surface contour of Mahanadi river basin accompanied with monitoring stations)

Twenty Nine different stations as mentioned below are selected across the stretch of the Mahanadi River. The selection of the sites and classes was done depending upon the industrial and mining activities along the river bank (Table 1, 2)

Table1.Showing the monitoring stations and the justification on the site selected

SL NO	MONITORING STATION	JUSTIFICATION ON THE SITE SELECTED
1	SUNDERGARH	WATER INTAKE POINT (MAJOR HUMAN SETTLEMENT)
2	JHARSUGUDA	IMPACT OF INDUSTRIAL AND MINE DISCHARGES, WATER INTAKE POINT
3	BRAJARAJNAGAR U/S	WATER QUALITY BEFORE INDUSTRIAL IMPACT. WATER INTAKE POINT AND MAJOR HUMAN SETTLEMENT
4	BRAJARAJNAGAR D/S	IMPACT OF INDUSTRIAL AND MINE DISCHARGES
5	HIRAKUD	MULTIPURPOSE DAM (IRRIGATION AND HYDROELECTRICITY)
6	POWER CHANNEL U/S	U/S OF BURLA TOWN, LARGE MEDICAL COLLEGE, HOSPITAL, UNIVERSITIES, OTHER EDUCATIONAL COMPLEXES, NURSING HOMES AND HCUs
7	POWER CHANNEL D/S	D/S OF BURLA AND CHIPLIMA TOWNSHIP
8	SAMBALPUR U/S	UPSTREAM OF SAMBALPUR TOWN
9	SAMBALPUR D/S	IMPACT DOMESTIC WASTE WATER
10	SONEPUR U/S	DOWNSTREAM OF CONFLUENCE OF MAJOR TRIBUTARY
11	SONEPUR D/S	DOWNSTREAM OF CONFLUENCE OF MAJOR TRIBUTARY AND MUNCIPAL SEWAGE DISCHARGE
12	TIKARPADA	CROCODILE BREEDING RESEARCH CENTRE AND SANCTUARY
13	NARSINGHPUR	THICKLY POPULATED AREA WITH INTENSIVE AGRICULTURAL PRACTICE
14	MUNDALI	WATER INTAKE POINT OF BHUBANESWAR CITY
15	CUTTACK U/S	UPSTREAM OF CUTTACK CITY
16	CUTTACK D/S	IMPACT OF WASTE WATER DISCHARGE OF CUTTACK CITY AND INDUSTRIAL WASTE DISCHARGE FROM JAGATPUR INDUSTRIAL

		ESTATE
17	CUTTACK FD/S	TO ASSESS WATER QUALITY IMPROVEMENT ALONG CUTTACK STRETCH
18	PARADEEP U/S	WATER QUALITY OF MAHANADI BEFORE INDUSTRIAL ACTIVITY AT PARADEEP
19	PARADEEP D/S	IMPACT OF WASTE WATER DISCHARGE OFF PARADEEP INDUSTRIAL AREA
20	TEL	MAJOR TRIBUTARY OF MAHANADI RIVER
21	CUTTACK U/S	UPSTREAM CUTTACK CITY
22	CUTTACK D/S	WASTE WATER DISCHARGE OF CUTTACK CITY
23	CUTTACK FD/S AT MATTAGAJPUR	DOWNSTREAM OF SEWAGE TREATMENT PLANT OF CUTTACK CITY, THICKLY POPULATED VILLAGE AT THE DOWNSTREAM OF CUTTACK CITY
24	CUTTACK FD/S AT SANKHATRASA	THICKLY POPULATED VILLAGE AT THE DOWNSTREAM OF CUTTACK CITY, IMPACT OF INTENSE AGRICULTURAL ACTIVITIES
25	BHUBANESWAR FU/S	UPSTREAM OF BHUBANESWAR CITY
26	BHUBANESWAR U/S	WATER INTAKKE POINT OF BHUBANESWAR CITY
27	BHUBANESWAR D/S	IMPACT OF WASTE WATER DISCHARGE OF BHUBANESWAR CITY
28	BHUBANESWAR FD/S	TO ASSESS IMPROVEMENT OF WATER QUALITY
29	CHOUDWAR D/S	D/S OF CHUDWAR TOWN

Table2.Standard prescribed tolerance limits for inland surface water

STANDARD PRESCRIBED TOLERANCE LIMITS FOR INLAND SURFACE WATER	
CLASSES	USE BASED CLASSIFICATION
CLASS-A	DRINKING WATER SOURCE WITHOUT CONVENTIONAL TREATMENT BUT AFTER DISINFECTION
CLASS-B	OUTDOOR BATHING
CLASS-C	DRINKING WATER SOURCE WITH CONVENTIONAL TREATMENT FOLLOWED BY DISINFECTION
CLASS-D	FISH CULTUIRE AND WILD LIFE PROPAGATION
CLASS-E	IRRIGATION, INDUSTRIAL COOLING OR CONTROLLED WASTE DISPOSAL

III. MATERIALS AND METHODS

SAMPLING AND PARAMETERS: Water samples were collected from 29 stations along the course of theMahanadi river system, starting from the Sundergarh Reservoir to Choudwar D/s. The sampling strategy was designed in such a way to cover a wide range of determinants at keysites that accurately represent the water environment quality of the river systems and account for tributary inputs that can have important impacts upon downstream water quality [8]. Various water quality parameters from the monitoring stations were analyzed yearly from 2000 to 2017. The mean value of the data sets**(Table 3)** was taken into consideration for evaluating the pollution load in the water system. The measured parameters include pH, Nitrate(NO_3), Total Dissolved Solids (TDS), Boron, Alkalinity, Calcium, Magnesium, Turbidity, Chloride (Cl^-), Sulphate (SO_4^{2-}), Fluoride(F^-) and Iron(Fe)

Table 3.MINIMUM, MAXIMUM, MEAN AND STANDARD DEVIATION OF WATER QUALITY PARAMETERSAT DIFFERENT MONITORING STATIONS FROM 2000 TO 2017

PARAMETERS	STATIONS	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION
PH	29	7.58	7.95	7.77975	0.08827797
DO	29	6.635	7.8	7.543938	0.304818956
BOD	29	1.273	3.71	1.762438	0.631641034
TC	29	1212.4	32942.66	6575.949	8757.921972
EC	29	144.86	7942.2	667.6681	1940.001825
NO_3	29	1.85	6.4	2.818563	1.045870481
TSS	29	28.63	76.09	40.61638	12.1990147
ALKALINITY	29	70.36	106.09	84.15	8.954079145
COD	29	6.63	25.22	11.88125	4.862956405
NH_4-N	29	0.51	0.96	0.61375	0.112538882
FREE NH_3	29	0.0197	0.0515	0.028488	0.007854245
TKN	29	3.44	11.069	5.851188	2.005488111
SAR	29	0.44	22.66	1.930625	5.528575728
TDS	29	86.54	13081.82	933.0636	3239.747484
TH	29	52.36	2158.9	204.278	521.3723727
CL^-	29	9.5	5013.282	324.9769	1250.218733
$S0_4^{2-}$	29	4.83	364.7	29.28688	89.45926177
F	29	0.285	0.941	0.3825	0.17211469
FE	29	0.597	2.38	1.323313	0.436365247

IV. RESULTS AND DISCUSSION

4.1WATER QUALITY TREND OF MAHANADI BASIN

MAHANADI RIVER:

About 86% of the catchment (72,691 sq. km. out of total of 84,372) and tributaries of Mahanadi (Seonath ,Jonk ,Hosdeo and Mond) above the dam are in Madhya Pradesh/chattisgarh. Since several large towns and industries (Rajnandagaon, Bhillai, Durg, Shimoga, Raipur, Bilaspur ,Korbo etc.) are lacated on the banks of these tributaries, they carry considerable pollution load to the reservoir water at Hirakud almost conforms to class –B, except for TC values.

Sambalpur is the major urban area (population about 1.5 lakhs, districts and division headquarters) immediately downstream of Hirakud reservoir (about 5 km). Apart from being a source of water supply,

Mahanadi at Sambalpur is used for bathing and waste water (untreated) disposal which is responsible for the observed deterioration of water quality at sambalpur D/s. From Sambalpur D/s to Sonepur (about 78 km along the river course), the river travels through a region with no major urban settlement or waste water outfall. Sonepur is the confluence point of Mahanadi with two of its important right bank tributaries namely Ong and Tel. Thus the water quality at Sonepur U/s, which is immediately downstream of Ong confluence, is quite satisfactory. Though Sonepur is the district headquarters with all consequent activities, the deterioration in the water quality at sonepur D/s is not as much as expected. This is primarily because Sonepur D/s on Mahanadi is actually the downstream of its confluence with Tel, which has a significant annual average flow with very low pollution load. Moreover, in spite of being the district headquarters, sonepur is still a small town (population: about 19000) with no noticeable growth in urban activities [9].

The 102 km, stretch of the river from Sonepur D/s to Tikarpada does not have any industry or urban settlement on its banks (except two small sub-divisional towns- (Boudh and Athamalllick) and there is no major waste water outfall. From Tikarpada to Narasinghpur (about 60 km), the river flows almost completely undisturbed. The Tikarpada- Narasinghpur sub- basin is neither agriculturally nor is industrially prosperous and human activities on its banks scarce. Hence relatively clean, unpolluted water is expected at Tikarpada and without much change in quality at Narasinghpur.

The Bhubaneswar Office of the Chief Engineer (Mahanadi and eastern Rivers) of the Central Water Commission (CWC), Govt. of India, also monitors the water quality of Mahanadi at Tikarpada every month.

BOD values at Tikarpada as reported by CWC and State Pollution Control Board, odisha during the period 2000-2014 are given in Table. As may be seen, the values obtained by both the organizations are quite comparable and more or less of same trend.

During its course from Narasinghpur to Cuttack (about 56 km), the river enters into its deltaic region, characterized by high population density and intense agricultural activities. Hence there is some deterioration in the quality of water entering into Cuttack (Cuttack U/s) particularly in respect of TC, but still conforming to

Class C. Within the city (Population: about 5.35 lakhs) the river receives considerable untreated waste water and the water quality gets further deteriorated at Cuttack D/s.

IB RIVER:

Water quality of this left bank tributary of Mahanadi at four locations- Sundergarh, Jharsuguda, Brajarajnagar (U/s and D/s). Till about late nineties, the water quality at Brajarajnagar was a matter of much concern due to discharge of effluent from a large paper mill. The mill has been closed since December 1998. Since none of the three towns is a large urban centre and there is no organized domestic waste water discharge to the river, the water quality generally remains at the Class-C level. Of late, Jharsuguda has turned into an important industrial hub of the state. However, the impact of industrial activities has not much impact on the water quality of IB River [10].

BHEDEN RIVER:

Water quality of his left bank tributary of IB River is monitored at only one location-Jharsuguda, which is the downstream of M/s Vedanta Aluminium Ltd. As the plant was in the commissioning phase during the period of study, no significant impact on the water quality of Bheden River at Jharsuguda is noticed. Water quality generally remains at the Class-C level.

KATHOJODI RIVER:

The monitoring station at Cuttack D/s on Kathojodi, a distributary of Mahanadi, is characterized by an untreated domestic waste water discharge outfall at its upstream and expectedly, there is significant deterioration of water quality to below Class-C with respect to BOD, TC and large deviations in FC to make the water unacceptable for most beneficial uses.

BIRUPA RIVER:

Birupa, another distributary of Mahanadi is monitored at the downstream of Choudwar, a small town, which had in the past, significant industrial activities with a textile, a large pulp and paper and a charge chrome industry with its thermal power plant. Presently only the charge chrome industry is in operation with marginal water pollution potential. Except occasional deviation in the coliform count, the water quality generally conforms to Class-C.

KUAKHAI AND DAYA RIVERS:

The monitoring stations on kuakhai (distributary of kathajodi River) at Bhubaneswar FU/s and U/s in the upstream of the water intake point (sub surface water through bore wells) of the Public Health Engineering Department, for the Bhubaneswar city. The water quality generally conforms to Class-C [11].

Bhubaneswar D/s on Daya (distributary of Kuakhai) is just beyond the city limits. The river receives the city waste water, atleast through one organized outfall, the GanguaNallah, in between, as a consequence of which the water quality is downgraded beyond Class-c and unacceptable for most beneficial uses in respect of BOD, TC, and frequent violations of FC. However, the water quality trend is improved to some extent at Bhubaneswar FD/s.

4.2WASTE WATER GENERATION

4.2.1 INDUSTRIAL SOURCES

Table4.List of major industries which are operating in Mahanadi basin

NAME OF THE INDUSTRIES AND LOCATION	PRODUCT
1.MAHANADI	
ARATI STEEL LTD, ATHAGARH	STEEL
HINDALCO INDUSTRIES LTD. SAMBALPUR	POWER
HINDALCO INDUSTRIES LTD.(SMELTER) SAMBALPUR	ALUMINIUM SMELTER PLANT
ORISSA POWER GENERATION CORPORATION(OPGC) , BANHARPALI	POWER
BARGARH CO-OPERATIVE SUGAR MILLS LTD, BARGARH	SUGAR
ACC CEMENT, BARGARH	CEMENT
BIJAYANANDA CO-OPERATIVE SUGAR MILL LTD, BOLANGIR	SUGAR

NAYAGARH SUGAR COMPLEX LTD ,NAYAGARH	SUGAR
COSBOARD INDUSTRIES LTD, CUTTACK	CARDBOARD AND PAPER
SMV BEVERAGES PVT. LTD, CUTTACK	SOFT DRINKS
PARADEEP PHOSPHATES LTD, JAGATSINGHPUR	PHOSPHATIC FERTILISER
IFFCO LTD, JAGATSINGHPUR	PHOSPHATIC FERTILISER
SKOL BREWERIES LTD, JAGATSINGHPUR	BEER
VEDANTA ALUMINIUM LTD JHARSUGUDA	ALUMINIUM SMELTER PLANT
STERLITE ENERGY(P) LTD, JHARSUGUDA	POWER
TRL KROSAKI REFRACTORIES , BELPAHAR	REFRACTORIES
ULTRA TECH CEMENT LTD, JHARSUGUDA	CEMENT
BHUSAN POWER AND STEEL LTD, JHARSUGUDA	IRON AND STEEL, POWER
BIRUPA	
INDIAN METALS AND FERRO ALLOYS LTD.(CPP), CHOUDWAR	POWER
INDIAN METALS AND FERRO ALLOYS LTD.(FERROALLOYS) CHOUDWAR	CHARGECHROME

Besides the large scale industries listed in the **(above table 4)**, there are several medium and small scale industries generating an estimated total about 100,000m³ of waste water per day. It should, however, be noted that the entire amount of waste water may not necessarily go the river system. In certain cases, the waste water is actually diverted to marshes and other detention basins, some of which overflow during the rainy season only [12].

4.2.2 MINING SOURCES

There are 15 number of coal mines of Mahanadi coal fields limited operating in the basins. Together they discharge 14,000 m³ of water per day, during the non-monsoon months which increase to about 33,000 m³ per day during the monsoon as per State Pollution Control Board, Odisha data book**(Table 5)**.

Table5.Coal Mines Operating in Mahanadi Basin in Odisha

NAME OF COAL MINES	TYPE
JHARSUGUDA DISTRICT	
IB-RIVER COLLIERY	OPENCAST
IB-PROPERTY COLLIERY	OPENCAST
ORIENT COLLIERY	UNDERGROUND
ORIENT-III COLLIERY	UNDERGROUND
IB-BLOCK 5TH COLLIERY	OPENCAST
GANDGHORA COLLIERY	OPENCAST
NEW-GANDGHORE COLLIERY	OPENCAST
N-W BLOCK GANDGHORA COLLIERY	OPENCAST
RAMPUR COLLIERY	UNDERGROUND
BELPAHAR	OPENCAST
LILARI	OPENCAST
SAMALESWARI	OPENCAST
LAKHANPUR	OPENCAST
SUNDERGARH DISTRICT	
BASUNDHARA	OPENCAST
KULDA	OPENCAST

4.2.3 DOMESTIC SOURCES

There are 44 urban local bodies in the basin in the below **(Table 6)** including some of the important cities and towns of Orissa like Bhubaneswar, Cuttack, Sambalpur, Puri, Paradeep. The estimated waste water discharge from the urban settlements in Mahanadi basin is about 345000m³ per day. None of the places except Cuttack has any organized sewerage system or sewage treatment plant. Consequently most of the untreated domestic waste water finds its way to the riverine system, contributing a BOD loading of about 68.6 tons per day (Assuming the BOD concentration of sanitary waste water is 200 mg/l) [13]. Since the villages do not have any organized water supply or drainage system, the waste water generated almost totally absorbed in the soil.

Table6. Urban Local Bodies in Mahanadi Basin In Odisha

DISTRICT	SL NO	ULB	POPULATION(2001 CENSUS)
SUNDERGARH	1	SUNDERGARH MUNCIPALITY	38402
JHAARSUGUDA	2	BELPAHAR MUNICIPALITY	32807
	3	BRAJARAJNAGAR MUNCIPALITY	76941
	4	JHARSUGUDA MUNCIPALITY	75570
BRAGARH	5	BARPALLI NAC	19154
	6	BARAGARH MUNCIPALITY	63651
	7	PADAMPUR NAC	15438
SAMBALPUR	8	BURLA NAC	42806
	9	HIRAKUD NAC	26397
	10	KUCHINDA NAC	13584
	11	RAIRAKHOL NAC	13722
	12	SAMBALPUR MUNCIPALITY	157763
NUAPADA	13	KHARIAR NAC	13402
	14	KHARIAR ROAD NAC	16627
KALAHANDI	15	BHAWANIPATNA MUNCIPALITY	60745
	16	JUNAGARH NAC	15579
	17	KESINGA NAC	16914
BOLANGIR	18	BOLANGIR MUNCIPALITY	85203
	19	KANTABANJHI NAC	20090
	20	PATNAGARH NAC	18685
	21	TITLAGARH NAC	30251
PHULBANI	22	PHULBANI MUNCIPALITY	33887
SONEPUR	23	BINIKA NAC	14537
	24	SONEPUR MUNCIPALITY	17535
	25	TARAVA NAC	7993
BOUDH	26	BOUDH NAC	17996
NAYAGARH	27	KHANDAPADA NAC	8754
	28	NAYAGARH NAC	14311
ANGUL	29	ATHAMALLICK NAC	11383
CUTTACK	30	CUTTACK MUNCIPAL CORPORATION	535139
	31	ATHAGARH NAC	15850
	32	BANKI NAC	15987
	33	CHOUDWAR MUNCIPALITY	52498
KHURDA	34	BHUBANESWAR	657477

		MUNCIPAL CORPORATION	
	35	BALUGAON NAC	15824
	36	JATANI MUMCIPALITY	57827
	37	KHURDA MUNCIPALITY	39034
PURI	38	KONARK NAC	15015
	39	NIMAPARA NAC	16914
	40	PIPILI NAC	14263
	41	PURI MUNCIPALITY	157610
KENDRAPADA	42	KENDRAPADA MUNCIPALITY	41404
JAGATSINGHPUR	43	JAGATSINGHPUR MUNCIPALITY	30688
	44	PARADEEP MUNCIPALITY	73633

1.2.4 AGRICULTURAL SOURCES

The basin has 29 completed, 9 ongoing and 35 numbers of proposed major and medium irrigation projects. Besides these, there are 748 completed and 638 ongoing minor irrigation projects in the basin. The quantity of water used for irrigation in the Mahanadi basin is quite large. About 88% of the water utilized for irrigation is used by crops, held back as soil moisture and lost through evaporation and transpiration. The remaining 12% of the total water used for irrigation constitutes the runoffs. The waste water flow from agricultural sector in Mahanadi Basin is of the order of 2160 million m^3 per year of which the return water from Odisha portion is about 1564.34 million m^3 per year. A part of pesticides and nutrients applied as fertilizers gets washed or leached with agricultural return waters. The amount of nutrients so leached increase with the intensity of application of pesticides and fertilizers. Assuming the loss of N,P,K and pesticides as 10%,5% (Due to Lower Solubility), 10% and 5% respectively, their estimated concentration in return water due to application of fertilizers and pesticides is given in below**(Table 7)**.

Table7. Estimated Concentration of N, P,K and Pesticides in Agricultural Return Water

COMPONENT	CONSUMPTION((T) /YEAR) (DURING 2010-2011)	ESTIMATED CONCENTRATION IN RETURN WATER(1564.34 MILLION M^3/YEAR)(Mg/l)
N	135717.66	8.68
P	74919.09	2.39
K	41948.57	2.68
Pesticides	483	0.02

V. CONCLUSION

The present study reveals that the water quality of Mahanadi River is quite safe as compared to the physico-chemical parameters point of view at present. However, due to increased industrial and human activities along its bank a constant monitoring of the water quality of the river is a must to maintain the river water quality [14].

- River Mahanadi is said to be the lifeline of the state Odisha. Most of the agriculture, industry and all round developments are due to rich water resource potential of this river. But the present concern is the increasing deterioration of water quality of the watershed is mainly attributed to the uncontrolled and improper disposal of solid and toxic waste from industrial effluents, agricultural runoff and other human activities. ***This alarming water pollution not only causing degradation of water quality but also threatens human health and balance of aquatic ecosystem, and economic development of the state.***

- From the assessment of physico-chemical study it could be clearly concluded that ***the status and quality of Mahanadi River water in Sambalpur city be an eye opener*** which is very much prone towards alarmed condition for Sambalpur city and its population [15].

The present study is useful in ascertaining the water quality of Mahanadi River along its entire stretch for its potability for industrial, agricultural and human use.

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