IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 15, Issue 5 Ver. IV (Sep. - Oct. 2018), PP 25-33
www.iosrjournals.org

Water Quality Assessment of Brahmani River At Talcher City, Odisha (A Case Study)

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Abstract: *Water, food, energy and the environment have got intertwined in a spiral of decline and degradation .The challenge is to slow the spin and reverse the direction. The world's thirst for water is likely to become one of the most pressing issues of the 21st century. Rapid pace of industrialization, concurrent growth of urbanization, need and change of life style of ever expanding population have the potential to damage the environment and degrade the available surface water sources. Since there has been growing concern about pollution in Talcher area due to industrial, mining and other anthropogenic activities, Central Pollution Control Board and Ministry of Environment & Forests have identified this zone as one of the hot spots in respect of pollution hazards. The present investigation deals with a comparative study of physico-chemical characteristics of water samples taken from four different sampling locations situated near the industrial zone of Talcher near Brahmani basin. The parameters were constantly monitored like pH, conductivity, hardness, DO, BOD, COD, TDS, TSS, Phosphate, Sulphate, Nitrate, Chloride etc. during 2015and 2016 in different seasons viz. Summer, Rainy, Post rainy &Winter. The depletion of DO, increase in COD, BOD, TSS etc. indicate that the water quality is deteriorating at different stretches of the river which is posing a threat to aquatic life. The present study is an attempt to provide a qualitative and quantitative status indicating the suitability of water sources for drinking purpose. The study on variations of physico-chemical characteristics along with its water quality of surface water resources fluctuated from different season to other making the sources unfit for human consumption.*

It was observed that many parameters of the sampled surface water were found within the tolerance limit as specified by W.H.O. and IS and some parameters were beyond the limit. Water Quality Analysis values for surface water in different seasons has been calculated to classify the sources according to pollution level and suitability for drinking water purpose.

Keywords: *Intertwined, Physico-chemical parameters, DO, BOD, COD, TDS, TSS, Hotspots, Effluents, Tolerance limits.*

Date of Submission: 13-10-2018 Date of acceptance: 28-10-2018

I. Introduction

TalcherIndustrial complex of Orissa is situated on the right bank of the river Brahmani at latitude 20^0 95 'N to $21^0$10'N and longitude 84^0 55'E to 85^0 28'E ,139m above sea level (ASL), and 150 km away from Bhubaneswar, the state capital of Orissa .This area is one of the largest coal belts of India. Taking the advantages of the location, vast coal deposits, water availability and the manpower Mahanadi Coal Fields Ltd. (MCL) has developed a number of open cast and underground mines in this industrial complex. Besides, a good number of coal based Thermal Power Plants (Talcher Super Thermal Power Project , Kaniha, Talcher Thermal Power Station, Talcher, Captive Power Plant, Nalco, Angul), several heavy industries (National Aluminimum Company, Angul, Heavy Water Project, Vikrampur, Bhushan Steel and Strips Ltd, Jindal Power and Steel Ltd, Silicon steel, Nava Bharat Ferroalloys, Monet Ispat Ltd, Rungta Ltd etc), Coal washeries and a large number of ancillary medium and small scale industrial Units have come up in the area in the last few years. All these mining and industrial activities have caused significant degradation of environmental quality and now this area is considered as one among 24 most polluted areas of India. The inhabitants of this area depend on ground water for their day to day uses besides mining and industrial activities. The discharge of effluents (partly treated or untreated) from different

industries and mines have led to depletion of water quality of ground water. Such an alteration in the water quality makes the life miserable by inducing a number of water borne diseases [1].

There is an increasing menace of water pollution throughout the globe. The major riverine system is getting polluted day by day in India. This is due to alarming rate of industrialization, urbanization and growth of mechanization. In India major cities and industries have been established on the bank of rivers. The natural quality of river water tends to be degraded due to humans' activities. The industrial growth is a major flux of discharging wastes including solid & liquid one. Rivers are used as a major sink of industrial wastes as well as municipal solid wastes. The river also supplies water to the entire region of industrial, irrigation and domestic purpose [2]. In India today acute pollution prevails in many rivers viz. Krishna, Tapti, Brahmaputra, Ganga, Hoogly&Brahmani. The industrial zones are developed in the bank of river Brahmani, near Talcher and Rourkela, Hoogly near Calcutta, Ganga near Kanpur and Baranasi etc. The quality of river water is decreasing because of pollution; hence there is an increasing upkeep interest to clean river water.

In the present work an attempt has been made to study the seasonal variations in the water quality of surface water at the vicinity of Talcher industrial complex of Orissa because, once the surface water is polluted it is very difficult to recharge it again. The water quality is monitored by studying the changes in the parameters like pH, Dissolved Oxygen, Turbidity, Total Alkalinity, Total Dissolved Solids, Total Hardness, Calcium, Magnesium, Chloride, Biochemical Oxygen Demand, Iron, Sulphate etc.

II. Review Of Literature

Water is one of the vital needs of all living beings. Humans need water in many daily activities like drinking, washing, bathing, cooking etc. If the quality of water is not good then it becomes unfit for drinking and other activities. The quality of water usually described according to its physical, chemical and biological characteristics [3]. Hence it becomes necessary to find the suitability of water for drinking, irrigation and Industry purpose.

The desirable limit of TDS is 500 mg/l. If TDS value is more than 500 mg/l, it may cause gastro intestinal irritation. High TDS presence in the water decreases the quality and affects the taste of water as found from **Guru Prasad, 2005.Sayyed et.al [2009]** assessed the surface water from the south-eastern part of Odisha city for the seasonal variation in their quality parameters. Using Piper diagram the hydrogeochemicalfacies were identified and the surface waters were classified with regards to the changes in their major chemical compositions. **Shimaa M. Ghoraba et.al [2008]** collected many ground water samples from different districts of Mahanadi,Odisha. The groundwater recorded a wide range in TDS. Chloride is one of the most important parameter in assessing the water quality and higher concentration of chloride indicates higher degree of organic pollution **(Yogendra andPuttaiah, 2008).Khare et.al [2010]** carried out on water quality assessment of Mahanadi, Sambalpur. He was done water analysis for the parameters like pH, DO, BOD, COD, TDS, calcium, Magnesium and Hardness for lake water. **Venkatesharaju*et al.*, [2010]** signifieswater recourses have critical importance to both natural and human development. It is essential for agriculture, industry and human existence. Water is one of the most abundant compounds of the ecosystem. **Mona A. Hagras et.al [2011]** assessed the quality of groundwater and to characterize the hydrochemical characteristics of the surface water in Odisha, surface water samples were collected from different cities of Odishaanalyzed for 15 water quality parameters. **Lohani et.al [2011]** depicts drinking water quality management through various physicochemical parameters and health hazard problems with their remedial measures in Bhubaneswar city of Odisha. **Sahu[2015]** describes the effect of poor water quality on human health was noted for the first time in 1854 by John Snow, when he traced the outbreak of cholera epidemic in London to the Thames river water which was grossly polluted with raw sewage.

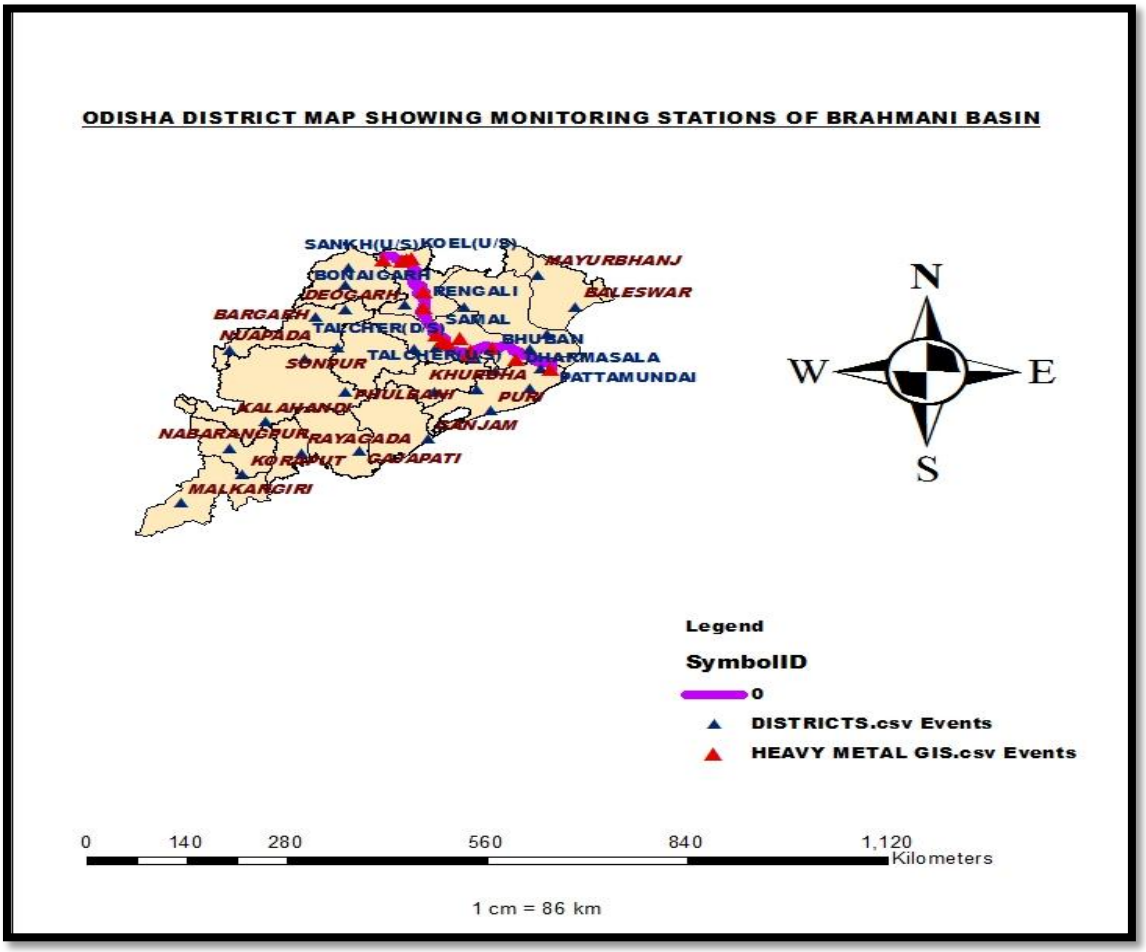
III. Study Area And Data Collection

Study Location:

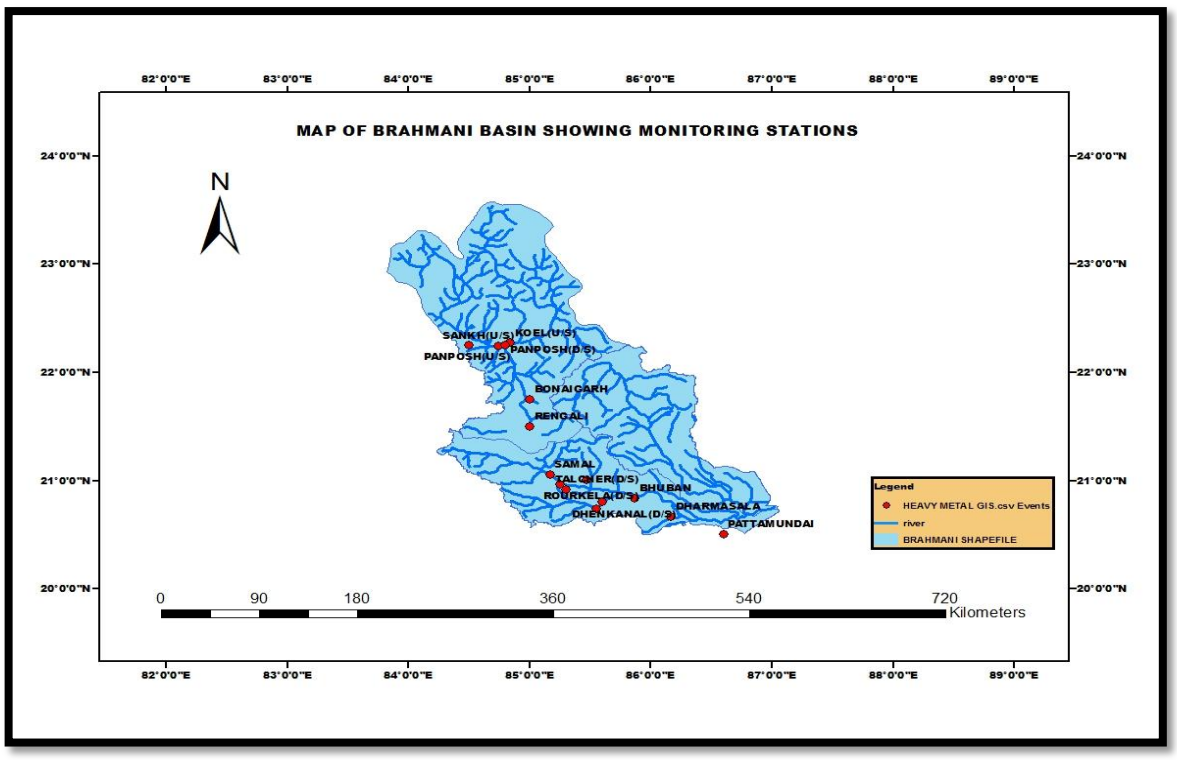
Brahmani, the second major river in Odisha, is formed by the combined waters of South Koel and Sankh rivers at Vedvyasa near Rourkela in the Sundergarh district. The left bank tributary South Koel originates near Nagri village in the Ranchi district of Jharkhand state. After its confluence with river Karo in Singhbhum district, it is known as koel [4]. From Manoharpur, it flows in the south-west direction for a distance of about 54 km uptoVedvyasa where the right bank tributary Sankh joins with it. River Sankh originates an elevation of 1000 m near village Lupungpat in Ranchi district of Jharkhand state.

The basin area of river Brahmani in Odisha constitutes 57.63% (figure 5) of the total basin area. The basin covers 9 revenue districts of the State.

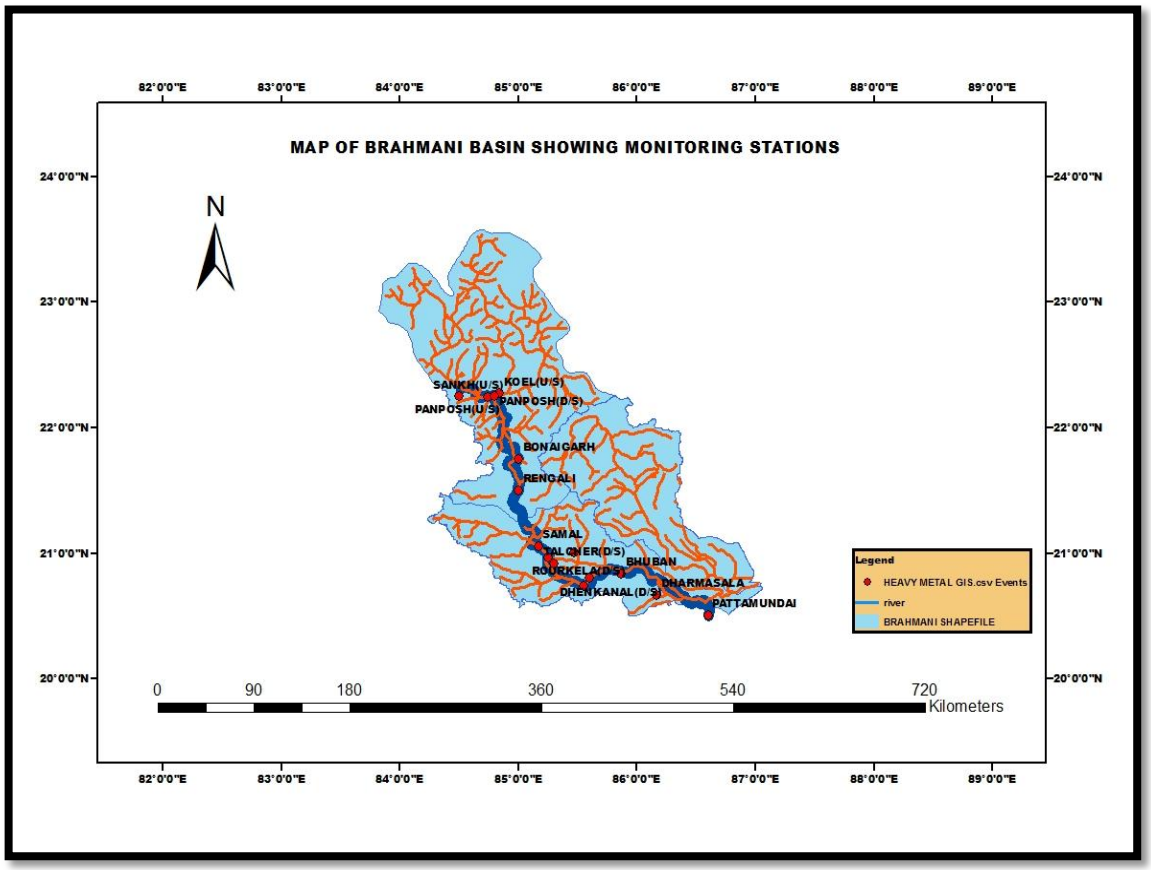
The below (figure 1, 2, 3, 4) showing monitoring stations of Brahmani basin by the application of GIS Software.



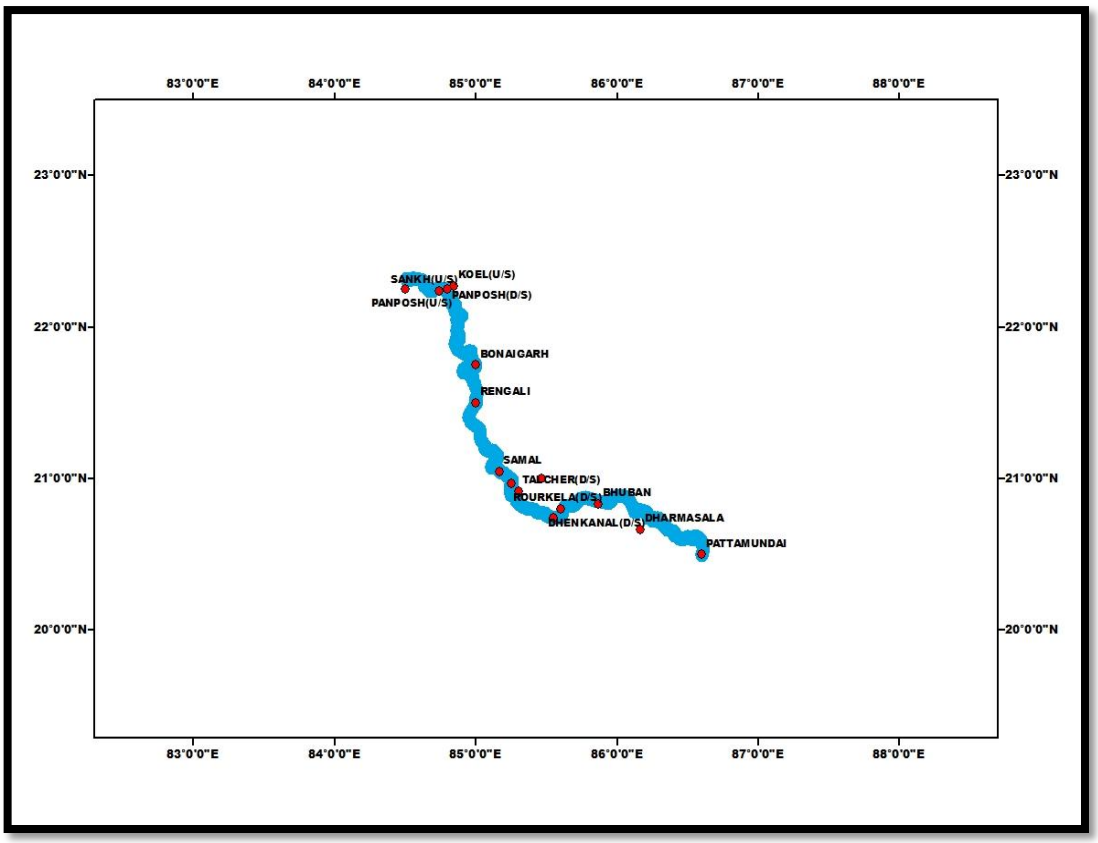
(**Figure1.**Odisha district map showing monitoring stations along with flow path of Brahmani basin)



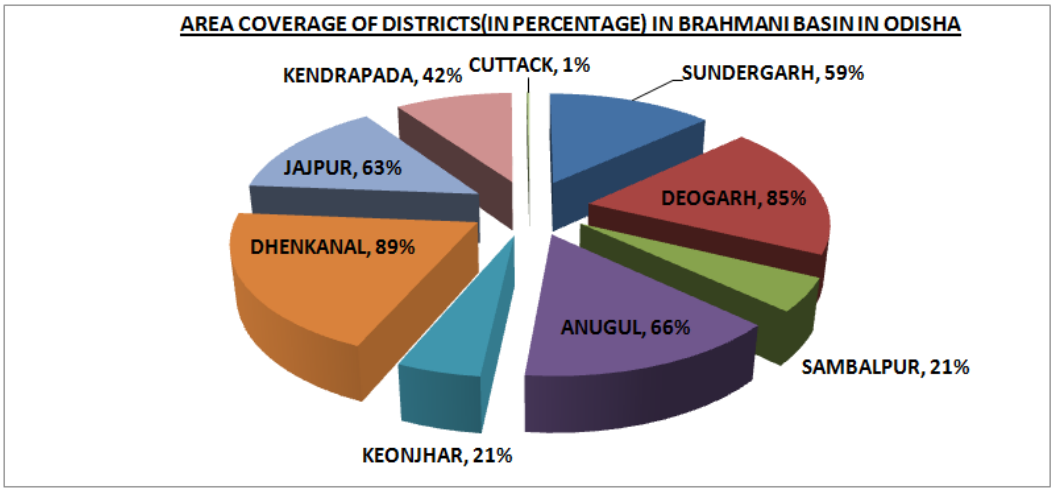
(**Figure2.** Brahmani basin showing monitoring stations)



(**Figure3.** Flow path of Brahmani basin showing monitoring stations)



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



(**Figure5.** Area coverage of districts of Brahmani basin in Odisha)

Four different stations as mentioned below are selected across the stretch of the Brahmani River. The selection of the sites was done depending upon the industrial and mining activities along the river bank (Table 1)

Table1.Showing the monitoring stations

LOCATION OF SAMPLING STATIONS	
SL NO	**NAME OF THE SAMPLE LOCATION**
1	**RIVER BRAHMANI AT SAMAL BARRAGE**
2	**TALCHER UPSTREAM OF RIVER BRAHMANI**
3	**NANDIRA DOWNSTREAM BEFORE CONFLUENCE POINT AT PUMP HOUSE**
4	**RIVER BRAHMANI AT KAMALANGA VILLAGE**

IV. Methodology

The selection of stations has been done mostly on the basis of proximity of major industries and municipal townships which are expected to make significant contributions to the pollution load. The Talcher industrial complex is situated on the bank of the river Brahmani which is about 8-10 KM away from the river bank. The present work deals with the assessment of water quality of the river Brahmani polluted by the waste effluent of Talcher industrial complex drained through the Nandirajhor in to the river. The complex grew up near by the coal mines of Talcher. It consists of Thermal power stations, coal based fertilizer plant of FCI producing urea, heavy water plant and chemical industries [5]. The effluent of the fertilizer plant is drained through the DeojharNallah which finally meets the NandiraJhor carrying effluents of other units and waste water of Talchertownship. The total waste born by the NandiraJhor finally enters into the river Brahmani. Treated and untreated municipal and industrial wastes are discharged directly into the river at various points. Water samples were collected in plastic bottles from each of these sites seasonally for two years (2015 & 2016). The samples were analyzed during summer, rainy, post rainy & winter per year mentioned as above. The samples were collected during day time from 10 AM to 5 PM at a distance of about 5 meters inside the river from the bank and at a depth of about 0.25 meters. The physical and chemical parameters were estimated according to methods described in standard methods for the examination of water and wastes water.

V. GIS Application

Geographic Information System:

GIS is a system of hardware and software used for storage, retrieval, mapping, and analysis of geographic data. A geographic information system, or GIS, is a computerized data management system used to capture, store, manage, retrieve, analyze, and display spatial information. GIS is an interdisciplinary tool, which has application in various fields such as Geography, Geology, Cartography, Engineering, Surveying, Rural & Urban planning, Agriculture, Water resources, etc.

VI. Results And Discussion

Water sample at different stretches of river Brahmani in the study area - (Physico-Chemical parameters of Brahmani River water) the turbidity of water sample of river Brahmani at Samal varies from 280 NTU to 335 NTU throughout the year 2015 & 2016. The maximum value in rainy season was obvious due to muddy water

flow. In summer and winter the values were 280 to 310 NTU which is more than the permissible limit (25 NTU) that may be due to the discharge of effluent in the study area at the upper end of Samal Barrage. In downstream of Kamalanga it was varies from 300 NTU to 350 NTU. The gradual increase in turbidity from up to downstream is the indication of pollution load due to industrial activity [6].

The pH of the river water at this place of study fluctuated within 7.6 to 8.2. The low PH 7.6 was observed in the summer season. It may be due to the discharge of effluents from the study area at the upper end of Samal Barrage. The pH at Talcher monitoring station was varies from 7.5 to 8.2 and at Kamalanga it was varies from 7.5 to 8.3. The tendency of fluctuating water pH may be due to the mixing of with washings water and industrial effluent.

The pH of the river water at this place of study fluctuated within 7.6 to 8.2. The low pH 7.6 was observed in the Rainy season and high pH 8.2 was observed in the summer season. It may be due to the discharge of effluents from the study area at the upper end of Samal Barrage. The pH at Talcher monitoring station was varies from 7.5 to 8.2 and at Kamalanga it was varies from 7.6 to 8.3. The tendency of fluctuating water pH may be due to the mixing of mine washings water and industrial effluent.

The D.O. present in water of river Brahmani at Samal Barrage was within the range of 5.9 to 6.5 mg/l which is shightly below than the standard and may be due to missing of deoxygenativing pollutant from the study area [7]. The D.O. in water sample at Talcher was varies 5.7 to 6.7 mg/l and at Kamalanga it was varies from 5.8 to 6.8 mg/l. The fluctuations in D.O. Level may be due to the mixing of effluents & pollutant in the river Brahmani

In the present study COD at Samal Barrage was varies from 13mg/l to 21 mg/l and at Kamalanga it was varies from 14mg/l to 23mg/l. It is seen that in three monitoring stations the COD level was higher in 2005 in comparison to 2005 in all season and which was also above the tolerance limit i.e. 10 mg/ l.

The BOD values in water sample at Samal Barrage was various from 2.0 to 2.6 mg/l during the monitoring period 2005 to 2006 where as it was 3.2 to 3.8 mg/l at Talcher and 8.6 to 4.3mg/l at Kamalanga respectively against the tolerance limit 3.0 mg/l. This may be due to pollution load which may be due to industrial activity [8].

In all three monitoring station over the river Brahmani at Samal, Talcher and Kamalanga the values of Sulphate (SO_4) are far below then the tolerance limit. The major sources of contamination of Phosphate (PO_4) in water are due to domestic sewage, detergent, agriculture runoff and industrial effluent. In three monitoring station of present study the phosphate value was varies from 1.9 to 3.8 mg/L. The NO_3 in all the three monitoring station over the river Brahmani at Samal, Talcher and Kamalanga the values were (0.6mg/l to 2.2 mg/l) below than the permissible limit. The Chloride (Cl) concentration at monitoring station Samal Barrage, Talcher and Kamalanga were 25mg/l respectively. Those values were below than the tolerance limit i.e. 200 mg/l [9].

It was observed that in river water at Samal Barrage availability were varies from 68mg/l to 85mg/l at Talcher it was varies from 52 mg/l to 97 mg/l. All the values in all the three monitoring stations of river Brahmani were below than the limiting standard.

The conductivity was found at Samal Barrage from 100 Mmho/cum to 214mmho/cum at Talcher it was varies from 120 Mmho/cum to 225mmho/cum. It was seen that in all the monitoring station was due to agricultural sum off, mines discharge mixing with the river water or Brahmani.

The TDS at Samal Barrage was varies from 150mg/L to 185mg/L and TSS from 100mg/L to 175mg/L and at Kanalanga TDS was varies from 210mg/L to 295mg/L and TSS was varies from 100mg/L to 160mg/L and at Talcher TDS was varies from 190mg/L. The TSS in off season was observed at higher side confirms the mixing of effluent from the industrial complex of Talcher to the river Brahmani [9].

The total hardness of water at Samal was varies from 97mg/L to 135mg/L at Talcher it was varies from 148mg/L to 188 mg/L and at Kamalanga 190mg/L to 204mg/L. Similarly the Lahardhan at Samal was varies from 48mg/L to 63mg/L at Talcher it was varies from 52mg/L to 68mg/L and at Kamalanga it was varies from 63mg/L to 80mg/L (**Table 2, 3, 4, 5**).

Table2.Physico-chemical analysis of River Brahmani at samal barrage (2015-2016)

.										
SAMPLING STATION-RIVER BRAHMANI AT SAMAL BARRAGE (PERIOD OF SAMPLING YEAR 2015-2016)										
SL NO	PARAMETERS	STD. AS PER IS 10500	SUMMER		RAINY		POST RAINY		WINTER	
			2005	2006	2005	2006	2005	2006	2005	2006
1	TURBIDITY	25	290	310	310	355	296	220	280	300
2	PH	6.5-8.5	8	8.2	7.7	7.8	7.6	7.7	7.8	7.9
3	CONDUCTIVITY	200	150	165	214	210	195	205	100	130
4	TSS	100	140	135	170	175	100	120	120	130
5	TDS	500	180	185	161	170	150	160	170	180

6	ALKALINITY	120	80	85	68	73	44	68	75	78
7	TOTAL HARDNESS	250	135	107	125	98	120	97	130	102
8	CALCIUM	75	60	63	48	53	48	48	56	59
9	MAGNESIUM	30	1	1.2	1.4	1.6	1.7	1.8	1.6	1.8
10	DO	4	6.6	6.5	6.4	5.9	6.2	6	6.5	6.2
11	BOD	3	2.5	2.6	2.3	2.4	2	2.1	2.4	2.5
12	COD	10	18	21	15	16	13	15	17	18
13	SULPHATE	200	20	19	16	18	14	16	18	15
14	PHOSPHATE	5	3.4	3.7	2.8	3.3	2.5	3.1	3.2	3.5
15	NITRATE	45	1.8	1.2	1.4	1	1.1	0.8	1.6	1.1
16	CHLORIDE	200	30	34	25	30	22	28	27	31
17	FAECAL COLIFORM	>50	930	970	720	820	680	800	810	950
18	TOTAL COLIFORM	>100	6500	5500	5800	4800	5400	4300	6100	5200

Table3. Physico-chemical analysis of upstream of River Brahmani (2015-2016)

PHYSICO CHEMICAL ANALYSIS OF SURFACE WATER SAMPLE IN STUDY AREA										
SAMPLING STATION-UPSTREAM OF RIVER BRAHMANI (PERIOD OF SAMPLING YEAR 2015-2016)										
SL NO	PARAMETERS	STD. AS PER IS 10500	SUMMER		RAINY		POST RAINY		WINTER	
			2005	2006	2005	2006	2005	2006	2005	2006
1	TURBIDITY	25	320	325	335	340	328	335	290	310
2	PH	6.5-8.5	8.2	8.1	7.8	7.9	7.5	7.6	7.9	8
3	CONDUCTIVITY	200	140	160	212	220	200	210	110	140
4	TSS	100	100	110	150	160	120	130	90	110
5	TDS	500	220	230	290	295	284	280	205	210
6	ALKALINITY	120	88	92	63	78	48	62	82	87
7	TOTAL HARDNESS	250	188	162	170	152	162	148	180	158
8	CALCIUM	75	64	68	51	57	82	87	61	62
9	MAGNESIUM	30	12	15	17	19	18	20	14	16
10	DO	4	6.5	6.7	6.3	6.2	6.2	5.7	6.4	6.5
11	BOD	3	3.7	3.8	3.5	3.6	3.4	3.2	3.6	3.7
12	COD	10	22	20	19	17	18	16	20	19
13	SULPHATE	200	22	23	18	19	14	16	20	21
14	PHOSPHATE	5	2.8	3	2.5	2.5	1.9	2.2	2.5	2.8
15	NITRATE	45	2	2.3	2	2	1.2	1.8	1.7	2.1
16	CHLORIDE	200	36	35	28	29	24	26	30	32
17	FAECAL COLIFORM	>50	1500	1800	1000	1400	800	1200	1200	1600
18	TOTAL COLIFORM	>100	8000	7000	6300	6250	6100	5800	7500	6500

Table4. Physico-chemical analysis of Nadira downstream before the confluence point at pump house (2015-2016)

PHYSICO CHEMICAL ANALYSIS OF SURFACE WATER SAMPLE IN STUDY AREA										
SAMPLING STATION-NADIRA DOWNSTREAM BEFORE THE CONFLUENCE POINT AT PUMP HOUSE (PERIOD OF SAMPLING YEAR 2015-2016)										
SL NO	PARAMETERS	STD. AS PER IS 10500	SUMMER		RAINY		POST RAINY		WINTER	
			2005	2006	2005	2006	2005	2006	2005	2006
1	TURBIDITY	25	325	330	335	352	330	342	310	320
2	PH	6.5-8.5	8.2	8.4	8.7	8.9	8	8.3	8.1	8.2
3	CONDUCTIVITY	200	171	185	192	195	180	187	162	180
4	TSS	100	190	180	184	192	172	175	170	180
5	TDS	500	210	205	117	110	109	98	128	120
6	ALKALINITY	120	60	57	48	49	28	42	54	53
7	TOTAL HARDNESS	250	120	150	170	210	165	205	145	190
8	CALCIUM	75	60	80	75	90	65	83	68	75
9	MAGNESIUM	30	15	18	17	22	16	20	14	17

10	DO	4	5.5	6.3	5.3	5.7	5.1	5.6	5.2	6.1
11	BOD	3	4.1	4.3	4.5	4.9	3.8	4.1	4.3	4.4
12	COD	10	28	26	24	21	21	19	26	23
13	SULPHATE	200	24	25	19	20	20	21	21	22
14	PHOSPHATE	5	3	3.2	2.6	2.7	2.4	2.5	2.8	2.9
15	NITRATE	45	1.3	1.5	1.7	1.9	1	1.2	1.4	1.6
16	CHLORIDE	200	32	38	27	32	25	29	30	34
17	FAECAL COLIFORM	>50	500	2400	1250	2000	1080	1800	1400	2200
18	TOTAL COLIFORM	>100	7900	7800	7200	7500	7000	7600	7800	8000

Table5. Physico-chemical analysis of River Brahmani at Kamalanga downstream (2015-2016)

PHYSICO CHEMICAL ANALYSIS OF SURFACE WATER SAMPLE IN STUDY AREA										
SAMPLING STATION-RIVER BRAHMANI AT KAMALANGA DOWNSTREAM (PERIOD OF SAMPLING YEAR 2015-2016)										
SL NO	PARAMETERS	STD. AS PER IS 10500	SUMMER		RAINY		POST RAINY		WINTER	
			2005	2006	2005	2006	2005	2006	2005	2006
1	TURBIDITY	25	310	330	320	350	316	342	300	320
2	PH	6.5-8.5	8.1	8.3	7.9	7.6	7.7	7.8	8	8.1
3	CONDUCTIVITY	200	160	170	220	225	210	215	120	160
4	TSS	100	120	130	145	135	118	125	160	155
5	TDS	500	205	200	185	190	190	195	210	205
6	ALKALINITY	120	92	97	74	82	52	73	87	91
7	TOTAL HARDNESS	250	200	204	190	194	188	190	195	197
8	CALCIUM	75	80	85	63	72	86	65	72	78
9	MAGNESIUM	30	27	28	22	24	18	23	22	21
10	DO	4	6.4	6.8	6.2	6.1	6.1	5.8	6.3	6.3
11	BOD	3	4.1	4.3	3.9	4	3.7	3.6	4	4.1
12	COD	10	20	23	16	19	14	17	18	21
13	SULPHATE	200	18	22	15	17	13	15	17	19
14	PHOSPHATE	5	3.2	3.3	2.5	2.8	2.1	2.6	2.8	3
15	NITRATE	45	2.2	1.1	1.6	0.8	1.3	0.6	1.8	1
16	CHLORIDE	200	32	37	26	33	23	30	28	35
17	FAECAL COLIFORM	>50	1300	1900	1000	1600	850	1500	1200	1700
18	TOTAL COLIFORM	>100	7000	6000	6500	5700	6100	5400	6800	5800

VII. Conclusion

It may be concluded that the pollution level at different stretches of river Brahmani shows increasing tendency as indicated by the depletion of Oxygen level, increasing values of BOD, COD. If DO deplete, water body will not support aquatic life and water will lose its natural purification capacity [11]. It has been observed that water quality is deteriorating at the confluence point where the effluents of Talcher Industrial complexmix inBrahmani River.Then gradually towards downstream the parameters decreases somehow. However again the pollution parameters increases when Nandira river carrying industrial pollution mixes in Brahmani and again gradually the water quality becomes little better when it reachesKamalanga and expected much better before it reaches Dhenkanal town [12].The present work provides a tool for seasonal and yearly variations of physico-chemical parameters of water resources of Talcher industrial complex which may be helpful in taking preventive measures.

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Chanchal Kumar Mukherjee . "Water Quality Assessment Of Brahmani River At Talcher City, Odisha (A Case Study)." IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) , vol. 15, no. 5, 2018, pp. 25-33