

Water Quality Analysis of Narmada River with Reference to Physico-Chemical Parameters at Hoshangabad City, M.P; India

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Abstract: Rivers are a major source for drinking water supply. Narmada River is considered to be the lifeline and west flowing river of the state of Madhya Pradesh, which covers 98797 sq. km. of total water shed area in India. In present study, the monitoring of water quality of Narmada River was carried out for one year from Jan.2019 to Dec.2019. The water samples collected from four main sampling stations at downstream of Hoshangabad city were analysed as per standard methods suggested by APHA (2012). The parameters as pH and Turbidity were determined in-situ. Statistical analysis is also carried out through correlation method and also evaluates Average Value (AV), Standard Deviation (SD), Standard Variance (SV), Standard Error (SE) and 95% Confidence Limit (CL) to assess the pollution load. The results revealed that Narmada River water quality is suitable and safe for domestic and irrigation purposes but not for drinking purpose without proper treatment because of Turbidity and TDS are not in the range of permissible limit according to the WHO and BIS standard suggested.

Keywords: Physico-Chemical Parameters, Water Quality, Statistical Analysis, Water pollution, Hoshangabad City, Narmada River

1. Introduction

Water is one of the most valuable resources on planet earth and is the lifeline of almost all living creatures on earth. The rivers plays an important role in providing drinking and irrigation water supplies. Narmada River flows through the three states of India Madhya Pradesh, Maharashtra and Gujrat and is also called the lifeline of Madhya Pradesh. It provides the clean water for domestic and irrigation purpose to Madhya Pradesh.

Study Area

Hoshangabad is the largest city among the cities situated at the bank of river Narmada. Narmada is the largest west flowing river in India and originates from Amarkantak in Madhya Pradesh. Hoshangabad a holy city is famous for its beautiful Ghats along river Narmada and is situated in between 77°58'30" longitude and 22°23'40" latitude. The river is being polluted here by receiving huge quantity of sewage, domestic wastes, municipal sewage along with industrial effluents from security paper mill (SPM) in addition to agricultural run-off that influence the water quality directly or indirectly. It flows 1350 km west through the state of Madhya Pradesh and Gujrat in term of its catchment area. Hence, it is intended to investigate physico-chemical parameters of river water.

2. Material and Methods

The water samples were collected from the river Narmada water from four selected stations where various pollution activities have large impact on water quality as S1(Sethanighat), S2 (Bandhrabhan), S3(Naoghat), S4(Dongarwara) for a period of twelve months during Jan.2019 to Dec.2019. The river water samples were collected in acid cleaned plastic containers as per standard method suggested by APHA (2012). The pH and Turbidity were estimated at sampling sites and for the determination of other parameters, samples were brought to laboratory

immediately and were determined as per the standard method.

3. Results and Discussion

The present study of various physico-chemical parameters on water of Narmada River suggested that the values of different parameters depending upon the hydrochemistry of the study area. The results obtained during the course of present study are tabulated in Table1 and 2. The results are shown by statistical evaluation as Minimum (MIN) and Maximum (MAX) values, Average Values(AV), Standard Deviation(SD), Standard Variance(SV), Standard Error (SE) and 95% Confidence Limit(CL) of the parameters for Narmada River water and are presented in Table1. The values of Correlation Coefficient (r) among various physico-chemical parameters of river water samples are tabulated inTable2.

pH:- pH is an important parameter, evaluating the acid-base balance of water. The pH of water is directly related to carbonate and bicarbonate ions present in water. The BIS limit of pH for drinking water is 6.5 – 8.0. The pH of the present study of Narmada River water is found to be in the range of 7.2 to 7.8 as shown in table1, whereas the average value with 95% CL was found to be (7.5 ± 0.2530) and showed negative correlation with BOD ($r = -0.1414$), whereas it showed positive correlation with all other physico-chemical parameters studied as shown in Table2.

Turbidity:- Turbidity is a water parameter that influences the light penetration. The Turbidity value of Narmada River water samples was found to be in the range of (188-214) NTU as shown in the Table1 and the average value of Turbidity with 95% CL was found to be (200.5 ± 10.8979) . The Turbidity showed negative correlation with BOD ($r = -0.0985$) and COD ($r = -0.0136$) whereas, it showed positive correlation with all other physico – chemical parameters as shown in Table2.

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Electrical Conductivity (EC):- Electrical Conductivity (EC) is an excellent indicator of TDS, which is a measure of salinity that affects the taste of potable water. The value of EC of water sample of Narmada River was observed to be in the range of (310 – 354) μ mhos/cm as shown in the Table1. The average value with 95% CL of EC was found to be (331 \pm 22.7727). The EC showed positive correlation with all physico–chemical parameters studied as shown in Table2.

Total Hardness (TH):-The Hardness of water is not a pollution parameter but indicates water quality. Hardness increases due to mixing of domestic wastes. In the present study TH of Narmada River water samples was found to be in the range between 214 mg/l to 262 mg/l as shown in the Table1. Similarly, the average value of TH with 95% CL was found to be (236.5 \pm 20.0756). The TH showed positive correlation with all physico–chemical parameters studied as shown in Table2.

Calcium Hardness (Ca-H):- Calcium is an important micronutrient in an aquatic environment. The concentration of Ca Hardness in Narmada River water during study period was found to be in the range of 48.0 mg/l to 68.0mg/l as shown in the Table1, whereas the average value with 95%CL was found to be (57.5 \pm 8.9638). The Ca Hardness showed negative correlation with Magnesium Hardness ($r = -0.08022$) and positive correlation with all other physico – chemical parameters have studied as shown in Table2.

Magnesium Hardness (Mg-H): Magnesium as cofactor for various enzymic transformations within the cell, especially in the transphorylation in algae, fungi and bacterial cell. The concentration of Mg-Hardness in Narmada River water sample was found to be 160.0 mg/l to 200.0mg/l as shown in the Table1. The average value of Mg-H with 95% CL was found to be (179 \pm 18.6968). The Mg-Hardness showed negative correlation with Ca-H ($r = -0.0802$), DO ($r = -0.0996$) and COD ($r = -0.2222$), whereas it showed positive correlation with all other physico–chemical parameters have studied as shown in Table2.

Total Alkalinity (TA): Total Alkalinity (TA) of water is described as its quantitative capacity to neutralize acids. Compounds like Carbonates, Bicarbonates and Hydroxides in water decreases the H⁺ ions and increases the pH of water. The present study showed the range of TA was 148-176 mg/l as shown in the Table1. The average value of TA with 95% CL was found to be (160 \pm 12.3959).The correlation study of TA showed positive correlation with all physico – chemical parameters studied in the present study as shown in Table2.

Total Dissolved Solids (TDS): Total Dissolved Solids (TDS) are the sum of all the chemical ions that are dissolved in water. It is due to the dissolution of gypsum, rocks soil etc. The maximum permissible limit of TDS for drinking water is 500 mg/l. In present study, TDS value of Narmada River water was found in the range between 384 mg/l to 408 mg/l as shown in the Table1. The average value of TDS with 95% CL was found to be (392.5 \pm 10.6603). The TDS showed negative correlation with COD ($r = -0.0738$) and positive correlation with all other physico–chemical parameters have studied as shown in Table2.

Chloride: Main source of Chloride in river water are sediments, sewage and industrial effluents. The BIS suggested the standard of Chloride is 250mg/l.The concentration of Chloride in Narmada River water was found to be in the range of 261 – 284 mg/l as shown in Table1, along with the concentration of an average value with 95% CL was found to be (271.75 \pm 9.5474).The correlation study of Chloride showed positive correlation with all physico – chemical parameters studied in the present study as shown in Table2.

Nitrate: The Nitrate is the basic constituent of all organisms and play a vital role in metabolism growth and reproduction. The high concentration of Nitrate in water indicates the quality of water due to the entry of waste water in river. The concentration of Nitrate in Narmada River water sample during study period was found to be in the range of 0.046 mg/l to 0.062 mg/l as shown in Table1, along with the concentration of the average value of Nitrate with 95% CL was found to be (0.053 \pm 0.0066). The Nitrate showed positive correlation with all physico–chemical parameters studied in the present study as in Table2.

Phosphate: Phosphate is the important nutrient necessary for the production growth of aquatic organisms. The increased application of fertilizers, use of detergents and discharge of domestic sewage greatly contribute to the heavy loading of Phosphorous in water. The concentration of Phosphates in Narmada River water samples varied between 0.16 mg/l to 0.24 mg/l, along with the concentration of an average value with 95% CL was found to be (0.195 \pm 0.0334) as shown in the Table1. The phosphate showed positive correlation with all physico–chemical parameters have studied as shown in Table2.

Dissolved Oxygen (DO): Dissolved Oxygen (DO) in water is of great importance to all aquatic organisms in water. Dissolved Oxygen in water depends on the physical, chemical and biological activities in the water body. The WHO suggested the standard value of DO is >5.00 mg/l. The concentration of DO in Narmada River water samples was found to be in the range of 3.2 mg/l to 3.8 mg/l as shown in Table1, along with the concentration of an average value with 95% CL was found to be (3.57 \pm 0.2577). The DO value showed negative correlation with Mg-Hardness ($r = -0.0996$), BOD ($r = -0.5553$) and COD ($r = -0.4200$). It showed positive correlation with all other physico–chemical parameters have studied as shown in Table2.

Biochemical Oxygen Demand (BOD):- Biochemical Oxygen Demand (BOD) is an indicator parameter to know the presence of biodegradable matter in the river water and express to degree of contamination. The present study showed the BOD value ranged from 8.6 mg/l to 9.4 mg/l. An average value of BOD with 95% CL was found to be (9.00 \pm 0.3578). The correlation study shows that BOD was negatively correlated with pH ($r = -0.1414$),Turbidity ($r = -0.0985$), DO ($r = -0.5553$) whereas, all remaining parameters studied showed positive correlation with BOD as shown in Table2.

Chemical Oxygen Demand (COD):- Chemical Oxygen Demand (COD) indicates the extent of chemical pollution

mainly industrial effluents. The COD value observed to be in the range between 128.1mg/l to 141.2 mg/l. An average value of COD with 95% CL was found to be (134.47±5.5073). The present correlation study showed that

COD was negatively correlated with Turbidity ($r = -0.0136$), Mg-H ($r = -0.2222$), TDS ($r = -0.0738$) and DO ($r = -0.4200$). All remaining parameters have studied, showed positive correlation with COD as in Table2.

Table1: Statistical Evaluation for Physico-Chemical Parameters of Narmada River Water Samples During Jan-2019 to Dec-2019

Parameters	MIN	MAX	AV	SD	SV	SE	CL (95.0%)
pH	7.2	7.8	7.5	0.2581	0.0666	0.1290	7.5 ± 0.2530
Turbidity	188	214	200.5	11.1205	123.6667	5.5602	200.5 ± 10.8979
Electrical Conductivity	310	354	331	23.2379	540	11.6189	331 ± 22.7727
Total Hardness	214	262	236.5	20.4857	419.6667	10.2428	236.5 ± 20.0756
Ca-H	48	68	57.5	9.1469	83.6666	4.5734	57.5 ± 8.9638
Mg-H	160	200	179	19.0787	364	9.5393	179 ± 18.6968
TA	148	176	160	12.6491	160	6.3245	160 ± 12.3959
TDS	384	408	392.5	10.8781	118.3333	5.4390	392.5 ± 10.6603
Chlorides	261	284	271.75	9.7425	94.9166	4.8712	271.75 ± 9.5474
Nitrates	0.046	0.062	0.053	0.006831	4.6780	0.003416	0.053 ± 0.0066
Phosphates	0.16	0.24	0.195	0.03415	0.0011	0.0170	0.195 ± 0.0334
DO	3.2	3.8	3.57	0.2629	0.0691	0.1314	3.57 ± 0.2577
BOD	8.6	9.4	9.00	0.3651	0.1333	0.1825	9.00 ± 0.3578
COD	128.1	141.2	134.47	5.6198	31.5825	2.8099	134.47 ± 5.5073

Table 2: Correlation Coefficient Values among the Various Physico-Chemical Parameters of Narmada River Water Samples during Jan-2019 to Dec-2019

Parameters	pH	Tur	EC	TH	Ca-H	Mg-H	TA	TDS	Cl ⁻	No ₃ ⁻	Po ₄ ³⁻	DO	BOD	COD
pH	1													
Tur	0.9983	1												
EC	0.9333	0.9261	1											
TH	0.4663	0.5077	0.5279	1										
Ca-H	0.7056	0.6848	0.9064	0.3717	1									
Mg-H	0.1624	0.2168	0.1323	0.8954	-0.0802	1								
TA	0.8981	0.9099	0.9435	0.7718	0.7836	0.4530	1							
TDS	0.9256	0.9451	0.8571	0.7464	0.5795	0.5235	0.9496	1						
Cl ⁻	0.4902	0.5307	0.5521	0.9995	0.3946	0.8841	0.7898	0.7627	1					
No ₃ ⁻	0.8315	0.8512	0.8819	0.8622	0.7148	0.5831	0.9875	0.9419	0.8764	1				
Po ₄ ³⁻	0.5291	0.5704	0.5627	0.9956	0.3734	0.8900	0.8023	0.7984	0.9966	0.8857	1			
DO	0.8344	0.8263	0.6054	0.0402	0.2979	-0.0996	0.5210	0.6816	0.0617	0.4267	0.1298	1		
BOD	-0.1414	-0.0985	0.0157	0.8021	0.0399	0.8421	0.2886	0.2014	0.7870	0.4276	0.7483	-0.5553	1	
COD	0.0114	-0.0136	0.3642	0.1124	0.7155	-0.2222	0.2419	-0.0738	0.1203	0.2179	0.0512	-0.4200	0.2469	1

4. Conclusion

Narmada river water is a chief source for drinking and irrigation, hence it should be free from impurities. People consuming it directly without proper treatment suffer great health hazards, which are significantly visible in the rural and tribal areas. Narmada River is also providing electricity to Madhya Pradesh and Gujrat. In the electricity production water should be free from impurities and hardness otherwise it adversely affects the turbines and boilers. From the above study, it may conclude that except Turbidity and TDS all the physico-chemical parameters were in permissible limit suggested by WHO and BIS 10500 at the study site of Narmada River. It is suggested that proper measures are necessary to avoid contaminations as water is used for drinking purpose and may be used after proper treatment and is also concluded that at present, the river water is suitable for irrigation and fishery purpose.

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