

## DRINKING WATER QUALITY ANALYSIS OF SURROUNDING RIVERS IN BHUBANESWAR, ODISHA

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### ABSTRACT

*With rapid growth of population, Industrial activities and deforestation, the water quality of surrounding rivers in Bhubaneswar, the capital of Odisha is gradually deteriorating. This city has become a environmental sensitive zone in the state of Odisha in India. Drinking water is supplied from surrounding rivers of Bhubaneswar like Kuakhai, Daya and Mahanadi. This supplied water from surrounding rivers becomes polluted when toxic substances, oxidized organics, inorganic, suspended solids, human, animal and plant pathogens enter into the water bodies. The treatment of surface water and waste water is necessary in order to maintain its quality standards for drinking water purposes. The objective of water treatment is to produce an adequate and continuous supply of water that is chemically, bacteriological free and aesthetically pleasing. Water samples from six different locations were collected in every month of pre monsoon, monsoon and post monsoon periods. Standard procedures were adopted to analyze and to calculate the different physico-chemical parameters of surface water samples using ISI standard procedure.*

**Keywords:** *Surface Water Pollution; Physico-Chemical Parameter; Seasonal Variation; Mahanadi, Daya and Kuakhai Rivers.*

### I INTRODUCTION

Water plays a great role for the existence of human beings and all living organisms. Surface water is mainly used for domestic need, industrial and agricultural purposes in most parts of the world as it is a replenish able resource. Due to unprecedented rapid population growth, urbanization and industrialization, water pollution problem have become increasingly evident and have led to serious ecological and environmental problems. The scope of present study is limited to drinking water quality of surrounding rivers in Bhubaneswar which is polluted due to domestic wastes & industrial establishment in the state of Odisha. This city is located between Latitude 20°21'N to 20°25'N and Longitude 85°44'E to 85°55'E and an elevation of about 45 meters above mean sea level (MSL) . This city is located in the western side of Mahanadi delta and on the bank of river kuakhai tributary and daya river flows along with the south eastern part of the city. During monsoon month, the humidity at Bhubaneswar varies between 75 to 85 percentages & during pre monsoon month it is between 50 to 60 percentages. The population of Bhubaneswar is about more than seven lacs as reported in census 2001. Public health engineering department of the state of odisha is looking after drinking water supply. The status of river water is very much useful as it determines the physiological lifecycle of plants, animals and human

kingdom. Now a days direct use of river water for drinking purpose bears significant problem because of the environmental hazards which are always associated with the development of the region. Industrial processes which consume high quality of water generally discharge wastewater containing a large number of pollutants thereby causing water pollution. The domestic sewage of Bhubaneswar City is responsible for generating pollutants which makes their way to canal and finally to river Daya, kuakhai and Mahanadi River. Parameters such as pH, Dissolved Oxygen (DO), Total Dissolved Solid (TDS), Turbidity have been considered out of twelve parameters as the four important water quality parameters for classifications of surface water.

## II METHODS AND PROCEDURES OF INVESTIGATION

The water sample were collected from each month at 3 points ( $S_1$ ,  $S_2$  &  $S_3$ ) across the river width at all the three sites with a view to monitor changes caused by the seasonal hydrological cycle during the study period (January 2013 – December 2013). Sampling, preservation and transportation of the water sample to the laboratory were as per standard methods.

Water sample were normally collected in the afternoon in a plastic non reacting bottles of 2 liters capacity. Immediately after sampling, preservatives were added and the bottles were re capped and sealed by the application of hot molten wax. The temperature of different water samples were measured at the site by sensitive red mercury thermometer. These sealed bottles were put in a thermo cool box till it was carried for laboratory analysis . Sodium Thiosulphate preservatives were used for sampling in tablet forms. The pH was measured by digital pH meter, sodium and potassium by flame photometer (Systronic digital). Total dissolved solid (TDS) was estimated by taking dried weight of the sample in platinum dishes. Analysis of calcium, magnesium and total hardness were done by EDTA method. Sulphate was determined by gravimetric method. Chloride by Mohr's method. Fluoride concentration was measured using Orion ion analyzer EA-940 with chloride ion selective electrode. Dissolved oxygen (DO), COD and BOD were estimated by standard procedure methodology of American Public Health Association (APHA, 1998)<sup>1</sup>. Heavy metals like Pb, Zn, Fe, Cu, Ni, concentration were determined by AAS (Model Perkin Elmer -303) after  $HClO_4$ ,  $HNO_3$  and HCl digestion. Standard procedure was adopted to find the faecal coli form and total coli form. The average value of the analysis result for different physico- chemical parameters have been tabulated in table- 1 to 12 for pre-monsoon, monsoon and post monsoon seasons.

(All the parameters in the following tables, concentration are expressed in mg/L except pH, Temp and Turbidity)

**Table 1**  
**Mahanadi River (Monthly variation)**

Month	Physico-chemical parameters											Heavy metal concentration					
	Temp.	PH	DO	BOD	COD	TDS	TH	$NO_3^-$	$F^-$	Cl <sup>-</sup>	TURB (NTU)	Fe	Ni	Cu	Zn	Pb	Cr (Vi)
Feb	26.02	7.5	6.1	2.2	10.10	1198	75	12.5	0.326	13.3	3.9	14.5	0.005	0.003	0.007	0.006	0.016
March	27.23	7.4	5.8	1.6	5.8	1201	82	14.5	0.328	16.3	4.1	16.5	0.008	0.004	0.008	0.007	0.017
April	27.29	7.5	5.9	1.5	9.1	1214	83	14.7	0.336	17.4	4.3	18.0	0.007	0.04	0.011	0.006	0.009
May	28.29	7.7	6.3	1.0	8.6	1216	85	14.9	0.400	18.4	4.0	20.8	0.008	0.004	0.012	0.007	0.008

June	28.45	7.6	6.2	2.0	7.8	1296	87	15.0	0.429	19.4	4.0	21.8	0.009	0.002	0.022	0.005	0.036
July	25.51	7.7	6.4	2.9	14.6	1318	76	10.55	0.207	13.6	4.3	7.30	0.005	0.002	0.006	0.005	0.007
Aug	25.09	7.6	6.6	2.8	15.6	1314	66	10.9	0.200	12.6	4.1	6.28	0.004	0.001	0.005	0.004	0.038
Sept.	24.99	7.6	6.3	2.7	16.2	1316	67	10.9	0.199	10.4	4.3	4.18	0.003	0.002	0.004	0.005	0.046
Oct.	24.91	7.6	6.2	1.9	16.5	1304	63	11.0	0.180	10.1	4.0	2.91	0.002	0.001	0.005	0.005	0.046
Nov	24.89	7.4	6.1	1.8	16.8	1298	61	11.1	0.170	9.0	3.9	2.71	0.003	0.001	0.004	0.005	0.048
Dec.	24.90	7.5	5.9	1.7	15.8	1274	63	11.0	0.160	8.8	4.0	12.3	0.004	0.002	0.006	0.006	0.46
Jan	25.80	7.5	6.0	2.1	10.6	1238	71	12.1	0.322	11.2	4.1	13.3	0.005	0.002	0.005	0.005	0.014

**Table 2**  
**Mahanadi River(Seasonal variation)**

Season	Physico-chemical parameters											Heavy metal concentration					
	Temp.	PH	DO	BOD	COD	TDS	TH	$NO_3^-$	$F^-$	Cl	TURB (NTU)	Fe	Ni	Cu	Zn	Pb	Cr (Vi)
Pre Monsoon	28.00	7.4	5.8	2.9	8.6	1207	8.5	14.7	0.334	17.4	4.1	18.00	0.007	0.003	0.002	0.006	0.010
Mansoon	25.51	7.5	6.3	1.5	15.6	1311	6.2	10.8	0.200	11.3	4.2	3.00	0.003	0.001	0.005	0.004	0.046
Post Mansoon	24.05	7.3	6.0	1.8	10.3	1278	6.5	11.7	0.226	12.4	3.9	14.00	0.005	0.002	0.006	0.004	0.011

**Table 3**  
**Kuakhai (Monthly variation)**

Month	Physico-chemical parameters											Heavy metal concentration					
	Temp.	PH	DO	BOD	COD	TDS	TH	$NO_3^-$	$F^-$	Cl	TURB (NTU)	Fe	Ni	Cu	Zn	Pb	Cr (Vi)
Feb	26.00	7.3	5.9	2.6	10.10	1195	75	12.5	0.326	13.3	3.9	14.5	0.005	0.007	0.007	0.006	0.015
March	27.21	7.2	5.9	1.5	9.8	1199	82	14.5	0.328	16.3	4.1	16.4	0.007	0.009	0.009	0.006	0.016
April	27.8	7.3	5.9	1.4	9.0	1203	83	14.6	0.335	17.3	4.2	18.0	0.008	0.010	0.010	0.005	0.008
May	28.29	7.3	6.1	1.0	8.5	1207	84	14.8	0.400	18.3	4.0	20.8	0.008	0.011	0.011	0.006	0.007
June	29.40	7.4	6.0	1.9	7.9	1269	88	15.10	0.428	19.3	4.0	21.9	0.009	0.012	0.012	0.005	0.036
July	25.50	7.6	6.3	3.0	14.5	1321	75	10.94	0.206	13.5	4.2	7.28	0.004	0.006	0.006	0.005	0.007
Aug	25.10	7.5	6.2	2.5	15.5	1308	65	10.8	0.200	12.5	4.1	6.23	0.003	0.004	0.004	0.006	0.036
Sept.	24.98	7.4	6.2	2.9	16.1	1315	66	10.8	0.198	10.3	4.2	4.15	0.003	0.005	0.005	0.005	0.046
Oct.	24.90	7.5	6.1	1.9	16.5	1301	63	11.0	0.180	10.1	4.0	2.9	0.002	0.005	0.005	0.005	0.048
Nov	24.89	7.4	6.1	1.8	16.9	1288	61	11.0	0.170	9.0	3.9	2.8	0.003	0.004	0.004	0.005	0.048
Dec.	24.80	7.3	5.9	1.7	15.9	1272	61	11.0	0.160	8.8	4.0	12.3	0.002	0.005	0.005	0.005	0.047
Jan	24.79	7.4	6.0	2.1	10.5	1235	70	12.0	0.332	11.2	4.0	13.4	0.005	0.006	0.006	0.006	0.014

**Table 4**  
**Kuakhai(Seasonal variation)**

Season	Physico-chemical parameters											Heavy metal concentration					
	Temp.	PH	DO	BOD	COD	TDS	TH	NO <sub>3</sub> <sup>-</sup>	F <sup>-</sup>	Cl <sup>-</sup>	TURB (NTU)	Fe	Ni	Cu	Zn	Pb	Cr (Vi)
Pre Monsoon	28.00	7.3	5.9	3.0	8.5	1201	84	14.6	0.333	17.3	4.0	18.00	0.008	0.003	0.001	0.006	0.010
Monsoon	25.50	7.6	6.2	1.4	15.5	1303	65	10.8	0.200	11.3	4.2	3.00	0.003	0.001	0.005	0.004	0.046
Post Monsoon	25.00	7.4	6.0	1.9	10.3	1274	61	11.6	0.225	12.2	3.9	14.00	0.005	0.002	0.006	0.005	0.015

**Table 5**  
**Daya River (Seasonal variation)**

Season	Physico-chemical parameters											Heavy metal concentration					
	Temp.	PH	DO	BOD	COD	TDS	TH	NO <sub>3</sub> <sup>-</sup>	F <sup>-</sup>	Cl <sup>-</sup>	TURB (NTU)	Fe	Ni	Cu	Zn	Pb	Cr (Vi)
Pre Monsoon	28.01	7.2	4.4	12	8.5	1296	85	14.5	0.333	17.4	4.0	18.00	0.009	0.004	0.002	0.006	0.010
Monsoon	25.50	7.7	5.0	10	15.4	1345	66	10.7	0.210	11.4	4.3	3.00	0.005	0.002	0.006	0.005	0.014
Post Monsoon	25.01	7.5	4.8	11	10.4	1317	62	11.7	0.25	12.4	3.8	14.00	0.006	0.003	0.007	0.005	0.015

**Table 6**  
**Daya River (Monthly variation)**

Month	Physico-chemical parameters											Heavy metal concentration					
	Temp.	PH	DO	BOD	COD	TDS	TH	NO <sub>3</sub> <sup>-</sup>	F <sup>-</sup>	Cl <sup>-</sup>	TURB (NTU)	Fe	Ni	Cu	Zn	Pb	Cr (Vi)
Feb	26.00	7.4	5.3	11	10.11	1240	76	12.6	0.327	13.4	3.8	14.6	0.005	0.003	0.0008	0.005	0.015
March	27.22	7.2	4.5	10	9.8	1298	84	14.5	0.338	16.5	4.1	15.4	0.006	0.003	0.009	0.006	0.017
April	27.28	7.2	4.5	10.5	9.0	1315	83	14.5	0.335	17.3	4.1	17.0	0.007	0.003	0.010	0.005	0.009
May	28.29	7.3	4.9	11	8.6	1331	86	14.8	0.339	18.6	4.2	21.8	0.008	0.003	0.010	0.005	0.008
June	28.30	7.2	4.8	11.8	7.9	1338	89	15.09	0.430	18.9	4.0	22.9	0.008	0.002	0.011	0.004	0.037
July	25.40	7.6	4.7	12	14.5	1344	74	10.84	0.207	13.4	4.4	7.29	0.004	0.003	0.006	0.005	0.008
Aug	25.9	7.4	4.6	11.5	15.6	1347	65	10.8	0.200	12.5	4.1	6.28	0.004	0.002	0.005	0.005	0.036
Sept.	24.98	7.4	4.5	12	15.9	1353	67	10.9	0.199	10.4	4.3	6.17	0.003	0.001	0.004	0.006	0.047
Oct.	24.91	7.4	4.4	10.7	16.6	1304	64	11.5	0.185	10.2	4.1	2.90	0.003	0.001	0.005	0.005	0.048
Nov	24.88	7.5	4.3	11	16.8	1319	61	11.1	0.170	9.2	3.8	2.9	0.004	0.001	0.005	0.005	0.049
Dec.	24.81	7.3	5.5	11.5	15.9	1321	62	11.0	0.160	8.9	4.0	12.4	0.003	0.002	0.005	0.005	0.046
Jan	24.79	7.5	4.3	11.7	10.6	1325	72	12.0	0.331	11.3	4.1	13.4	0.006	0.002	0.006	0.006	0.013

Table 7

Seasonal variation of physico-chemical parameters																		
	PHD Water supplied points at Naraj ,Mahanadi River						PHD Water supplied points at Palasuni, Kuakhai River						PHD Water supplied points at Samantrapur , Daya River					
Season	Temp.	PH	DO	TDS	Fe	BOD	Temp.	PH	DO	TDS	Fe	BOD	Temp.	PH	DO	TDS	Fe	BOD
Pre Monsoon	28.0	7.4	6.1	98	0.166	2.3	28.00	7.3	5.9	121	0.191	2.4	28.01	7.2	5.1	172	0.222	2.65
Mansoon	25.51	7.5	6.4	196	0.290	3.0	25.50	7.6	6.1	200	0.294	3.05	25.50	7.7	5.3	289	0.302	3.25
Post Mansoon	25.01	7.4	6.0	118	0.230	2.6	25.00	7.4	7.3	124	0.270	2.7	25.01	7.5	5.2	224	0.301	2.5

Table 8

Monthly variation of physico-chemical parameters																		
	PHD WATER SUPPLIED POINTS AT NARAJ ,Mahanadi River						PHD WATER SUPPLIED POINTS AT PALASUNI, Kuakhai River						PHD WATER SUPPLIED POINTS AT SAMANTARAPUR ,Daya River					
Month	Temp.	PH	DO	TDS	Fe	BOD	Temp.	PH	DO	TDS	Fe	BOD	Temp.	PH	DO	TDS	Fe	BOD
Feb	26.02	7.5	6.1	104	0.179	1.9	26.00	7.3	5.9	116	0.198	1.8	26.00	7.4	5.4	195	0.209	2.0
March	27.21	7.1	6.1	101	0.165	2.1	27.21	7.2	5.9	119	0.192	2.4	27.22	7.2	5.1	168	0.217	2.8
April	27.29	7.3	6.3	98	0.163	2.3	27.28	7.3	5.9	120	0.188	2.6	27.28	7.2	5.2	165	0.229	2.9
May	28.30	7.3	6.2	96	0.158	2.8	28.29	7.3	6.1	118	0.186	2.7	28.29	7.3	5.1	158	0.234	2.9
June	28.30	7.3	6.5	202	0.290	2.8	28.40	7.4	6.0	208	0.298	2.9	28.30	7.2	5.4	281	0.308	3.0
July	25.51	7.7	6.4	210	0.293	2.9	25.50	7.6	6.2	211	0.296	3.0	25.40	7.6	5.5	283	0.310	3.4
Aug	25.10	7.6	6.6	206	0.290	3.1	25.10	7.5	6.2	209	0.291	3.2	25.9	7.4	5.3	295	0.312	3.5
Sept.	24.9	7.6	6.3	168	0.285	3.2	24.98	7.4	6.2	172	0.289	3.1	24.98	7.4	5.3	298	0.314	3.1
Oct.	24.91	7.6	6.2	128	0.237	2.9	24.90	7.5	6.1	130	0.278	2.9	24.96	7.4	5.2	247	0.309	2.9
Nov	24.89	7.4	6.1	124	0.233	2.7	24.89	7.4	6.1	124	0.271	2.8	24.88	7.5	5.2	236	0.305	2.8
Dec.	24.90	7.5	5.9	112	0.229	2.5	24.80	7.3	5.9	122	0.267	2.6	24.81	7.3	5.2	211	0.301	2.4
Jan	24.80	7.5	6.0	106	0.224	2.4	24.79	7.4	6.0	121	0.263	2.5	24.79	7.5	5.1	201	0.288	2.1

All the physic- chemical parameters analyzed, Fe concentration are given in tabular form in Table-7 and 8. The concentration of other heavy metals detected are not given in the table since it remains below the detection limit (BDL).

### III RESULTS & DISCUSSION

Huge amounts of money has been spent and some effort has been made by the municipalities, industries and governments during the last four decades to enhance the quality of water for domestic and industrial

consumption and reduce its pollution. However, very little effort if any has been made by these agencies to keep the general public information, in simple and understandable terms, as to what this vast effort and investment is achieving, or not achieving, in water quality enhancement. In this study analysis of water quality in different seasons was carried out to determine the seasonal variation of Physico-chemical Parameters and Heavy metals of water. The result is listed in the table.

### Mahanadi River

The water quality of Mahanadi River during different seasons are presented in Table 1-2; and highlighted as follow

#### Pre-monsoon

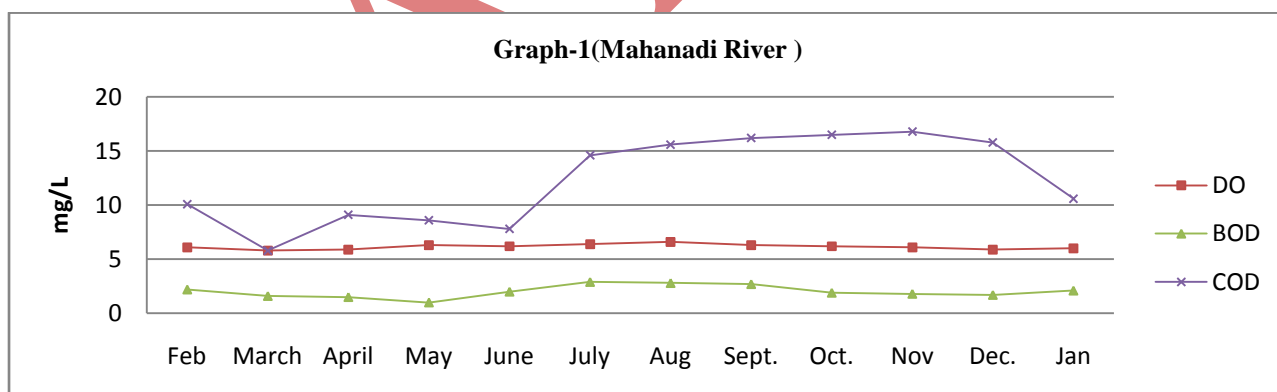
Water sample from Mahanadi river at Naraj shows pH value varied between 7.4 to 7.7 and dissolve oxygen > 5 mg/L indicating the healthy state of the river system. Dissolved Solids (TDS) varied between 1198 to 1216. High TDS which may be due to the tidal action of the sea. However the BOD value nearly 1 to 2.2 mg/L indicated the domestic sewage pollution throughout the river. Low concentration of BOD was recorded during post monsoon due to a huge volume of fresh water that diluted the organic matter resulting in the decrease in the BOD values (Bagde and Verma 1985; Palharya and Malvial 1988)

#### Monsoon

pH of water samples varied between 7.6 to 7.7 at Naraj. Dissolved Solids (TDS) varied between 1296 to 1318 mg/L. Dissolved Oxygen varied between 5 mg/L to 6.3 mg/L. Likewise BOD values varied between 2 mg/L to 2.9 mg/L in fishery harbor. However fluoride values are between 0.200 mg/L to 0.334 mg/L.

#### Post-monsoon

pH of water samples varied between 7.4 to 7.6 at Naraj. TDS of water samples varied between 1238 to 1304 mg/L. However the BOD values varied between 1.7 to 2.0 mg/L



### Kuakhai River

The water quality of Kuakhai River in different seasons are presented in Table 3-4 and highlighted below.

#### Pre-monsoon

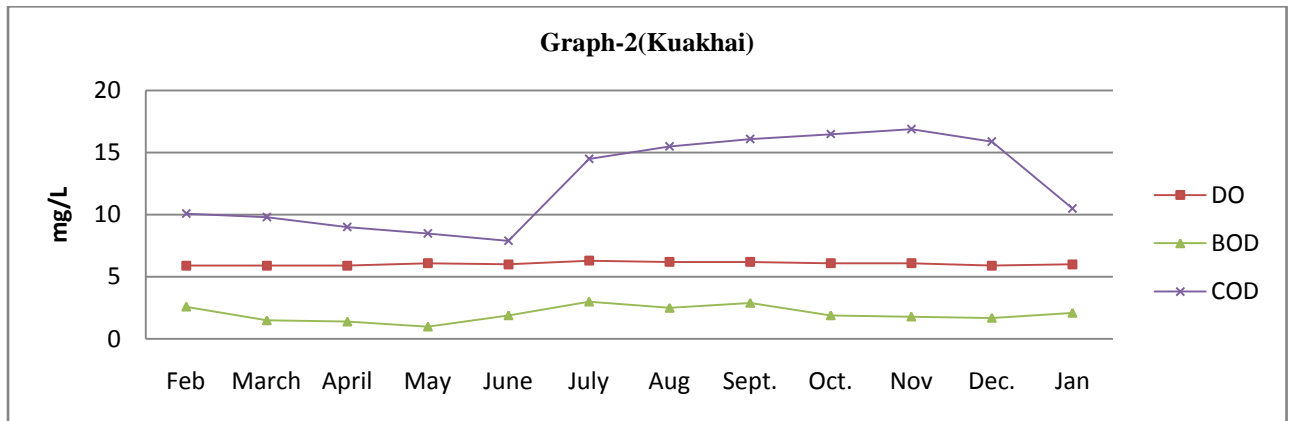
pH of water samples varied between 7.2 to 7.3. BOD of water samples varied between 1 to 2.6 mg/L indicated that the domestic sewage pollution through the River .TDS of water varied from 1195 to 1207. DO value varied 5.9 to 6.0. Total hardness of water sample varied from 82 to 88 mg/L. However Fluoride value varied from 0.328 to 0.428.

**Monsoon**

pH of water samples varied between 7.4 to 7.6 at Palasuni. Dissolved Solids (TDS) varied between 1269 to 1329 mg/L. Dissolved Oxygen varied between 6.1.mg/L to 6.3 mg/L. Likewise BOD values varied between 1.9 mg/L to 3 mg/L. However fluoride values are between 0.180 mg/L to 0.206 mg/L.

**Post-monsoon**

pH of water samples varied between 5.9 to 6.1 at Palasuni.TDS of water samples varied between 1235 to 1301 mg/L. However the BOD values varied between 1.9 to 2.1 mg/L



**Daya River**

The water quality of Daya River in different seasons are presented in Table 5-6 and highlighted below.

**Pre-monsoon**

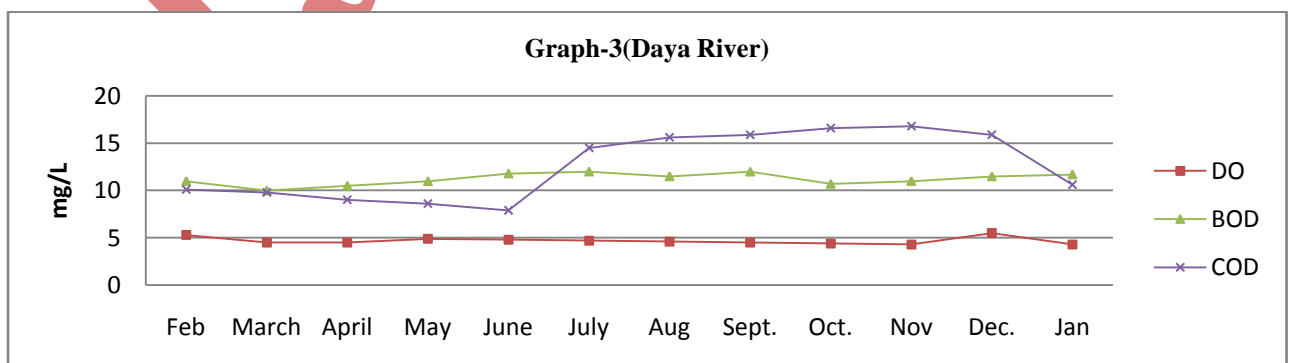
Water sample from Daya River at Samantapur shows pH value varied between 7.2 to 7.4 and dissolve oxygen, <5 mg/L. BOD value nearly 10 to 11 mg/L indicated the domestic sewage pollution to the river. Dissolved Solids (TDS) varied between 1240 to 1331 mg/L.

**Monsoon**

pH of water samples varied between 7.2 to 7.6 at Palasuni. Dissolved Solids (TDS) varied between 1338 to 1353 mg/L. BOD value nearly 11.5 to 12 mg/L.

**Post-monsoon**

pH of water samples varied between 7.3 to 7.5 at Palasuni. TDS of water samples varied between 1304 to 1325 mg/L. However the BOD values varied between 10.7 to 11.7 mg/L



#### IV CONCLUSION

The different physico-chemical parameters were analyzed and some parameters like BOD, COD and heavy metal Fe were observed beyond the permissible limit which shows that the river water is gradually deteriorated. The BOD value in Daya River was found to be higher than the other sampling station and has low DO value. The low DO and higher BOD value in the river is attributed to high organic load from sewage of Bhubaneswar city. So the water quality of the Daya River is found to be the most Polluted River. Then after treatment process of PH department, the supplied drinking water which were studied, has also found some irregularity due to some parameters like total coliform, BOD and higher concentration of iron which is remain closed or beyond the permissible limit (as per standard prescribed IS:2296-1992 and drinking water specification IS-10500:1991)

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