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Environmental Degradation of River Shivnath Physico-Chemical Analysis and Water Quality Index of River Water and Measures to its Restoration

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ABSTRACT: Now a day's scarcity of water, river pollution is going to become problematic issue for India. The river lies in west to east direction of Chhattisgarh Shivnath River is the one of most important river in Chhattisgarh. It is the life line of Durg District. In this research work analysed the changes of physic-chemical characteristic and determine water quality index of Shivnath River due to urbanization in early cities and industries like rice mill, sugar mill, sponge iron plants cement industries, bricks industries, anthropogenic sources and activities, deforestation etc. We have collected total Nine number of samples in Shivnath river.

We analysed the physico-chemical characteristics and water quality index of Shivnath River. The obtained results were compared with water quality criteria for inland surface water (Central Pollution Control Board 1979).Water Quality Index (WQI) was calculated. The water quality index has been calculated by using the standards of drinking water quality recommended by the World Health Organisation (WHO), Bureau of Indian Standard (BIS) and Indian Council for Medical Research (ICMR). The weighed arithmetic index method has been used for the calculation of water quality of water body.

From the assessment of water quality index and physic-chemical study Water quality index varies from good water quality to very poor water quality ranges from 47.89 to 85.62. Average water quality index is approx. 64.91 is poor water quality of river. These results are varying due to pollution and natural self purification of river but in future when industries anthropogenic activities etc will increase as well as surface loading and hydraulic loading also increase which affects the characteristics of water. Hence from the assessment of water quality and physico-chemical study it concluded that water quality index is poor which showed, the investigated water sources are not fit for human consumption before treatment. The analytical study also indicates the needs for periodic monitoring of water sources and its scientific studied on the basis of results obtained some measures for restoration of water body are suggested. Quality of water in the river is suggested, along with future scope of research in the area. Based on the results obtained during the study, it is suggested that a river action plan in line with Nation River Action Plan be formulated for future up gradation of water quality of the river.

Keywords: Environmental Degradation, Physico-Chemical Parameters.

I. INTRODUCTION

Shivnath River is a major tributary of the Mahanadi is one of the important river of Chhattisgarh. It originates from Panabars Hills 624 meters above sea level in the AmbagarhChowki Division of Rajnandgaon District of Chhattisgarh. The river flows in the north east direction from its source and joints the Mahanadi River near the town ShivrinarayanJanjgir-Champa District of Chhattisgarh. Its total length is 290 km. Many project ore situated in these rivers Mongra Barrage in Rajnandgaon District, Sutiyapat Kabirdham, Maroda Dam, Durg, BeharakhorKabirdham, Khapari, Durg, Ruse Dam Rajnandgaon, Dhara dam, Rajnandgaon. This river supplies water to many industries and drinking water to the many districts of Chhattisgarh.

Chhattisgarh is the richest Indian state in natural resources coal, bauxite, iron, limestone and other types of precious stones. Durg district has been developed as industrial hub due to these richest raw materials.

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A number of bricks plants and other plant situated on both side of river. Industrial and domestic sewage is continuously discharge and results in river water pollution therefore water is unsafe for human and animal consumption. Hence I have undertaken the Environmental degradation physico chemical analysis of Shivnath river water in Durg District.

- In Durg District different types of industries located at the bank of river industrialization, mining activities, rapid urbanization cause pollution.
- Treated and untreated waste water generated from the industries / urban centers finds its way into the river or canals through nullahs / rivers RasmdaNala and SamodaNala.

II. MATERIALS AND METHODS

2.1 Methodology

The total length of shivnath River is 290 Km but in Chhattisgarh it flows. Hence it is not possible to select sampling point near about some distances. Hence we selected those major points where shivnath River gets chances to become Pollute in Durg district due to anthropogenic activities. Power house plants, rice mills, Industries, sponge iron plant etc. we have taken water sample of upstream and downstream of sampling station at near about distances.

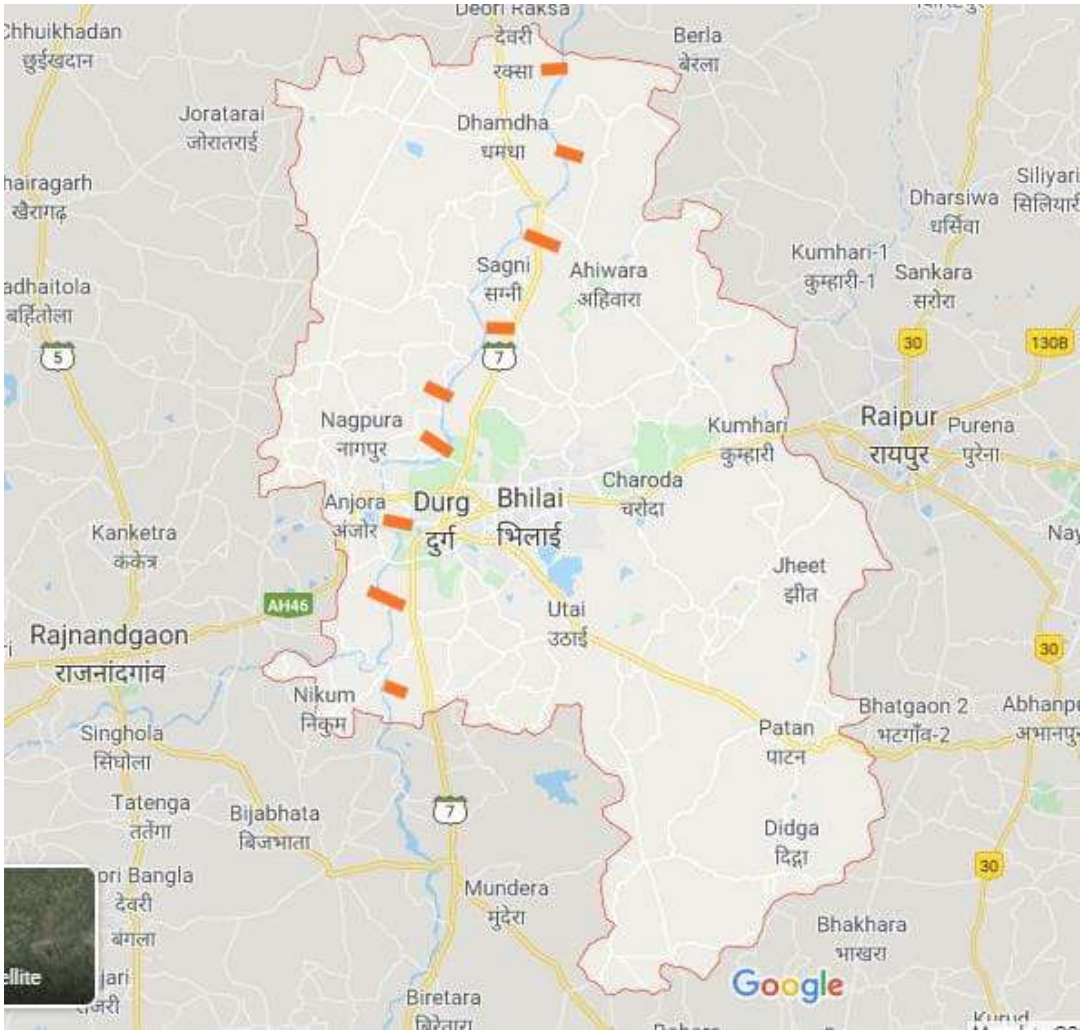

Fig. 1: Selection of point for sampling

2.2 Methodology of Sample Collection

Methodology of sample collection is accordance to IS 3025-1987 (Part-I).

The experimental method involved in the collection of grab samples in clean plastic containers of 1 liter capacity at 09 different locations. In month of march 2020 Samples were

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collected from the surface water layer and to take sample from about 30 cm below the surface at the centre of the main flow. By opening and keeping the mouth of the container against the flow of water collected it.

Filling the bottles: Samples for the determination of Physico-chemical parameters one sample precaution, which is not however, adequate in all cases, is to fill the bottle completely and stopper them in such a way that there is no air above the sample.

Sampling Locations: Samples should be collected, as far as possible from mid stream at mid depths. Sampling to near the bank provide fictitious results. Site should be selected preferably where marked quality changes occur and where there are important river uses such as confluences, major river discharges or abstractions. Samples can also be taken from boats wherever feasible for rivers and lakes. Unsafe bank should be avoided. When it is intended to monitor the effects of a discharge, both Upstream and downstream sampling is necessary. Mixing of discharge with receiving water is important. Rivers many Kilometers will be necessary. Therefore in case of longer river there should be three fixed sampling locations in a cross section (left, middle and right) the left and right one should be far enough from the bank. Sampling should extend to an appropriate distance downstream to assess effects on the river. Ideally sample should be taken from a turbulent point, where the flow is stream lined, turbulence should be induced.

For BOD, the capacity of 300 ml of sample was used in BOD bottle made by Borosil. These were washed with chromic acid and washing soda and rinsed with tap water followed by double distilled water; the neck and stopper were wrapped with butter paper with the help of rubber band. The bottles were then sterilized in an autoclave at 15 lbs pressure, (121^{o}C) for 15 to 25 minutes. Pipettes of different volume size were washed and fitted with cotton plug at the upper end; these were then wrapped in butter paper and sterilized in an autoclave at 15 lbs pressure at 121^{o}C for 15-20 minutes. Petri dishes were washed and then sterilization in an oven at (160^{o}C – 180^{o}C) for 1 to 2 minutes.

2.3 Study Area

In these research work, analysis to be conducted in Durg districts. In these selected study are many type of industries located at the bank of river side like steel plant, bricks industries, rice mills, small handicraft industries, Agro based, Soda water, Cotton textile, M/s. BEC Foods, Kuthrel, M/s. Jay Balaji Industries, Borai, M/s. Topworth Steel P.L. Borai, M/s. HariomInguts& Power PL. Bhilai, M/s. Ecofren Power & Project Ltd, Chankhuri, M/s. Raipur Power & Steel PL Borai. Some industries are direct and indirect affect the river water. There are we are selected these location.

1. S1 = Vinaykpur cross regulator (Sampling station-S1)
2. S2 = Changotianicut (Sampling station-S2)
3. S3 = Bhardakonari tape (Sampling station-S3)
4. S4 = Mahmraanicut (Sampling station-S4)
5. S5 = Katri joint (Sampling station-S5)
6. S6 = Rasmraanicut (Sampling station-S6)
7. S7 = Kotni bank (Sampling station-S7)
8. S8 = Urla feeder (Sampling station-S8)
9. S9 = Hulki diversion (Sampling station-S9)

Table 1: Classification of Inland Surface Waters (CPCS Standards) and Comparison of results with standard value

S. No.	Characteristics	A'	B'	C'	D'	E'	S1	S2	S3	S4	S5	S6	S7	S8	S9
1.	pH value	6.5 - 8.5	6.5 - 8.5	6.5-8.5	6.5-8.5	-	7.18	7.17	7.22	7.18	7.13	7.22	7.1	7.15	7.2
2.	Total Dissolved Solids, mg/l, Max	500	-	1500	-	-	265	276	290	296	342	297	306	294	240
3.	Total alkalinity	200	-	-	-	-	76	80	86	82	60	68	82	70	76
4.	Total	20	-	-	-	-	68	72	78	76	52	70	75	68	60

S. No.	Characteristics	A'	B'	C'	D'	E'	S1	S2	S3	S4	S5	S6	S7	S8	S9
	hardness	0													
5.	Total suspended solids	500	-	1500	-	-	56	62	66	82	216	85	156	64	56
6.	Calcium hardness	200	-	-	-	-	32	36	38	40	30	34	40	38	32
7.	Magnesium hardness	200	-	-	-	-	34	32	36	30	26	30	32	32	34
8.	Chlorides (as Cl), mg/l, Max	250	-	600	-	-	17	18	21	25	22	32	21	19	17
9.	Nitrates (as NO_3), mg/l, Max	20	-	50	-	-	0.8	1	0.9	1	0.8	1.1	0.9	0.8	0.8
10.	Sulphates (as SO_4), mg/l, Max	400	-	400	-	-	12	14	18	20	16	20	22	14	12
11.	Dissolved Oxygen, mg/l, Min	6	5	4	4	-	6.6	6.2	5.8	6.6	6.2	5.2	5.8	5.4	6.7
12.	Biochemical Oxygen Demand, mg/L, Max	2	3	3	-	-	2	4.8	2.4	2	3.5	5.2	2.4	4.6	2.4
13.	Copper (as Cu), mg/l, max.	1.5	-	1.5	-	-	-	-	-	-	-	-	-	-	-
14.	Iron (as Fe), mg/l, Max	0.3	-	50	-	-	-	-	-	-	-	-	-	-	-
15.	Zinc (as Zn), mg/l, Max	15	-	15	-	-	-	-	-	-	-	-	-	-	-
16.	Lead (as Pb), mg/l, Max	0.1	-	0.1	-	-	-	-	-	-	-	-	-	-	-

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S. No.	Characteristics	A'	B'	C'	D'	E'	S1	S2	S3	S4	S5	S6	S7	S8	S9
17.	Manganese (as Mn), mg/l, max.	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-

Determination of Water Quality Index: In this study, for the calculation of water quality index, thirty important parameters were chosen. The WQI has been calculated by using the standards of drinking water quality recommended by the World Health Organisation (WHO), Bureau of Indian Standards (BIS) and Indian Council for Medical Research (ICMR). The weighted arithmetic index method (Brown et. al.,) has been used for the calculation of WQI of the water body. Further, quality rating or sub index (q_n) was calculated using the following expression.

$$q_n = \frac{100[V_n - V_{io}]}{[S_n - V_{io}]}$$

(Let there be n water quality parameters and quality rating or sub index (q_n) corresponding to n^{th}parameter is a number reflecting the relative value of this parameter in the polluted water with respect to its standard permissible value.)

q_n= Quality rating for the n^{th}Water quality parameter

V_n= Estimated value of the n^{th}parameter at a given sampling station.

S_n= Standard permissible value of the n^{th}parameter.

V_{io}= Ideal value of nth parameter in pure water. (i.e., 0 for all other parameters except the parameter pH and Dissolved oxygen (7.0 and 14.6 mg / l respectively)

Unit weight was calculated by a value inversely proportional to the recommended standard value $S_n$of the corresponding parameter.

$W_n = K / S_n$

W_n= unit weight for the nth parameters

S_n= Standard value for nth parameters

K = Constant for proportionality

The overall Water Quality Index was calculated by aggregating the quality rating with the unit weight linearly.

$$WQI = \frac{\Sigma W_n q_n}{\Sigma W_n}$$

Table 2: Comparison of water quality index to standard value

S. No.	Sampling station	Water quality index of sample	Water quality status
1.	S1	47.89	Good water quality
2	S2	70.86	Poor water quality
3	S3	59.83	Poor water quality
4	S4	48.09	Good water quality
5	S5	69.03	Poor water quality
6	S6	85.62	Very Poor water quality
7	S7	66.06	Poor water quality
8	S8	79.32	Very Poor water quality
9	S9	57.55	Poor water quality
Average value		64.91	Poor water quality

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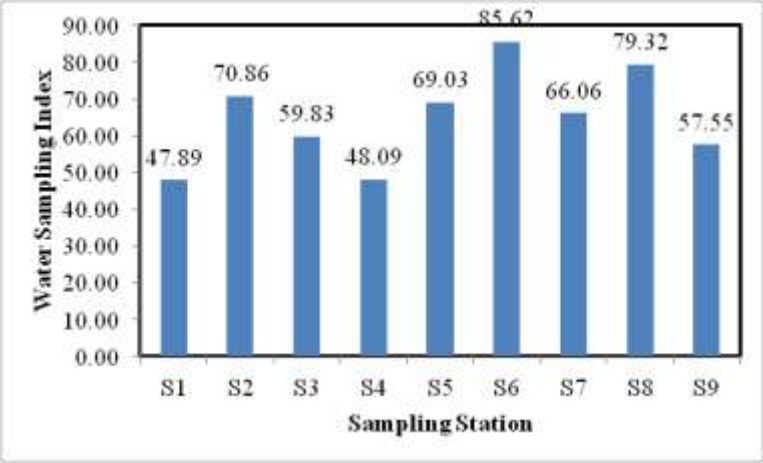

Fig. 2: Graphical representation between Sampling Station and Water Quality Index

III. RESULTS AND DISCUSSION

1. The standard pH range given by Central Pollution Control Board (CPCB) necessary for drinking water source without conventional treatment but after disinfection, outdoor bathing (organized), and drinking water source with conventional treatment followed by disinfection waste disposal, propagation of wild life, fisheries is from 6.5 to 8.5. The pH value of water sample in the study area ranged from 7.10 to 7.22. On an average, pH of all samples was in desirable limit as prescribed by CPCB standard.
2. Total solids, total dissolved solids and total suspended solids of this water body were found below the limits. CPCB and ICMR / BIS for TDS provided limit not to exceed more than 1500 mg / l and 500 mg / l respectively.
3. Total alkalinity of water in terms of $CaCO_3$ varied from 60-86 mg / l. The values of total alkalinity were comparatively moderate. The water for domestic use having alkalinity less than 100 mg / l is safe. Minimum alkalinity was found from the sample station S5 and maximum alkalinity was found from sample station number S3.
4. The hardness of the sampling points was recorded between the ranges of 52 mg / l (S5) to 78 mg / l (S3).
5. Chloride concentration of the sampling points was recorded between the ranges of 17 mg / l (S1) to 32 mg / l (S6). The concentration of chloride in water is not exceeding 250 mg / l.
6. Nitrate of the sampling points was recorded within the limits. However its small quantity reacts with various compounds present in our body and form carcinogenic compounds.
7. The problems caused by sulphate gives a bitter taste to water if it exceeds a concentration of 250 mg / l. Its concentration was recorded between the ranges of 12 mg / l to 22 mg / l.
8. Dissolved oxygen of the sampling points was found between the ranges of 5.2 mg / l (S6) to 6.7 mg / l (S9). CPCB and ICMR / BIS WHO, provided guidelines for the solubility of atmospheric oxygen in fresh water ranges from 4 mg / l and 5 mg / l respectively.
9. Biological Oxygen Demand indicates microbial pollution in water, the results indicate that water is much suffered from microbial pollution, Biological Oxygen Demand of other selected samples are in the range from 2 mg / l (S1) to 5.2 mg / l (S6). Maximum value is these sample 5.2 mg/l (S6)and minimum value is 2 mg/l (S1) & (S4).
10. Results show that the river is polluted due to organic loading especially from the domestic waste from Durg city and the residential colonies of industries due to high level of B.O.D. at the sampling stations S2, S6 . As per classification of inland surface waters (CPCB standards) the river, falls under the category of E' i.e., river water is suitable for irrigation and industrial purposes, signifying significant pollution in the river.
11. **WQI:** Water quality index was calculated of selected water samples as the basis of chosen water quality parameters. The results were ranging from 47.89 of the sampling site S1 which comes under the category of good water quality to 85.62 of the sampling site S6 which is very poor water quality. The average water quality index is 64.91 that is poor water quality. These values of water quality index are clearly showing that the water sources of study area are polluted because of all kinds of discharges from various sources.

IV. CONCLUSION

1. From assessment of physic-chemical study it could be clearly concluded that water is no severely polluted hence for only domestic purpose not for drinking purpose.
2. Physico chemical parameter is changed to first sampling point to last sampling point of Shivnath River due to industrial, anthropogenic activities, sand mining and environmental effect.
3. The result of water analysis show that the water quality index at sampling point S6, S8 are very poor water quality and S2, S3, S5, S7, S9 are poor water quality index due to high level of biochemical oxygen demand as per standard values of CPCB, ICMR and BIS expert sampling point S1 and S4 is good water quality index. Looking to the development potential of Durg due to abundance of natural resources it is expected that the industrialization and urbanization, mining and other activities will future increase, resulting into increased pollution load in the river. This call for immediate measures to be taken for waste strength and volume reduction .as the river is getting polluted continuously from various sources it is suggested that a river action plan be chalked out for restoration of river water quality covering the following.

(a) Interception and diversion of nallas falling into river.
(b) Construction of more anicut in river
(c) Sewage treatment plant for domestic waste water.
(d) Maximum rescue and recycle of treated waste water.
(e) Tree plantation along the river and at various places in the city as per the availability of land.
(f) Public awareness programs for proper sanitation water pollution and its control etc.

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