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ASSESSMENT OF WATER QUALITY FOR DAMODAR RIVER IN BOKARO DISTRICT, JHARKHAND, INDIA

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ABSTRACT: Water samples were collected from eight different sites for two successive years in order to analyze the various Physico-chemical parameters of river water. The assessment of water quality has been made by calculating water quality Index (WQI) for physico-chemical parameters of different sites. The values of water quality index of river water at all eight sites are found to be above standard value which is a clear indication of severely polluted water.

Key Words: Water Quality Index, Physico-chemical parameter, Damodar River

INTRODUCTION

The Damodar, in fact, in her course through highly populated and highly industrialized area of coalfield has become a repository of many types of wastes produced by various human activities like industrial, agricultural and domestic. The polluted plight of the river is enhanced with passing time due to continuous and uncontrolled discharge of toxic and hazardous effluents into it by over 46 industries located on its banks or in its vicinity particularly in Bokaro - Dhanbad areas of Jharkhand. Apart from these agricultural run-off from the catchment area and domestic wastes from thick population of this belt simply increase the extent of pollution of the river making the Damodar a constant agony from pollution view point [M.P.Sinha, 1985; S.K.Singh, 1991; Bhattacharya,1994;Banergee,2003].

MATERIALS AND METHODS

Monitoring sites: In the present study, total eight sites were selected under the Physico-chemical analysis of water pollution. These are:

Table: 1: Water quality sampling site

S.No	Site Name
Site 1	Bhandaridah (B.R.L.) Gate No. 4 U/S
Site 2	Bhandaridah (B.R.L.) Gate No.4 D/S
Site 3	Tenu Bokaro Nahar
Site 4	Bastejee bridge
Site 5	Raja Bera bridge
Site 6	Telmuchu bridge
Site 7	Birsa bridge (Bhowra)
Site 8	Bokaro Thermal Power Plant (B.T.P.S. Bridge),

Sampling Procedure:

Water samples were collected from the eight different sites by dip (grab) sampling method. The samples were collected from 1/3, ½ and 2/3 width of the river and mixed together to obtain a composite sample. The samples thus collected were stored in clean narrow mouth polyethylene bottles having double stopper. The bottles have been cleaned, rinsed with tap water and then with distilled water. Prior to the collection, the sample bottles were thoroughly rinsed with sample water being collected. Water temperature was measured on the site using mercury thermometer. The bottles were immediately closed. Each sample bottles were clearly labeled with water proof ink and other relevant details were recorded. All samples were collected from various sources of water around the areas under investigation.

Chemical reagents and Instruments:

All chemicals used in the study were obtained from Merck, Rankem, Ranbaxy India and were of analytical grade. Double distilled water was used throughout the study. All glass wares and other sample containers were thoroughly cleaned and finally rinsed with double distilled water several times prior to use. Standard instruments such as PHAN LABINDIA µp controlled pH Analyzer **,** HACH conductivity / TDS meter, BOD Incubator **,** Reflux Apparatus **,** Magnetic stirrer **,** Chemita 2500 UV – VIS spectrophotometer and Flame Photometer have been used. Before actual measurements, these instruments were calibrated with standard solutions of known concentrations

Methods of Analysis:

Physico-chemical analysis was conducted following standard methods **[**APHA, 18th Ed**].** The analysis has been conducted at PG Dept. of Chem. Ranchi University, Ranchi, MECON, Ranchi and Cambridge Institute of Technology, Tatisilwai, Ranchi. The analytical data quality was ensured through careful standardization, and procedural blank measurements.

RESULTS AND DISCUSSION

Water quality index:

Water quality index (W.Q.I.) has been regarded as one of the most effective way to communicate water quality. The application of a single water quality index mathematically computed to represent the integrated effect of the individual concentrations of a large number of pollutants was studied by Agarwal. A modified Walski and Parkar WQI based on the geometrics of the transformed sensitivity functions for selected water quality parameters was applied to the data related to the rivers Ganga, Yamuna and Kali. In another Study, the three water quality indices viz. NSF, multiplicative and the Walski – Parkar – model were applied. The Walski-Parker Model was found to be more useful in predicting the water quality index for health related use where coliform density was of major concern. For non health related activities both the NSF and multiplicative models were found to be applicable.

Water quality index for Ram Ganga river water at Moradabad at eight different sites has been calculated with the help of fourteen physico-chemical parameters estimated following standard methods and procedures. River water at all the sites is found to be severely polluted. Water quality indices were calculated using the method proposed by Tiwari and Mishra **[**Tiwari, 1985**].** Following equations have used:

1. Quality rating $q_n = 100\ [(V_n - V_i)/(V_s - V_i)]$; Where Vn = Actual amount of nth parameter, V_i = The ideal value of this parameter; V_i = O except for pH and DO, V_i = 7.0 mg/lit for pH and V_i = 14.6 mg/lit for DO; V_S = Its standard

2. Unit weight, (Wn) for various parameters is inversely proportional to the recommended standard (S_n) for the corresponding parameter

$W_n = K/S_n$; $\sum_{n=1}^{n=14} Wn = 1$, considered here

3. Sub indices, $(SI)_n = (q_n)^{W_n}$

4. The overall WQI was calculated by taking geometric mean of these sub indices.

$$WQI = \sum_{n=t}^{n=14} (SI)_n = \sum_{n=t}^{n=14} (q_n)^{Wn} \quad \text{OR} \quad WQI = \text{Anti log } 10 \sum_{n=1}^{n=14} Wn \log 10\, q_n$$

It has been assumed for W.QI of water:

WQI	< 50	-	Fit for human consumption
WQI	< 80	-	Moderately polluted
WQI	> 80	-	Excessively polluted
WQI	> 100	-	Severely polluted

The assessment of water quality has been also made by calculating water quality index for physico-chemical parameters of different sites. Water Quality Index represents the most effective way to communicate water quality.
Physico-chemical parameters, their WHO standards and assigned unit weights have been represented in Table 2. Water Quality Index (WQI) for different sites are given in table 3-10

Table 2: Physico-chemical parameters, their WHO standards and assigned unit weights

Parameter	WHO standard	Assigned unit weight (Wn)
pH	7.08 – 8.5 (8.0)	0.029088
Conductivity (µs/cm)	0.3	0.775675
Total suspended solids (mg/l)	100	0.002327
Total dissolved solids (mg/l)	500	0.000465
Total hardness (mg/l)	100	0.002327
Alkalinity (mg/l)	100	0.002327
Ca-Hardness (mg/l)	100	0.002327
Mg-Hardness (mg/l)	30	0.007757
BOD (mg/l)	6	0.038784
COD (mg/l)	10	0.023270
Chloride (mg/l)	200	0.001164

Table 3: Water Quality Index calculation for parameters of site I

Parameters	Actual value	Quality rating (q_n)	Wn log q_n	W.Q.I.
pH	7.74	26	0.041158	**218.9**
Conductivity (µs/cm)	170.3	567.3	2.136241	
Total suspended solids	29.67	29.67	0.003426	
Total dissolved solids	160.6	32.12	0.000700	
Total hardness (mg/l)	103.3	103.3	0.004686	
Alkalinity (mg/l)	113.50	113.50	0.004781	
Ca-Hardness (mg/l)	30.70	30.70	0.003460	
Mg-Hardness (mg/l)	8.03	26.76	0.011107	
BOD (mg/l)	4.53	75.5	0.072834	
COD (mg/l)	42.50	425	0.061162	
Chloride (mg/l)	9.44	4.72	0.000784	

Table 4: Water Quality Index calculation for parameters of site II

Parameters	Actual value	Quality rating (q_n)	Wn log q_n	W.Q.I.
pH	7.37	63	0.052339	**322.9**
Conductivity (µs/cm)	250.9	836.3	2.266803	
Total suspended solids	132	132	0.008974	
Total dissolved solids	312.8	62.53	0.000835	
Total hardness (mg/l)	144	144	0.005124	
Alkalinity (mg/l)	159.3	159.3	0.005022	
Ca-Hardness (mg/l)	31.92	31.92	0.003499	
Mg-Hardness (mg/l)	12.32	41.06	0.012515	
BOD (mg/l)	6.20	103.3	0.078114	
COD (mg/l)	161.5	1615	0.074654	
Chloride (mg/l)	27	13.5	0.001315	

Table 5: Water Quality Index calculation for parameters of site III

Parameters	Actual value	Quality rating (q_n)	Wn log q_n	W.Q.I.
pH	7.02	2	0.008756	**353.5**
Conductivity (µs/cm)	325.7	10.85	2.354693	
Total suspended solids	592.33	592.33	0.006452	
Total dissolved solids	262.5	52.5	0.000791	
Total hardness (mg/l)	121.5	121.5	0.004850	
Alkalinity (mg/l)	148.17	148.17	0.005051	
Ca-Hardness (mg/l)	40.75	40.75	0.003746	
Mg-Hardness (mg/l)	7.15	23.83	0.010682	
BOD (mg/l)	5.26	104.1	0.078244	
COD (mg/l)	151.83	1518.3	0.074030	
Chloride (mg/l)	20.75	10.37	0.001182	

Table 6: Water Quality Index calculation for parameters of site IV

Parameters	Actual value	Quality rating (q_n)	Wn log q_n	W.Q.I.
pH	7.08	8	0.026269	**301.1**
Conductivity (µs/cm)	261.5	871.6	2.280730	
Total suspended solids	51	51	0.003973	
Total dissolved solids	156.1	31.22	0.000694	
Total hardness (mg/l)	152.1	152.1	0.005077	
Alkalinity (mg/l)	148.33	148.33	0.005052	
Ca-Hardness (mg/l)	32.66	32.66	0.003523	
Mg-Hardness (mg/l)	14.23	47.4	0.12999	
BOD (mg/l)	5.10	85	0.074830	
COD (mg/l)	60.83	608.3	0.64786	
Chloride (mg/l)	12.36	6.18	0.000920	

Table 7: Water Quality Index calculation for parameters of site V

Parameters	Actual value	Quality rating (q_n)	Wn log q_n	W.Q.I.
pH	7.48	48	0.48903	321.3
Conductivity (µs/cm)	262	873.3	2.281386	
Total suspended solids	61.17	61.17	0.004157	
Total dissolved solids	200.6	40.12	0.000745	
Total hardness (mg/l)	151	151	0.005070	
Alkalinity (mg/l)	162.17	162.17	0.005142	
Ca-Hardness (mg/l)	34.01	34.01	0.003564	
Mg-Hardness (mg/l)	14.69	48.96	0.013108	
BOD (mg/l)	6.23	103.8	0.078196	
COD (mg/l)	63.67	636.7	0.065247	
Chloride (mg/l)	11.76	5.88	0.000895	

Table 8: Water Quality Index calculation for parameters of site VI

Parameters	Actual value	Quality rating (q_n)	Wn log q_n	W.Q.I.
pH	7.90	90	0.056845	325.0
Conductivity (µs/cm)	260.3	869.6	2.279181	
Total suspended solids	70	70	0.004293	
Total dissolved solids	213.1	42.62	0.000757	
Total hardness (mg/l)	172.5	172.5	0.005205	
Alkalinity (mg/l)	188.67	188.67	0.005295	
Ca-Hardness (mg/l)	36.58	36.58	0.003637	
Mg-Hardness (mg/l)	15.59	51.96	0.013308	
BOD (mg/l)	6.98	116.3	0.080111	
COD (mg/l)	73.83	738.3	0.066743	
Chloride (mg/l)	12.63	6.31	0.000931	

Table 9: Water Quality Index calculation for parameters of site VII

Parameters	Actual value	Quality rating (q_n)	Wn log q_n	W.Q.I.
pH	7.30	30	0.042966	402.0
Conductivity (µs/cm)	337.6	1125.3	2.366792	
Total suspended solids	888	888	0.006860	
Total dissolved solids	338.6	67.72	0.000851	
Total hardness (mg/l)	225.1	225.1	0.005473	
Alkalinity (mg/l)	137.17	137.17	0.004973	
Ca-Hardness (mg/l)	38.43	38.43	0.003687	
Mg-Hardness (mg/l)	7.76	25.86	0.010957	
BOD (mg/l)	11.17	186.1	0.0088029	
COD (mg/l)	127.67	127.61	0.072278	
Chloride (mg/l)	30.96	15.48	0.001384	

Table 10: Water Quality Index calculation for parameters of site VIII

Parameters	Actual value	Quality rating (q_n)	Wn log q_n	W.Q.I.
pH	7.81	81	0.026269	348.5
Conductivity (µs/cm)	313.6	1045	2.341853	
Total suspended solids	29.83	29.83	0.003431	
Total dissolved solids	221.6	44.32	0.000765	
Total hardness (mg/l)	236.8	236.8	0.005525	
Alkalinity (mg/l)	146	146	0.005036	
Ca-Hardness (mg/l)	31.64	31.64	0.003491	
Mg-Hardness (mg/l)	14.73	49.1	0.013117	
BOD (mg/l)	5.42	90.3	0.075849	
COD (mg/l)	68.33	683.3	0.065961	
Chloride (mg/l)	13.79	6.89	0.000975	

Table 11: Calculated W.Q.I. values of Damodar river water of Bokaro District

S. No	Site Name	W.Q.I
Site 1	Bokaro Thermal Power Plant	218.9
Site 2	Bhandaridah (B.R.L.) U/S	322.9
Site 3	Bhadaridah (B.R.L.) D/S	353.9
Site 4	Tenu Bokaro Nahar	301.1
Site 5	Raja Bera Bridge	321.1
Site 6	Bastejee bridge	325.0
Site 7	Telmuchu bridge	402.0
Site 8	Birsa bridge	348.5

A critical analysis of the data of W.Q.I. presented in Table 11 reveals many interesting features regarding the status of river water pollution at all eight different sites at Bokaro District during the course of study. The values of Water Quality Index of river water at all eight sites are found to be above 100 which is a clear indication of severely polluted water. The W.Q.I. at site No. 1 is 218.9 while at site No.8, it is 348.5. This indicates that the river water quality is degraded during the course of its flow at Bokaro. The W.Q.I. value is found very high at site III (353.9), site7 (402.0) and site8 (348.5). Very high values of W.Q.I. at site no. 3, 7 and 8 might be because of different types of human activities and mixing up to effluents carrying industrial, domestic and city sewage discharge. Thus, Damodar river water is severely polluted and unfit for human consumption. This might be causing a number of health hazards to human being and animals dependent on this water.

Summary and Conclusion

The study reveals that the level of pollution is lowest (W.Q.I. 218.9) on the upstream side of the river at site I, before it enters the zone of maximum industrial activity. The river pollution level becomes highest (W.Q.I. 402.0) on the downstream side at site VII, as it has received effluents from different industrial plants and it has become unfit for public supply. The values of Water Quality Index of river water at all eight sites are found to be above 100 which is a clear indication of severely polluted water. Therefore, some major steps like Ganga action plan should be taken up to provide good quality water.

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