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Physico-Chemical Parameters of River Water of Baitarani Basin in Odisha – An Assessment

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Abstract : The proposed research aims to assess the physicochemical properties and water quality of the Baitarani River in Odisha. Between January 2019 and December 2019, eight samples were collected from eight sampling stations around the Baitarani basin on each month's first working day. Various physicochemical parameters were analyzed, including TDS, pH, EC, BOD, Sodium, calcium, potassium, magnesium, DO, Total Hardness, Total Alkalinity, and others. The analysis revealed that the allowed levels established by WHO and the Indian Council of Medical Research (ICMR) were present in the majority of the parameters examined.

Key Terms: Physico-chemical parameters, TDS, EC, BOD, DO, Total Alkalinity, Total Hardness

INTRODUCTION

Baitarani is an important east-flowing river in peninsular India, draining into the Bay of Bengal. In the state of Odisha lies the major portion of its catchment, whereas a small stretch in the upper reach lies in the state of Jharkhand. The river originates from the hill ranges (Gonasika Guptaganga Hills) of Keonjhar district of Odisha near Mankaranacho village at an elevation of about 900 m. The catchment area of the basin comes to 10,982 sq. km in total. This basin is approximately located between east longitudes of 85°10' to 87°03' and north latitudes of 20°35' to 22°15'. River Brahmani, river Subarnarekha and river Budhabalang with the Bay of Bengal surround the Baitarani basin on the southwest, north, and east respectively.

Water being the basic need of inhabitants, its quality and safety must be studied before use, as the increasing population puts tremendous pressure on the limited water resources.[1] The present study aims to evaluate the river water quality concerning bacteriological and physico-chemical parameters. Quite a large number of parameters are necessary to detect the water quality comprehensively. In rural areas of a developing country, bacteriological or biological contamination causes major water quality problems, whereas rapid urbanization and industrialization may also cause serious problems on account of significant chemical and physical contamination of water bodies. Groundwater contamination is significantly more likely to occur than surface water pollution, yet once polluted, rehabilitation is extremely complex and time-consuming.[2]

The studies and science of water quality had progressed since the year 1854, when John Snow noted for the first time how poor water quality affected human health, when the outbreak of the cholera epidemic in London was traced by him to the river Thames which became grossly polluted with raw sewage. [3] Poor drinking water and sanitary conditions account for 80% of all diseases in developing countries.

The most essential aspect of river water quality from a health perspective is its physicochemical properties. Thus, it is quite necessary to constantly monitor the quality of river water to record any variation in quality over time so that outbreaks of diseases or health disorders can be prevented. This study records and analyzes the quality of river water at eight different sampling stations along the Baitarani basin, as below.

Table 1: Different sampling station for Physico-Chemical Studies

Sample Code	Name of the station	River / Tributary	State	District	Latitude	Longitude
S_1	Champua	Baitarani	Odisha	Keonjhar	22°03'57"	85°40' 24"
S_2	Rimuli	Aradei	Odisha	Keonjhar	20.85951	86.40231
S_3	Keonjhar	Aradei	Odisha	Keonjhar	21.62893	85.58169
S_4	Swampatna	Baitarani	Odisha	Keonjhar	21.6319	85.89080
S_5	Anandpur	Mushal	Odisha	Keonjhar	21°31'34.19"	85°36'29.39"
S_6	Belabahali	Kushei	Odisha	Keonjhar	21.35011	86.05472
S_7	Anandpur	Baitarani	Odisha	Keonjhar	21°12'40"	86°07'14"
S_8	Akhuapada	Baitarani	Odisha	Bhadrak	20°55'0.7284"	86°23'45.1536"

MATERIAL AND METHOD:

During the study/analysis period from January 2019 to December 2019, water samples were taken on the first working day of each month at eight separate stations, as shown below, using dry and clean polythene bottles. The obtained samples were stored at 10°C to test and analyze various physicochemical properties. Based on the sampling stations, the water samples collected were grouped under eight categories, as shown below:

Table 2: Grouping of water samples collected

Sample Code	Details
S_1	Baitarani at Champua
S_2	Aradei at Rimuli
S_3	Aradei at Keonjhar
S_4	Baitarani at Swampatna
S_5	Mushal at Anandpur
S_6	Kushei at Belabahali
S_7	Baitarani at Anandpur
S_8	Baitarani at Akhuapada

The laboratory water samples were analyzed using standard procedures. [4] The parameters studied include pH, total dissolved solids (TDS), total alkalinity, sodium (Na), potassium (K), dissolved oxygen (DO), biochemical oxygen demand (BOD), turbidity, electrical conductivity, total hardness, and bacteriological parameters. Immediately after collecting the water samples, the dissolved oxygen and pH levels were tested. Table 12 displays the average, minimum, and maximum values of several physicochemical characteristics.

DISCUSSION ON RESULTS:

Temperature, as one key element, affects the physicochemical properties and biological reactions in water. With increasing temperatures, the chemical reaction accelerates while the solubility of dissolved oxygen and other gases decreases. During this study, the temperature of Baitarani water was observed to vary from 21°C to 34°C.

pH LEVEL:

Most naturally occurring (raw) water sources have pH values ranging from 6.5 to 8.5[2]. Generally, water with a pH value lower than 6.5 could be acidic, corrosive and pH greater than 8.5 could be hard water. Irrigation water having a pH value lying outside this range may indicate presence of toxic ions and cause nutritional imbalance. Also, irrigation equipments can be greatly affected by an abnormal pH in water. The same goes for safety when it comes to drinking water. The United States Environmental Protection Agency (EPA) recommends that water be delivered in a pH range of 6.5 to 8.5.

It was discovered that all 96 water samples examined had pH levels within this range. The average pH of the samples ranged from 7.36 to 7.74. The surface water of Kushei (a tributary of Baitarani) near Belabahali was found to be higher in pH than the water from the other test locations (Table 3).

Table 3: Concentration of pH in water samples

Months	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8
Jan,2019	7.57	7.23	7.65	7.21	7.23	7.96	7.32	7.22
Feb,2019	7.03	7.43	7.50	7.36	7.64	7.94	7.39	7.50
Mar,2019	7.25	7.88	7.66	7.57	8.08	8.10	7.80	7.80
Apr,2019	7.20	6.61	7.55	7.47	7.21	7.30	7.27	7.24
May,2019	7.57	7.23	7.11	7.10	7.23	7.96	7.32	7.18
Jun,2019	7.90	7.51	7.51	7.47	7.45	7.75	7.08	7.16
Jul,2019	7.55	7.48	7.38	7.38	7.28	7.63	7.23	8.32
Aug,2019	7.16	7.58	7.28	7.50	7.13	7.29	7.25	7.45
Sep,2019	7.07	7.60	7.60	7.50	7.45	7.47	7.44	7.61
Oct,2019	7.29	7.43	7.90	7.27	7.33	7.51	7.34	7.34
Nov,2019	7.28	7.40	7.56	7.22	7.28	7.93	7.31	6.18
Dec,2019	7.41	7.96	7.50	7.60	7.74	8.08	7.52	7.61
Mean	**7.36**	**7.45**	**7.52**	**7.39**	**7.42**	**7.74**	**7.36**	**7.38**

S_1 =Baitarani at Champua, S_2 = Aradei at Rimuli, S_3 = Aradei at Keonjhar, S_4 = Baitarani at Swampatna, S_5 = Mushal at Anandpur, S_6 = Kushei at Belabahali, S_7 = Baitarani at Anandpur, S_8 = Baitarani at Akhuapada

ELECTRICAL CONDUCTIVITY:

Electrical conductivity is a measurement of water's capacity to conduct electric current. The EC is a fundamental metric for assessing water quality. It is an important metric for estimating the concentration of dissolved salts in water. Salt concentration in irrigation water is also measured in terms of EC. It is directly correlated to agricultural productivity, yield and sustainability. Poor conductivity of electricity is a characteristic of pure water. Presence of acids, bases and salts increases electrical conductivity of water. Acid rain caused by air pollution is one of the causes of increase in the electrical conductivity of surface water. Since electrical current is conducted by the ions in a solution, the conductivity of water increases as the concentration of anions and cations increases; this will indicate more dissolved electrolytes. Water having an EC value not more than 400 µmho/cm is suitable for drinking purposes, according to WHO standards. Water having electrical conductivity ranging from 0.7 – 3.0 dS/m (i.e. 700 – 3000 µmho/cm) is considered to be suitable for irrigation as per FAO standards. The EC values of the water samples were found to be quite good, ranging from78 µmho/cm to 920 µmho/cm, which are within the permissible higher limit as shown in Table-4.

Table 4: Electrical conductivity in water samples, in micromho/cm

Months	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8
Jan,2019	224.00	202.00	204.00	186.00	343.00	115.00	202.00	254.00
Feb,2019	358.00	352.00	243.00	423.00	193.00	186.00	211.00	137.00
Mar,2019	153.00	246.00	833.00	185.00	226.00	277.00	184.00	920.00
Apr,2019	621.00	511.00	303.00	338.00	381.00	231.00	466.00	238.00
May,2019	224.00	202.00	119.00	102.00	343.00	115.00	202.00	108.00
Jun,2019	132.00	198.00	309.00	160.00	192.00	259.00	102.00	159.00
Jul,2019	175.00	184.00	122.00	196.00	311.00	188.00	308.00	473.00
Aug,2019	135.00	191.00	118.00	123.00	165.00	193.00	168.00	178.00
Sep,2019	89.00	163.00	78.00	108.00	116.00	176.00	114.00	180.00
Oct,2019	163.00	118.00	182.00	117.00	198.00	257.00	364.00	110.00
Nov,2019	163.00	118.00	275.00	117.00	198.00	257.00	364.00	110.00
Dec,2019	109.00	712.00	179.00	134.00	175.00	313.00	143.00	166.00
Mean	**212.17**	**266.42**	**247.08**	**182.42**	**236.75**	**213.92**	**235.67**	**252.75**

S_1 =Baitarani at Champua, S_2 = Aradei at Rimuli, S_3 = Aradei at Keonjhar, S_4 = Baitarani at Swampatna, S_5 = Mushal at Anandpur, S_6 = Kushei at Belabahali, S_7 = Baitarani at Anandpur, S_8 = Baitarani at Akhuapada

Table 5: Concentration of Total hardness in water samples, in mg/L

Months	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8
Jan,2019	96.45	123.51	88.12	59.47	102.50	78.28	103.20	69.14
Feb,2019	85.68	97.32	66.24	84.52	77.52	58.68	32.64	48.36
Mar,2019	87.55	103.51	95.14	85.63	65.32	99.14	85.14	77.12
Apr,2019	121.50	36.10	76.10	93.41	94.55	69.17	78.32	85.11
May,2019	78.41	85.34	47.36	88.01	91.30	44.21	106.50	95.20
Jun,2019	96.11	55.20	88.14	36.20	78.10	84.32	113.25	100.20
Jul,2019	69.23	81.74	91.46	32.64	56.21	74.02	112.36	56.20
Aug,2019	84.32	70.61	58.58	62.76	78.46	94.15	97.92	105.32
Sep,2019	118.32	110.16	45.03	88.10	64.22	69.36	65.10	45.20
Oct,2019	99.30	55.10	95.34	125.36	98.12	65.41	111.30	78.47
Nov,2019	68.36	78.20	91.46	103.00	55.20	49.10	98.30	88.64
Dec,2019	68.30	79.30	84.33	105.22	56.33	84.10	69.20	44.01
Mean	**89.46**	**81.34**	**77.28**	**80.36**	**76.49**	**72.50**	**89.44**	**74.41**

S_1 =Baitarani at Champua, S_2 = Aradei at Rimuli, S_3 = Aradei at Keonjhar, S_4 = Baitarani at Swampatna, S_5 = Mushal at Anandpur, S_6 = Kushei at Belabahali, S_7 = Baitarani at Anandpur, S_8 = Baitarani at Akhuapada

Table 6: Concentration of Total alkalinity in water samples, in mg/L.

Months	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8
Jan,2019	64.37	92.56	160.20	165.74	42.53	140.80	72.41	84.48
Feb,2019	62.77	102.30	57.41	68.12	66.96	78.49	50.99	90.53
Mar,2019	63.11	104.50	77.24	88.41	85.23	151.32	61.35	93.14
Apr,2019	74.61	49.12	35.14	98.14	113.77	78.46	98.07	52.11
May,2019	99.32	82.41	98.90	103.51	95.12	79.24	78.41	55.01
Jun,2019	98.11	63.30	45.21	102.20	89.10	77.12	63.51	95.33
Jul,2019	48.24	56.03	78.24	85.01	56.20	111.30	96.12	94.12
Aug,2019	58.10	79.10	54.03	77.21	99.62	84.23	114.25	84.03
Sep,2019	70.79	99.94	64.01	87.55	54.32	179.35	45.80	85.11
Oct,2019	65.20	98.41	56.02	77.10	65.22	84.11	97.92	29.30
Nov,2019	84.30	79.12	65.30	94.02	94.32	55.01	96.12	91.10
Dec,2019	58.11	67.44	109.30	73.60	56.17	94.23	72.14	93.88
Mean	**70.59**	**81.19**	**75.08**	**93.38**	**76.55**	**101.14**	**78.92**	**79.01**

S_1 =Baitarani at Champua, S_2 = Aradei at Rimuli, S_3 = Aradei at Keonjhar, S_4 = Baitarani at Swampatna, S_5 = Mushal at Anandpur, S_6 = Kushei at Belabahali, S_7 = Baitarani at Anandpur, S_8 = Baitarani at Akhuapada

Table 7: Concentration of Calcium in water samples, in mg/L.

Months	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8
Jan,2019	15.68	21.95	38.45	18.56	21.95	42.34	18.82	22.53
Feb,2019	18.62	31.04	31.04	7.76	17.07	43.46	31.04	25.09
Mar,2019	15.68	28.22	29.79	34.49	25.09	34.49	37.63	64.29
Apr,2019	19.01	20.59	32.93	39.20	28.51	11.08	42.77	32.93
May,2019	15.68	21.95	13.05	13.05	21.95	42.34	18.82	11.42
Jun,2019	15.68	20.38	160.72	101.90	25.09	26.66	3.14	125.44
Jul,2019	17.25	20.38	25.09	15.68	31.36	25.08	29.79	47.04
Aug,2019	16.32	17.95	31.01	24.48	19.58	31.01	17.95	37.54
Sep,2019	32.59	24.83	6.21	10.86	20.18	18.62	20.18	15.52
Oct,2019	38.40	37.63	15.68	15.68	17.25	31.36	14.11	17.25
Nov,2019	16.90	33.79	21.50	21.50	23.04	38.40	19.97	24.58
Dec,2019	15.44	33.97	15.65	18.52	33.97	41.69	20.07	23.16
Mean	**19.77**	**26.06**	**35.09**	**26.81**	**23.75**	**32.21**	**22.86**	**37.23**

S_1 =Baitarani at Champua, S_2 = Aradei at Rimuli, S_3 = Aradei at Keonjhar, S_4 = Baitarani at Swampatna, S_5 = Mushal at Anandpur, S_6 = Kushei at Belabahali, S_7 = Baitarani at Anandpur, S_8 = Baitarani at Akhuapada

Table 8: Concentration of Magnesium in water samples, in mg/L.

Months	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8
Jan,2019	1.88	12.23	9.50	10.15	9.40	8.47	10.35	7.53
Feb,2019	3.72	3.72	13.97	22.35	8.89	10.24	2.79	11.29
Mar,2019	8.47	7.53	3.76	9.41	6.58	7.53	14.73	4.70
Apr,2019	4.75	3.80	8.46	5.64	9.50	2.85	2.85	4.70
May,2019	1.88	12.23	4.89	0.98	9.40	8.47	10.35	5.87
Jun,2019	10.34	15.05	160.72	133.30	6.58	9.40	13.17	125.44
Jul,2019	6.58	7.53	12.23	5.64	6.58	3.76	4.70	0.94
Aug,2019	0.98	16.65	0.98	0.98	2.94	1.96	3.92	1.96
Sep,2019	3.72	4.66	1.86	3.72	3.72	1.86	1.86	1.86
Oct,2019	5.64	5.64	9.41	4.70	3.76	3.76	3.76	5.64
Nov,2019	3.69	5.53	7.37	2.76	7.37	5.53	4.61	4.61
Dec,2019	2.78	5.55	9.31	1.80	1.85	3.70	3.70	1.85
Mean	**4.54**	**8.34**	**20.21**	**16.79**	**6.38**	**5.63**	**6.40**	**14.70**

S_1 =Baitarani at Champua, S_2 = Aradei at Rimuli, S_3 = Aradei at Keonjhar, S_4 = Baitarani at Swampatna, S_5 = Mushal at Anandpur, S_6 = Kushei at Belabahali, S_7 = Baitarani at Anandpur, S_8 = Baitarani at Akhuapada

Table 9: Concentration of Total Dissolved Solid in water samples, in mg/L.

Months	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8
Jan,2019	91.45	90.45	56.15	95.40	142.60	90.65	135.20	276.00
Feb,2019	55.04	132.50	153.80	78.14	88.42	145.60	98.14	91.54
Mar,2019	69.17	401.50	98.60	69.74	98.60	188.50	87.35	96.71
Apr,2019	65.12	44.21	96.20	70.43	154.20	241.60	102.30	84.26
May,2019	114.80	53.40	98.61	78.14	165.30	250.40	104.30	94.88
Jun,2019	53.29	115.00	142.20	65.35	94.79	119.40	58.67	64.57
Jul,2019	80.48	93.95	55.79	91.75	133.90	94.36	138.10	259.00
Aug,2019	56.00	109.00	67.81	73.12	62.18	96.69	81.23	120.00
Sep,2019	43.94	83.60	37.25	53.52	57.54	87.48	57.43	88.18
Oct,2019	52.03	39.59	95.80	69.38	133.50	218.20	91.53	57.38
Nov,2019	50.82	122.40	137.80	74.53	95.89	154.90	86.98	89.77
Dec,2019	64.15	396.10	95.50	68.35	97.90	181.30	77.27	89.81
Mean	**66.36**	**140.14**	**94.63**	**73.99**	**110.40**	**155.76**	**93.21**	**117.68**

S_1 =Baitarani at Champua, S_2 = Aradei at Rimuli, S_3 = Aradei at Keonjhar, S_4 = Baitarani at Swampatna, S_5 = Mushal at Anandpur, S_6 = Kushei at Belabahali, S_7 = Baitarani at Anandpur, S_8 = Baitarani at Akhuapada

Table 10: Concentration of Sodium in water samples, in mg/L.

Months	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8
Jan,2019	3.40	9.80	12.50	7.60	7.10	18.20	5.90	8.50
Feb,2019	2.80	24.70	19.70	28.10	6.60	14.30	6.70	24.50
Mar,2019	3.70	13.80	11.70	14.70	10.50	15.00	7.10	4.70
Apr,2019	14.60	8.30	15.20	18.00	7.60	11.60	3.60	8.50
May,2019	3.40	9.80	3.80	3.50	7.10	18.20	5.90	3.50
Jun,2019	2.60	10.10	12.70	4.70	10.60	13.30	4.60	4.90
Jul,2019	9.00	10.70	5.20	6.60	18.90	10.70	18.90	65.40
Aug,2019	1.50	6.00	2.90	3.60	4.00	6.70	3.80	4.80
Sep,2019	2.00	4.30	2.40	3.40	4.90	5.80	3.30	4.80
Oct,2019	17.00	9.20	6.90	5.90	13.50	4.60	10.40	5.80
Nov,2019	2.60	10.20	8.10	5.40	7.50	13.40	6.10	7.60
Dec,2019	4.20	13.20	6.50	3.60	9.20	19.50	7.50	9.50
Mean	**5.57**	**10.84**	**8.97**	**8.76**	**8.96**	**12.61**	**6.98**	**12.71**

S_1 =Baitarani at Champua, S_2 = Aradei at Rimuli, S_3 = Aradei at Keonjhar, S_4 = Baitarani at Swampatna, S_5 = Mushal at Anandpur, S_6 = Kushei at Belabahali, S_7 = Baitarani at Anandpur, S_8 = Baitarani at Akhuapada

Table 11: Concentration of Potassium in water samples, in mg/L.

Months	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8
Jan,2019	1.70	0.90	1.10	1.70	1.10	1.00	1.00	1.00
Feb,2019	1.30	1.50	8.90	2.50	1.00	0.90	1.10	2.10
Mar,2019	2.30	1.20	3.10	3.30	1.10	1.20	1.30	1.50
Apr,2019	1.40	1.80	3.20	3.50	2.80	1.50	1.80	5.50
May,2019	1.70	0.90	1.70	1.50	1.10	1.00	1.00	1.30
Jun,2019	1.90	1.50	2.10	1.20	1.10	1.00	1.10	1.30
Jul,2019	2.70	2.50	1.40	5.20	2.80	2.70	2.80	2.80
Aug,2019	0.30	0.20	0.20	0.20	0.30	0.10	0.10	0.40
Sep,2019	1.00	1.10	1.30	1.40	0.60	0.90	1.80	1.20
Oct,2019	2.50	4.60	0.90	2.60	2.40	2.60	2.00	2.70
Nov,2019	0.90	0.90	2.00	0.90	0.80	0.80	0.90	0.70
Dec,2019	1.50	1.00	0.80	0.70	0.80	1.10	0.90	1.00
Mean	**1.60**	**1.51**	**2.23**	**2.06**	**1.33**	**1.23**	**1.32**	**1.79**

S_1 =Baitarani at Champua, S_2 = Aradei at Rimuli, S_3 = Aradei at Keonjhar, S_4 = Baitarani at Swampatna, S_5 = Mushal at Anandpur, S_6 = Kushei at Belabahali, S_7 = Baitarani at Anandpur, S_8 = Baitarani at Akhuapada

Table 12: Concentration of Dissolved oxygen in water samples, in mg/L.

Months	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8
Jan,2019	7.41	5.70	7.37	5.58	5.51	6.46	6.65	6.56
Feb,2019	4.67	3.93	5.43	3.44	5.61	5.61	5.61	2.22
Mar,2019	4.25	3.70	5.52	5.37	5.73	4.62	3.88	3.68
Apr,2019	4.39	1.53	4.07	3.88	4.58	4.20	5.16	0.22
May,2019	7.41	5.70	3.67	4.44	5.51	6.46	6.65	4.25
Jun,2019	3.98	3.98	2.53	4.16	3.26	3.98	4.53	3.98
Jul,2019	1.98	5.58	7.02	3.60	3.96	6.30	4.14	3.24
Aug,2019	6.47	4.44	3.88	4.07	4.62	4.25	2.77	4.81
Sep,2019	4.62	4.99	3.14	4.99	4.99	5.36	5.55	2.96
Oct,2019	5.55	6.26	4.47	2.15	4.12	4.47	5.37	5.01
Nov,2019	6.05	5.29	2.65	2.83	4.16	5.67	5.26	4.91
Dec,2019	3.48	4.21	4.61	5.85	3.11	2.56	5.67	5.86
Mean	**5.02**	**4.61**	**4.53**	**4.20**	**4.60**	**4.64**	**5.10**	**3.98**

S_1 =Baitarani at Champua, S_2 = Aradei at Rimuli, S_3 = Aradei at Keonjhar, S_4 = Baitarani at Swampatna, S_5 = Mushal at Anandpur, S_6 = Kushei at Belabahali, S_7 = Baitarani at Anandpur, S_8 = Baitarani at Akhuapada

Table 13: Concentration of BOD in water samples, in mg/L.

Months	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8
Jan,2019	1.93	1.35	1.35	1.95	1.35	1.36	1.36	1.56
Feb,2019	1.21	1.38	0.57	1.10	1.06	1.42	1.24	0.39
Mar,2019	0.75	0.76	1.18	1.39	0.95	0.94	0.57	1.51
Apr,2019	0.63	0.97	0.57	0.57	0.82	0.44	1.02	0.56
May,2019	1.93	1.35	1.38	1.00	1.35	1.36	1.36	0.62
Jun,2019	2.21	2.94	1.11	1.66	2.56	2.21	2.02	2.75
Jul,2019	0.73	1.49	1.32	1.11	1.47	1.67	1.83	1.46
Aug,2019	1.38	0.80	0.61	1.16	0.80	1.16	0.95	1.17
Sep,2019	0.50	0.69	0.99	1.05	0.34	1.42	2.15	0.63
Oct,2019	0.59	0.60	0.60	0.38	1.64	0.75	1.30	0.59
Nov,2019	1.79	0.67	0.80	0.80	2.12	1.78	0.85	0.84
Dec,2019	0.60	2.41	0.50	1.46	1.30	0.58	3.33	0.64
Mean	**1.19**	**1.28**	**0.92**	**1.14**	**1.31**	**1.26**	**1.50**	**1.06**

S_1 =Baitarani at Champua, S_2 = Aradei at Rimuli, S_3 = Aradei at Keonjhar, S_4 = Baitarani at Swampatna, S_5 = Mushal at Anandpur, S_6 = Kushei at Belabahali, S_7 = Baitarani at Anandpur, S_8 = Baitarani at Akhuapada

Table 14: Physico-chemical Characters of river water

Parameters	Sampling Stations								
	S_1			S_2			S_3		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
pH	7.03	7.90	7.36	6.61	7.96	7.45	7.11	7.90	7.52
Electrical conductivity	89.00	621.00	212.17	118.00	712.00	266.42	78.00	833.00	247.08
Total hardness	68.30	121.50	89.46	36.10	123.51	81.34	45.03	95.34	77.28
Total alkalinity	48.24	99.32	70.59	49.12	104.50	81.19	35.14	160.20	75.08
Calcium	15.44	38.40	19.77	17.95	37.63	26.06	6.21	160.72	35.09
Magnesium	0.98	10.34	4.54	3.72	16.65	8.34	0.98	160.72	20.21
TDS	43.94	114.80	66.36	39.59	401.50	140.14	37.25	153.80	94.63
Sodium	1.50	17.00	5.57	4.30	24.70	10.84	2.40	19.70	8.97
Potassium	0.30	2.70	1.60	0.20	4.60	1.51	0.20	8.90	2.23
DO	1.98	7.41	5.02	1.53	6.26	4.61	2.53	7.37	4.53
BOD	0.50	2.21	1.19	0.60	2.94	1.28	0.50	1.38	0.92

Table No: 14 Cont….

Parameters	S_4			S_5			S_6		
	Min	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
pH	7.10	7.60	7.39	7.13	8.08	7.42	7.29	8.10	7.74
Electrical conductivity	102.00	423.00	182.42	116.00	381.00	236.75	115.00	313.00	213.92
Total hardness	32.64	125.36	80.36	55.20	102.50	76.49	44.21	99.14	72.50
Total alkalinity	68.12	165.74	93.38	42.53	113.77	76.55	55.01	179.35	101.14
Calcium	7.76	101.90	26.81	17.07	33.97	23.75	11.08	43.46	32.21
Magnesium	0.98	133.30	16.79	1.85	9.50	6.38	1.86	10.24	5.63
TDS	53.52	95.40	73.99	57.54	165.30	110.40	87.48	250.40	155.76
Sodium	3.40	28.10	8.76	4.00	18.90	8.96	4.60	19.50	12.61
Potassium	0.20	5.20	2.06	0.30	2.80	1.33	0.10	2.70	1.23
DO	2.15	5.85	4.20	3.11	5.73	4.60	2.56	6.46	4.64
BOD	0.38	1.95	1.14	0.34	2.56	1.31	0.44	2.21	1.26

Parameters	S_7			S_8		
	Min	**Max**	**Mean**	**Min**	**Max**	**Mean**
pH	7.08	7.80	7.36	6.18	8.32	7.38
Electrical conductivity	102.00	466.00	235.67	108.00	920.00	252.75
Total hardness	32.64	113.25	89.44	44.01	105.32	74.41
Total alkalinity	45.80	114.25	78.92	29.30	95.33	79.01
Calcium	3.14	42.77	22.86	11.42	125.44	37.23
Magnesium	1.86	14.73	6.40	0.94	125.44	14.70
TDS	57.43	138.10	93.21	57.38	276.00	117.68
Sodium	3.30	18.90	6.98	3.50	65.40	12.71
Potassium	0.10	2.80	1.32	0.40	5.50	1.79
DO	2.77	6.65	5.10	0.22	6.56	3.98
BOD	0.57	3.33	1.50	0.39	2.75	1.06

* Electrical conductivity in micromho/cm and others in mg/L except turbidity and pH.

S_1 =Baitarani at Champua, S_2 = Aradei at Rimuli, S_3 = Aradei at Keonjhar, S_4 = Baitarani at Swampatna, S_5 = Mushal at Anandpur, S_6 = Kushei at Belabahali, S_7 = Baitarani at Anandpur, S_8 = Baitarani at Akhuapada

TOTAL HARDNESS:

Water's hardness is caused by the presence of soluble calcium and magnesium salts. Ions of barium, strontium and manganese also contribute to hardness to some extent. Though hard water may have moderate health benefits, it damages household appliances, water pipes, boilers and other industrial and agricultural equipments. Hardness in water prevents formation of leather with soap. The hardness of water is measured in mg/L as an equivalent of calcium carbonate concentration. The acceptable hardness limit for calcium carbonate is 300 mg/L. [5] The total hardness is estimated using the presence of calcium and magnesium ions in the water samples as depicted in Table-5 and 6. Our study disclosed that the level of hardness in all of the collected water samples is much below the permissible limit as shown in Table-5.

TOTAL ALKALINITY:

Alkalinity is the total amount of acid-neutralizing substances present in water. It indicates the pH change-resisting capacity of water, avoiding changes in its pH that would make it more acidic (buffering capacity). It shows a solution's capacity to react with acid and buffer pH. Alkalinity is measured as the equivalent quantity of calcium carbonate formed by the salt of weak acid and bicarbonate salts. It is not a pollutant. Though some given evidences indicate its role in heart diseases, alkalinity has no known adverse health concerns. [6] Furthermore, WHO and ICMR have set no permissible or excessive total alkalinity levels for water. In accordance to USPHS, the value of total alkalinity as CaCO3 is 120 mg/L. According to IS (1992), the ideal alkalinity limit is 200 mg/L for drinking water. In this investigation, the total alkalinity of the water surfaces is significantly lower than the permissible limit.

TOTAL DISSOLVED SOLID:

Total dissolved solids (TDS) is the sum of all dissolved organic and inorganic substances. This includes minerals and ions that are dissolved in water in a particular quantity. Sodium, Magnesium, Potassium, Calcium, Carbonate, Bicarbonate, Chloride and Sulphate are the most prominent ions. TDS is an important parameter when it comes to assessment of water quality as it indicates the presence of important minerals and nutrients as well as hazardous toxic ions which must be filtered out before consumption. A sudden rise in the TDS levels of a water body may indicate pollution by an external source. Ecological balance may be disturbed by an excess amount of TDS. Even with a reasonable amount of dissolved oxygen, it may produce an imbalance in osmotic control and suffocate aquatic life. [7]

The Bureau of Indian Standards (BIS) recommends an upper TDS level limit of 500 mg/L, but WHO recommends a TDS of 300 mg/L for drinking water. As such, water with a TDS level exceeding 500 mg/L is considered poor and undesirable for drinking purposes. The general TDS level range for irrigation water lies from 0-2000. Our analysis revealed that the TDS levels of all water samples collected from various sampling stations are within the safe limit as shown in Table 7.

SODIUM AND POTASSIUM:

Sodium and Potassium are essential elements in humans and are found in all body tissues and fluids. Potassium is the principal intracellular cation, while sodium is the primary extracellular cation. They perform specific functions like maintaining normal levels of fluid inside cells, influencing muscle activity and supporting normal blood pressure etc.[8] Generally, they are not considered harmful at normal intake levels from drinking water sources. According to WHO, sodium and potassium consumption from drinking water is highly unlikely to adversely affect healthy individuals.

The sodium and potassium limitations for drinking water, according to the European Economic Community, are 200 mg/L and 10 mg/L, respectively. As per the Penn State Laboratory, the desirable upper limit for sodium in irrigation water is 30 mg/L. Potassium level doesn't pose any high level of concern for plant growth. The study outlines that the sodium and potassium concentrations in any water sample do not exceed the maximum permissible limit as shown in Tables 10 and 11.

DISSOLVED OXYGEN:

Dissolved oxygen (DO) is a measure of the oxygen concentration in water. It is a significant parameter for assessing water quality since it represents the physical and biological activities that exist in the water as well as the metabolic balance. A high DO content enhances the flavor of water, but it also speeds up corrosion in water pipes and other residential and commercial equipment. Studies show that DO levels between 4-9 mg/l support a large, diverse, and healthy fish population.

The European Economic Community has specified that the standard DO value for drinking water is 5mg/L. It was found that the vast majority of the samples have permissible DO values as per drinking water norms. This indicates there is no acute problem with domicile sewage effluents and waste dumping, both of which induce microbial contamination, consuming the DO as shown Table 12. [9,10]

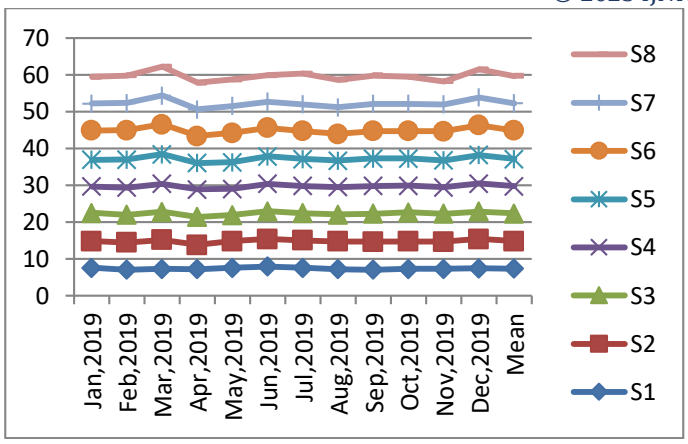

Fig-1 Concentration of pH in water samples.

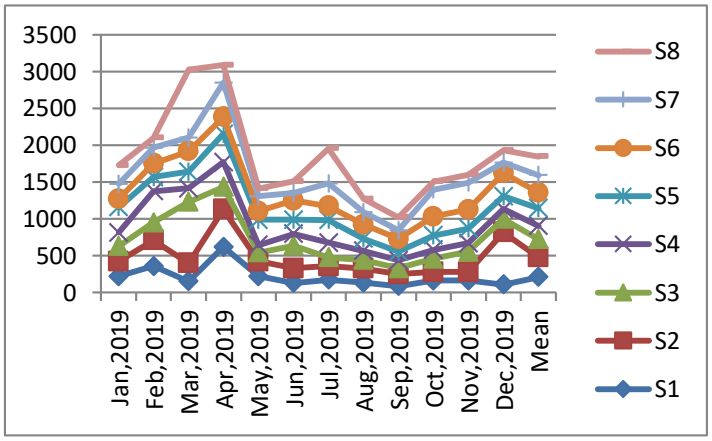

Fig-2 EC in water samples, in micromho/cm.

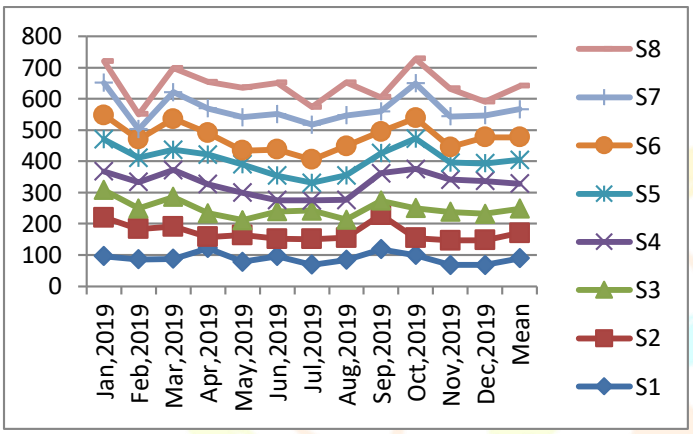

Fig-3 Concentration of Total hardness in water samples

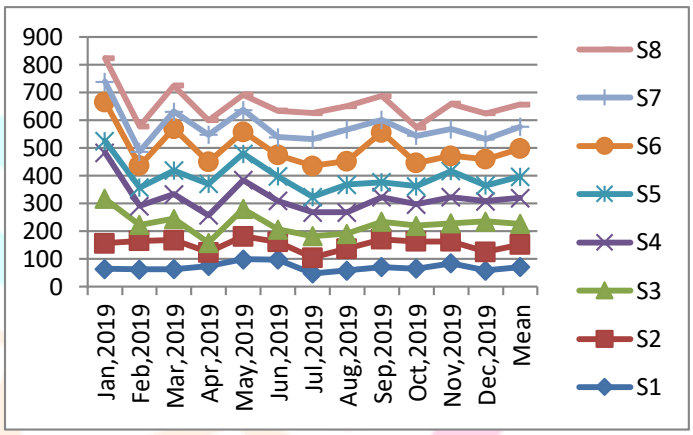

Fig-4 Concentration of Total alkalinity in water samples

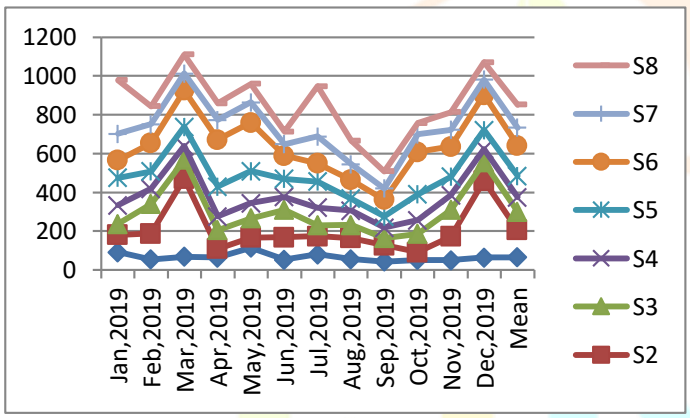

Fig-5 Concentration of Calcium in water samples

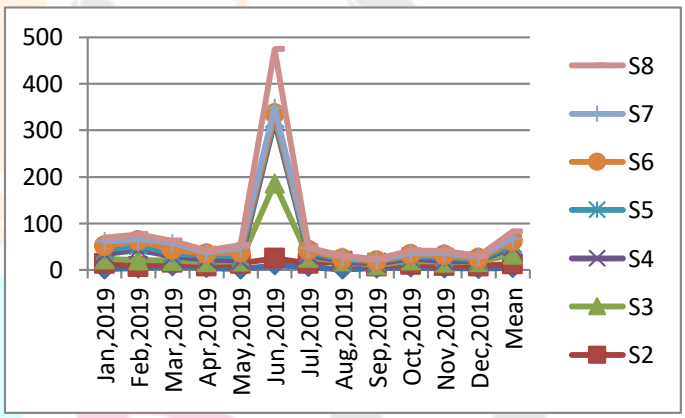

Fig-6 Concentration of Magnesium in water samples

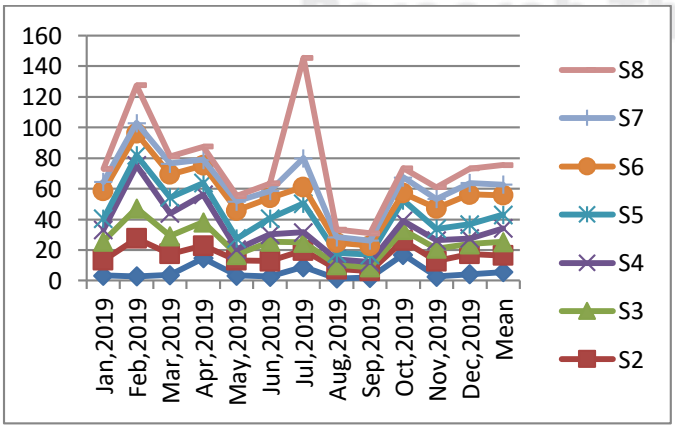

Fig-7 Concentration of Dissolved Solid in water samples

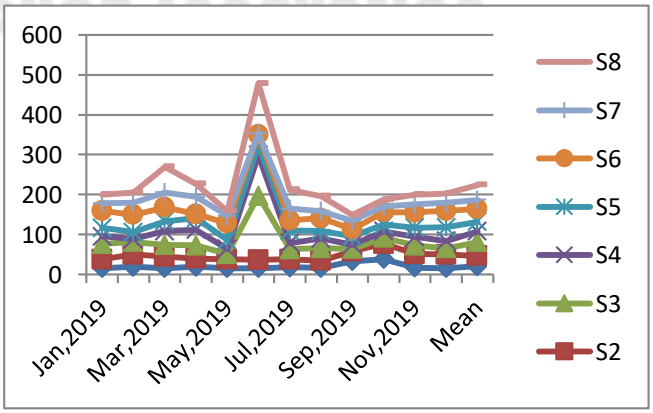

Fig-8 Concentration of Sodium in water samples

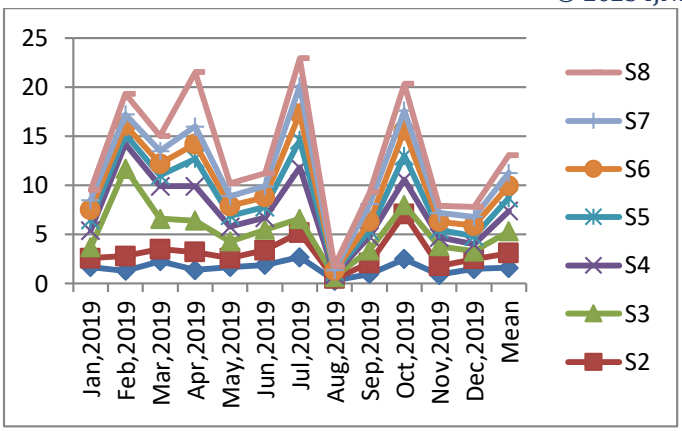

Fig-9 Concentration of Potassium in water samples

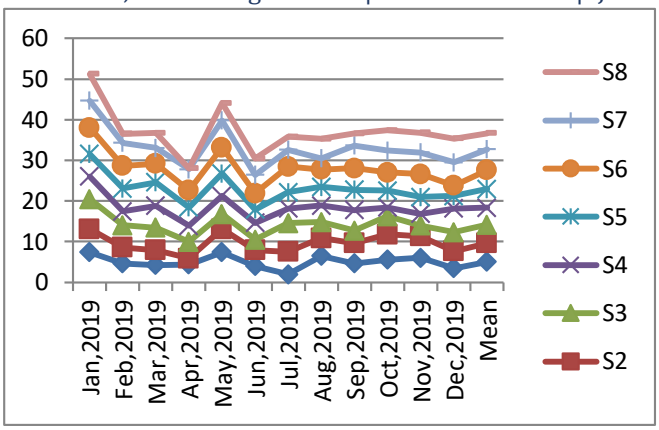

Fig-10 Concentration of Dissolved oxygen in water samples

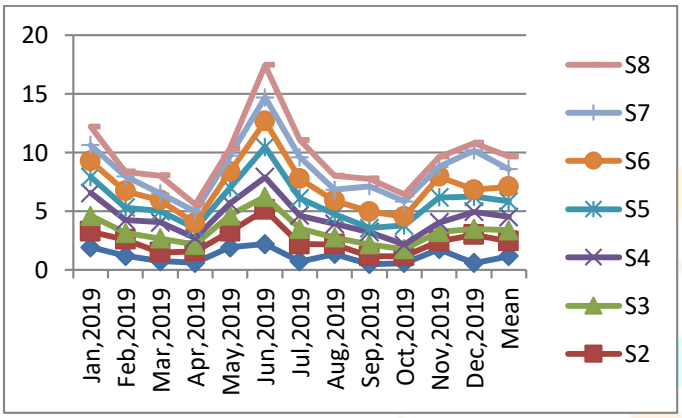

Fig-11 Concentration of BOD in water sample

BIOCHEMICAL OXYGEN DEMAND:

Biochemical oxygen demand (BOD) is the amount of dissolved oxygen (DO) required by aerobic microorganisms to degrade (oxidize) organic materials in a water body at a given temperature and time. BOD is an essential water quality evaluation indicator since it reflects the presence of organic matter in a water source. This implies that it is a direct indication of pollution levels in water bodies and their sources. It is generally assessed as the amount of oxygen consumed by microorganisms present in water throughout a 5-day test period at 20°C. When BOD levels surpass 6.0 mg/L, the water body is certainly contaminated, indicating the presence of organic materials being degraded by microorganisms. A BOD value of 1-2 mg/L is considered appropriate for safe drinking water. The investigation showed that all of the samples have BOD levels substantially lower than 6.0 mg/L as shown in Table 13. This shows that the Baitarani River water is relatively clean and may be suitable for drinking purposes.

CONCLUSION:

The current investigation reveals that all physicochemical characteristics, including DO and BOD samples, are within the maximum permissible limits. Thus, river water is palatable. As a result, the type of pre-treatment required for contaminated/polluted water may not be necessary here for safe human and animal consumption. Monthly variable figures/ trends during the entire study period with respect to the analyzed parameters are also shown in figures 1 to 11.

On the whole, it is apparent from the present investigation that Baitarani River water is not yet polluted by contaminants from diverse natural and anthropogenic sources and hence requires less pretreatment/purification for safe use by dependent populations. However, to maintain the same or better quality in the future, continued monitoring of the water quality of the river should be ensured keeping in view the massive mining activities and sporadic industrialization/ urbanization going on in the river basin in Jharkhand state as well as Keonjhar district of Odisha.

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