Determination of Water Quality Index for Brahmani River in terms of Physico-Chemical Parameters for suitability of drinking purpose

Himanshu Sekhar Rath , Mira Das, U.N .Dash

Abstract*: In this paper, the water quality standard of Brahmani River, the second largest river of Odisha, is determined using the Water Quality Index. Water samples were collected monthly from nine sampling stations during June -2013 to May-2014, and various parameters were taken into consideration such as pH, EC , biological oxygen demand, total dissolved solids, the concentration of hydrogen ions, dissolved oxygen, turbidity, phosphates, nitrates, chlorides, total hardness, electrical conductivity and alkalinity. The water quality index considered as a metric are good for drinking at the stations one, three, five, six, and nine and poor at station four. The study highlights the significance of make use of the water quality standards at every station to preserve the river quality.

***Index Terms*: Water Quality Index, Total Hardness, Dissolved Oxygen, Biochemical Oxygen Demand, Total Dissolved Solids**

I. INTRODUCTION

Human life and living things in nature cannot survive without water. Water is one of the important element of life. So conservation of water as well as pollution free is one of the major aspect of research. Water can be treated in form of quantity and quality. Poor water quality indirectly creates water borne diseases like cholera and jaundice. The Brahmani represent a major seasonal stream in the Odisha state. The meeting of two rivers Sankh and South Koel generate into Brahmani river and flows through the districts of Sundargarh, Deogarh, Angul, Dhenkanal, Cuttack, Jajapur, and Kendrapara. Brahmani along with the rivers Mahanadi and Baitarani. An outsized delta is created before flowing into the Bay of Bengal Sea. As a result , a large population of Odisha depends upon the Brahmani river for drinking as well as irrigation purpose. The basin is thick in natural resources ore,coal and rock.The present study aims at detecting the quality of water across the Brahmani River in respect of physico-chemical and bacteriological parameters.

The study is meted out in Brahmani watercourse that is that the second largest watercourse of Odisha is additionally one amongst the foremost necessary terra firma watercourse systems in India. The point at which two rivers Koel and Sankh meet at Vedvyasa close to Rourkela within the district of Sundergarh provides rise to the watercourse Brahmani. It travels southward through the districts of Sundergarh, Deogarh, Angul, Dhenkanal, Jajpur, and Kendrapara and eventually flows in to Bay of Bengal. It makes the lifeline of the inhabitants of those districts. Major industries like Rourkela manufacturing plant (RSP) at Rourkela, National aluminum Company (NALCO) at Anugul and therefore the approaching industries like Bhusan manufacturing plant and therefore the Kalinga Nagar Industrial advanced within the district of Jajpur ar beat the bank of Brahmani watercourse, that is taken into account collectively of the India's necessary industrial areas better-known for ore mining, production, power generation, cement production and alternative connected activities. Therefore Brahmani watercourse is joined by many drains caring industrial effluents, town wastes and mining residues. As water is one the foremost basic wants of the habitants, its characteristic should be studied before use. This study aims at finding out the presence of trace and unhealthful significant metals. Significant metals and bimetal parts are present in the river water that are extremely unhealthy and might cause damage to humans even at low concentrations.

II. MATERIALS AND METHODS

Water samples were collected monthly, from June -2013 to May-2014 from nine completely different stations as mentioned Figure.1, in clean and dry polyethylene bottles. The water samples were collected and preserved for testing of varied parameters at 10 degree Celsius throughout the amount of qualitative analysis. The water samples were analyzed in the Chemical Laboratory, using the standard methods [1]. The hydrogen ion concentration and Dissolved gas of water samples were measured now once sampling at the sector itself. Samples were subjected to filtration before qualitative analysis. The determination of TDS was done by hydrometric method whereas the whole hardness was dole out by EDTA complexometric volumetric analysis methodology [1].The Winkler's alkali iodide azide methodology was followed for the estimation of DO and physique. Nitrate was resolute quantitative analysis procedure [1-2] fecal coliform population was analyzed by MPN /100 mil methodology by growing on M-FC medium at temperature forty four degree Celsius and counted once forty eight hours.

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Table 1: Different laboratory methods used to determine the water quality parameters.

Sl.No	Water Quality Parameter	Unit	Method used	Place
1	BOD in sample	mg/l	Winkler's Alkali Iodide-azide Method	Laboratory
2	TDS amount in sample	mg/l	Thermostatic oven	Laboratory
3	pH of water sample	pH units	WTW portable multi-meter-340i	in situ
4	DO of water sample	mg/l	Winkler's Alkali Iodide-azide Method	in situ
5	Amount of Faecal Coliform present in water sample	MPN/100ml	M-FC Medium at Temperature 44.5o C	In Laboratory
6	Amount of NO3-	mg/l	Colorimeteric process	In Laboratory
7	Cl-	mg/l	Silver Nitrate Titration Method	In Laboratory
8	SO42-	mg/l		
9	Conductivity	mho /cm	WTW portable multi-meter 340i	in situ
10	Ca2+	mg/l	Titration with EDTA-2Na and EBT as an indicator.	In Laboratory
11	Mg2+	mg/l	Titration with EDTA-2Na and EBT as an indicator.	In Laboratory
12	Na+	mg/l		In Laboratory
13	K+	mg/l		In Laboratory

III. SAMPLING AND SELECTION PARAMETERS

Samples of river water were taken in polythene bags at different stations across the river in each month from June -2013 to May-2014. Water for drinking purpose is determined with the help of water quality index. Rapid urbanization of the cities along the river side has tremendous effect on the water resources and thereby disturbing the ecosystem. Faecal contamination has become a major risk to human health those leaving across the river side. In some countries there hazards occur associated with specific chemical contaminants such as arsenic produced from left over industrial wastes considerably with time. The potential for fecal contamination in untreated or inadequately treated. The minimum level of analysis ought to be done to test for indicators of faecal pollution. Various parameters are taken into consideration during the process.

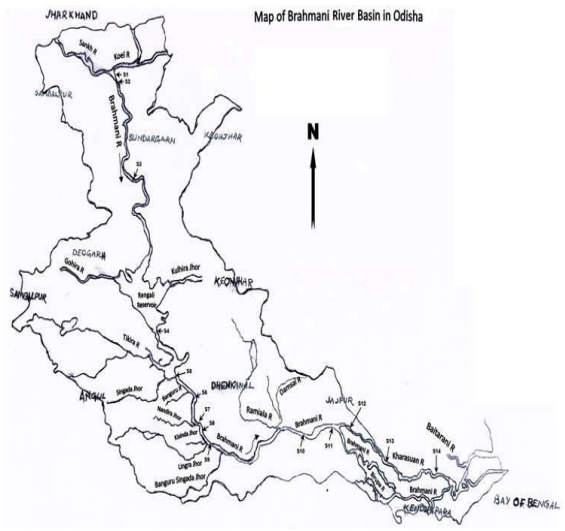

Figure 1: Different Stations of Brahmani River Basin in Odisha.

A. Water Quality Index

Water of hand dug wells of Nigeria are found to be contaminated by coliforms and nitrate when assessed using water quality index [9]. Water quality index (WQI) provides data concerning water quality in a single worth. WQI determines the adverse effect of different parameters in water

pollution amount on the overall quality of water [4-5]. Water quality index can be measured in terms of physico chemical and biological indices [5]. The physico-chemical indices area unit supported the values of numerous physico-chemical parameters in a water sample, whereas biological indices area unit derived from the biological data. Here try has been made to calculate the water quality index of the study space based mostly on physico-chemical parameters such as BOD, TDS, pH, DO and alkalinity. Twenty two parameters are taken into consideration of water quality index to assess the quality of ground water and a measure of correlation factor determines the significance of relationship between the parameters[3].The water quality of Chilika lagoon was monitored during pre-monsoons and post-monsoon periods which shows the concentration of TDS and salt in permissible limit increases during pre-monsoon time[10].In this paper[11],different parameters such as pH, TDS, EC, BOD and DO are monitored to determine the water quality index of thirty-four water bodies along the Faridpur-Barishal road in Bangladesh.

$$Qj = \frac{(M_j - L_j)}{(S_j - L_j)} \qquad (1)$$

$$W_j = \frac{K}{S_j} \qquad (2)$$

$$T = W_j Q_j \qquad (3)$$

$$WQI = \sum_{j=1}^{n} \frac{T}{\sum_{j=1}^{n} W_j} \qquad (4)$$

where, is the rating of the jth parameter, is the unit weight of the jth parameter, n is the number of parameters concerned with quality of drinking water, is the value of the parameter in each sample monitored during laboratory process, is the ideal-value and is the standard-value of the jth parameter. The weightage unit of each parameter was calculated a value inversely proportional to the standard of the World Health Organization (Si) World Health Organization, 2011[12][7]. Table 2 shows the calculated range of WQI value of water suitable for different purposes as stated by Shweta et al. [5].

Table 2: Water Quality Index for drinking purpose.

Range values of WQI	Quality of Water
WQI less than equals to 25	Excellent for drinking
WQI between 26 and 50	Good for drinking
WQI between 51 and 75	Poor for drinking
WQI between 76 and 100	Very Poor quality for drinking
WQI greater than 100	Unsuitable for drinking purpose

Table 3:1st Station-Tilga

Parameters	Range	Mean
BOD	0.2-2.0	0.9
TDS	142-303	197.8
pH	7.3-7.9	7.6
DO	6.4-8.7	7.5
NO_3^-	0.7-0.84	0.73
Cl^-	9.4-21.4	14.9
SO_4^{2-}	1.3-37.1	9.4
Conductivity	84-126	104
Ca^{2+}	6-13	10
Na^+	1.4-16.3	5.8

B. Results and Discussions

BOD is the amount of oxygen needed by the microorganisms to decompose into organic compounds throughout 5 days within the laboratory as defined in [6].Usually ,BOD is around 1mg/l for clear water and above 5mg/L it is treated to be polluted[8].

TDS is defined as the amount of the organic matter present in water. TDS is directly proportional to the amount of conductivity and also has an impact on pH of water. TDS affects the taste of water. Water tastes excellent for TDS less than 300mg/L, good for TDS value between 300 and 600 mg/L, fair between 600 and 900 mg/L and unacceptable for TDS value greater than 1200mg/L. Water with TDS value less than 300mg/L is treated to be tasteless.

pH is a measure of how much water is acidic or basic in nature. The value goes from 0-14, with seven being neutral. pH scale of less than seven indicate acidity, whereas a pH scale of larger than seven indicates a base. DO is the amount of oxygen dissolved in water. Aquatic life is directly depended on the amount of dissolved oxygen. DO is necessary for decay of bacteria and organic matter within water. The below table 3-11 shows the different parameters to be taken into consideration of water quality index.

Table 4: 2nd Station -Jareikela

Parameters	Range	Mean
BOD	0.2-1.6	0.5
TDS	250-594	392
pH	7.2-8.0	7.6
DO	6.0-8.5	7.0
NO_3^-	0.78-9.53	2.64
Cl^-	11.3-30.2	19.9
SO_4^{2-}	1.2-36.2	8.3
Conductivity	157-330	222
Ca^{2+}	11-27	19
Na^+	2.4-15.3	8.0

Table 5: 3rd Station-Pamposh

Parameters	Range	Mean
BOD	0.2-1.4	0.6
TDS	121-392	210.9
pH	7.0-8.4	7.5
DO	5.0-7.5	6.9
NO_3^-	0.7-0.71	0.71
Cl^-	11.3-22.6	16.2
SO_4^{2-}	1.0-49.0	17.1
Conductivity	132-250	191
Ca^{2+}	6-30	19
Na^+	1.4-9.3	6.0

Table 6: 4th Station-Roukela Steel Plant

Parameters	Range	Mean
BOD	0.6-19.8	3.3
TDS	100-410	160.5
pH	6.5-8.2	7.5
DO	2.2-10.7	5.6
NO_3^-	0.76-1.22	1.07
Cl^-	22.6-50.9	33.7
SO_4^{2-}	24.6-59.2	44.2
Conductivity	260-610	375
Ca^{2+}	14-42	30
Na^+	2.8-23.0	13.5

Table 7: 5th Station-Gomlai

Parameters	Range	Mean
BOD	0.2-1.0	0.6
TDS	116-350	177.7
pH	6.8-8.0	7.6
DO	5.2-7.9	6.9
NO_3^-	0.21-0.71	0.66
Cl^-	11.3-34.0	17.6
SO_4^{2-}	4.1-53.0	19.8
Conductivity	102-280	196
Ca^{2+}	10-24	18
Na^+	3.0-12.1	7.5

Table 8: 6th Station-Talcher

Parameters	Range	Mean
BOD	0.2-2.0	0.8
TDS	106-342	167
pH	7.1-8.0	7.6
DO	6.0-8.5	7.5
NO_3^-	0.7-0.71	0.71
Cl^-	9.4-34.0	16.2
SO_4^{2-}	2.8-198.7	27.1
Conductivity	105-171	137
Ca^{2+}	10-53	20
Na^+	3.6-5.9	4.8

Table 9: 7th Station-Nandira

Parameters	Range	Mean
BOD	0.2-2.0	0.8
TDS	132-348	260.3
pH	7.3-7.8	7.5
DO	1.8-7.9	6.5
NO_3^-	0.8-1.22	0.88
Cl^-	11.3-41.2	25.4
SO_4^{2-}	15.0-78.4	43.1
Conductivity	132-490	310
Ca^{2+}	13-38	26
Na^+	5.1-24.3	14.5

at different stations are calculated to determine the quality of water for drinking purpose.

Table 10: 8th Station-Kamalanga

Parameters	Range	Mean
BOD	0.8-1.8	0.8
TDS	124-385	267.9
pH	7.2-7.9	7.6
DO	4.6-8.5	7.1
NO_3^-	0.73-9.63	1.56
Cl^-	11.3-34.0	22.2
SO_4^{2-}	13.8-204.8	53.2
Conductivity	125-470	281
Ca^{2+}	11-50	26
Na^+	4.1-25.2	12.5

Table 11: 9th Station-Jenapur

Parameters	Range	Mean
BOD	0.2-1.4	0.6
TDS	129-348	253.2
pH	7.0-7.9	7.6
DO	6.2-7.9	7.1
NO_3^-	0.7-0.71	0.71
Cl^-	9.4-18.9	13.2
SO_4^{2-}	3.2-56.8	14.9
Conductivity	120-190	142
Ca^{2+}	14-34	18
Na^+	3.9-10.8	5.6

Table 12 reflect the different standard, ideal ,monitored value of parameters at nine stations across the city .The WQI value

Table 12: Water Quality Index (WQI) of Brahmani River at nine stations

Parameter	Station	Standard Value()	Ideal value	Monitored Value	Sub-Index	Weightage Unit	WQI
BOD	1	5	0	0.9	18	0.2	3.6
	2	5	0	0.5	10	0.2	2
	3	5	0	0.6	12	0.2	2.4
	4	5	0	3.3	66	0.2	13.2
	5	5	0	0.6	12	0.2	2.4
	6	5	0	0.8	16	0.2	3.2
	7	5	0	0.8	16	0.2	3.2
	8	5	0	0.8	16	0.2	3.2
	9	5	0	0.6	12	0.2	2.4
TDS	1	1000	0	197.8	19.78	0.001	0.01978
	2	1000	0	392	39.2	0.001	0.0392
	3	1000	0	210.9	21.09	0.001	0.02109
	4	1000	0	160.5	16.05	0.001	0.01605
	5	1000	0	177.7	17.77	0.001	0.01777
	6	1000	0	167	16.7	0.001	0.0167
	7	1000	0	260.3	26.03	0.001	0.02603
	8	1000	0	267.9	26.79	0.001	0.02679
	9	1000	0	253.2	25.32	0.001	0.02532

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pH	1	7.5	7	7.6	120	0.133	15.96
	2	7.5	7	7.6	120	0.133	15.96
	3	7.5	7	7.5	100	0.133	13.3
	4	7.5	7	7.5	100	0.133	13.3
	5	7.5	7	7.6	120	0.133	15.96
	6	7.5	7	7.6	120	0.133	15.96
	7	7.5	7	7.5	120	0.133	15.96
	8	7.5	7	7.6	120	0.133	15.96
	9	7.5	7	7.6	120	0.133	15.96
DO	1	5	14.6	7.5	73.9583	0.2	14.7917
	2	5	14.6	7	79.1667	0.2	15.8333
	3	5	14.6	6.9	80.2083	0.2	16.0417
	4	5	14.6	5.6	93.75	0.2	18.75
	5	5	14.6	6.9	80.2083	0.2	16.0417
	6	5	14.6	7.5	73.9583	0.2	14.7917
	7	5	14.6	6.5	84.375	0.2	16.875
	8	5	14.6	7.1	78.125	0.2	15.625
	9	5	14.6	7.1	78.125	0.2	15.625
NO^{3-}	1	50	0	0.73	1.46	0.02	0.0292
	2	50	0	2.64	5.28	0.02	0.1056
	3	50	0	0.71	1.42	0.02	0.0284
	4	50	0	1.07	2.14	0.02	0.0428
	5	50	0	0.66	1.32	0.02	0.0264
	6	50	0	0.71	1.42	0.02	0.0284
	7	50	0	0.88	1.76	0.02	0.0352
	8	50	0	1.56	3.12	0.02	0.0624
	9	50	0	0.71	1.42	0.02	0.0284
Cl^{-}	1	350	0	14.9	4.25714	0.003	0.01277
	2	350	0	19.9	5.68571	0.003	0.01706
	3	350	0	16.2	4.62857	0.003	0.01389
	4	350	0	33.7	9.62857	0.003	0.02889
	5	350	0	17.6	5.02857	0.003	0.01509
	6	350	0	16.2	4.62857	0.003	0.01389
	7	350	0	25.4	7.25714	0.003	0.02177
	8	350	0	22.2	6.34286	0.003	0.01903
	9	350	0	13.2	3.77143	0.003	0.01131

SO_4^{2-}	1	250	0	9.4	3.76	0.002	0.00752
	2	250	0	8.3	3.32	0.002	0.00664
	3	250	0	17.1	6.84	0.002	0.01368
	4	250	0	44.2	17.68	0.002	0.03536
	5	250	0	19.8	7.92	0.002	0.01584
	6	250	0	27.1	10.84	0.002	0.02168
	7	250	0	43.1	17.24	0.002	0.03448
	8	250	0	53.2	21.28	0.002	0.04256
	9	250	0	14.9	5.96	0.002	0.01192
Conductivity	1	250	0	104	41.6	0.004	0.1664
	2	250	0	222	88.8	0.004	0.3552
	3	250	0	191	76.4	0.004	0.3056
	4	250	0	375	150	0.004	0.6
	5	250	0	196	78.4	0.004	0.3136
	6	250	0	137	54.8	0.004	0.2192
	7	250	0	310	124	0.004	0.496
	8	250	0	281	112.4	0.004	0.4496
	9	250	0	142	56.8	0.004	0.2272
Ca^{2+}	1	200	0	10	5	0.005	0.025
	2	200	0	19	9.5	0.005	0.0475
	3	200	0	19	9.5	0.005	0.0475
	4	200	0	30	15	0.005	0.075
	5	200	0	18	9	0.005	0.045
	6	200	0	20	10	0.005	0.05
	7	200	0	26	13	0.005	0.065
	8	200	0	26	13	0.005	0.065
	9	200	0	18	9	0.005	0.045
Na^+	1	200	1	5.8	2.41206	0.004	0.00965
	2	200	1	8	3.51759	0.004	0.01407
	3	200	1	6	2.51256	0.004	0.01005
	4	200	1	13.5	6.28141	0.004	0.02513
	5	200	1	7.5	3.26633	0.004	0.01307
	6	200	1	4.8	1.90955	0.004	0.00764
	7	200	1	14.5	6.78392	0.004	0.02714
	8	200	1	12.5	5.77889	0.004	0.02312
	9	200	1	5.6	2.31156	0.004	0.00925

Table 13 depicts the water quality index of the Brahmani River. Different parameters mentioned above are taken into account to determine the quality of water. Most of the sampling sites are good for drinking purpose.

Table 13: Water Quality Index value of different sampling sites

Stations	WQI values	WQI category
1	34.90468	Good
2	46.44183	**Good(on border line)**
3	35.75377	Good
4	57.33764	**Poor**
5	38.01099	Good
6	35.53731	Good

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7	47.33599	**Good (on border line)**
8	45.82396	**Good (on border line)**
9	35.76561	Good

IV. CONCLUSION

Quality of water depends upon organic and inorganic parameters .The result shows that in all the eight stations the quality of water is good for drinking purpose while precaution has to take at station four as it shows poor water quality index. It indirectly determines the concentration of the different parameters such as TDS, DO, BOD, and pH value in the different stations. The value of Chloride indicates the hardness of water. There is a need of treatment before consumption of water for drinking as in some stations the water quality index is very near to the border line of being contaminated by organic as well as inorganic matter.

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