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Physico-chemical studies in selected stretch of River Narmada, Madhya Pradesh

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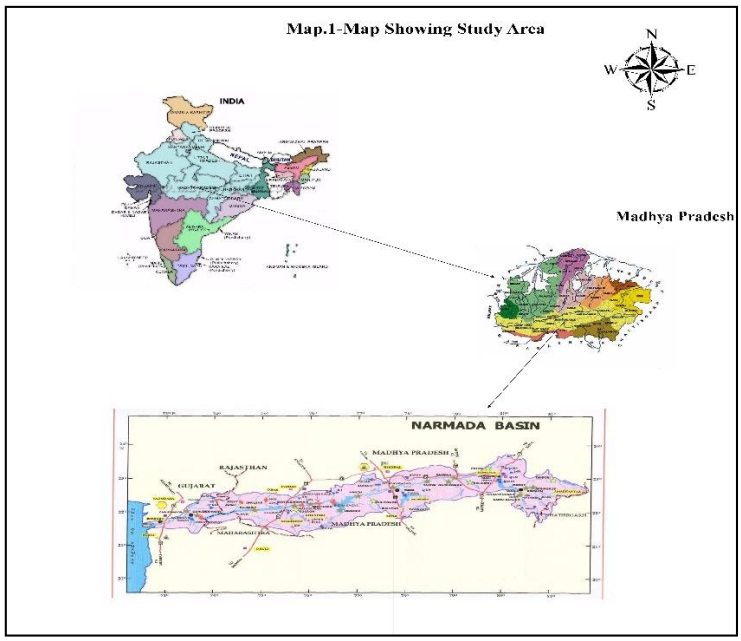
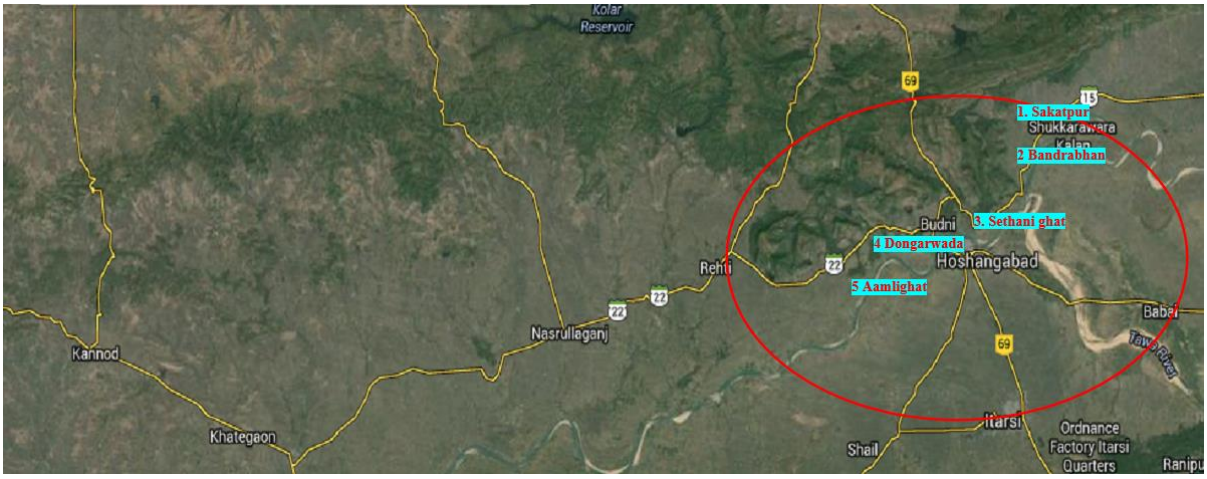
Abstract
The present study was carried out for a period of two year from July 2015 to April 2017 to enumerate the various Physico-chemical parameters of Narmada River. Water samples were taken from sampling sites seasonally and were analyzed as per standard methods. Maxima of Conductivity, Orthophosphate, Turbidity, Chloride were recorded in monsoon and Maxima of Total Dissolved Solid (TDS), Dissolved Oxygen (DO) were observed during winter. Temperature was recorded maximum in summer and minimum in winter season. Total Hardness and Chloride were observed maximum in post monsoon. DO concentration was higher in winter and lower in summer. Narmada river water is the main source of drinking, Irrigation, fish culture and other important activities for central India. Hence the present investigation is consisting to observe the chemical and physical constituent of Narmada River water and the quality of water pollution status of river.

Keywords: physico-chemical parameters, pollution status, Narmada river

1. Introduction
Water is one among the prime necessities of life required for growth and activity of all living beings on globe. Only small amount of water that occurs in fresh water rivers, streams, lakes and tanks is available for the terrestrial life (Wetzel 1975) [21]. Rivers and streams have become the dump yards of domestic sewage and industrial effluents. Alarming increase in human population and unethical urbanization has lead to the pollution of fresh water bodies to a great extent. Rivers are the major sources of drinking water, besides their usage in agriculture, washing, bathing etc. Pollution of these may invite unhygienic conditions and water born infectious diseases not only for humans but also the biota depending and living in it.

Narmada river ecosystem is said to be one of the most important river ecosystem in India and life line of Madhya Pradesh. It flows from Amarkantak hills to Gulf of Cambay. It supports the local economic activities such as agriculture, fishery, ecotourism, irrigation and water supply for domestics and industries. Now a day's water quality of river ecosystem degradation by various sources becomes an important issue around the world. Usage of more land for agricultural purposes, soil, salinization and increase in the use of agricultural fertilizers, common pesticide use, and erosion have become problems threatening natural water source. The river is being polluted here by much city sewage along with industrial effluents from Security paper Mill as it provide a cheaper mode of waste disposal. In Narmada river huge quantity of domestic waste, municipal sewage dumped daily in addition to industrial effluents and agricultural run-off. Hence it is intended to investigate physico- chemical parameters of river water.





1. Sakatpur, 2. Bandrabhan, 3. Sethani ghat, 4. Dongarwada, 5. Aamlighat

Fig 1: Study Area

2. Material and Methods

Water samples were collected from the river Narmada water from five selected sites S1 (Sakatpur), S2 (Bandrabhan), S3 (Sethanighat), S4 (Dongarwada) and S5 (Aamlighat) for a period of two year during 2015-2017(Map-1). The river water samples were collected in different sampling bottles as per standard method APHA (2002) [1]. The Temperature, pH, electrical conductivity and turbidity were estimated at sampling sites. The other parameters were measured by the procedure is given by APHA (2002) [1] and Adoni (1985) [2] in the laboratory**.** The investigation period was divided into four seasons i.e. pre-monsoon, post-monsoon, winter and summer season.

3. Result and Discussion

The Physico-chemical characteristics of the water of Narmada River in Madhya Pradesh are showing fluctuation at the five study sites during the two year study period**.** A summary of physical and chemical parameters of the study area are given in (Table 1). The minimum, maximum, mean and standard deviation values are as shown.

3.1 Water Temperature

The water temperature ranged between 17.1 ºC to 26.2ºC (Mean ± SD = 21.57 ± 2.25). The lowest water temperature 17.1ºC was recorded at bottom of S1 sampling site in the season of winter (January, 2017) while highest water temperature was 26.2ºC at surface S1 sampling site in the season of summer (April, 2017), which is given in (Table 1 & Figure 2). Sharma *et al.* (2001) [12], Yogesh *et al.* (2001) [20] and Deepika Saini & Dube (2017) [4] also reported the same type of fluctuation in various freshwater bodies.

3.2 Potential Hydrogen (pH)

The pH observed at seven sampling sites ranged from 7.5 to 8.9 (Mean ± SD = 8.39 ± 0.31). The minimum 7.5 pH was recorded at the bottom of S1 sampling site in season of post monsoon (October, 2015) while highest 8.9 pH was recorded at surface S3 sampling site in season of post monsoon **(**October, 2017) which are summarized in (Table 1 & Figure 2). Our results similar with the findings of Sharma *et al.* (2004&2011) [11, 12] & Deepika Saini & Dube (2017) [4].

3.3 Conductivity

The conductivity varied between 180 µs/cm to 480 µs/cm (Mean ± SD = 276 ± 63.96). The minimum conductivity of 180 µs/cm was observed at the both sampling site viz., surface of S1 and S4 in the season of winter, 2016) while the maximum conductivity of 480 µs/cm was measured at bottom of S4 sampling site in the season of monsoon (July, 2016) which is summarized in (Table 1 & Figure 3). The exchange of inorganic ions by increased micro flora during the winter showed the moderate values of conductivity during the winter period.

3.4 Total Dissolved Solid (TDS)

Total dissolved solid values ranged from 109 ppm - 270 ppm (Mean ± SD = 157.24 ± 39.52). The highest value was recorded as 270 ppm at the surface of S4 sampling site in the season of winter (January 2017) and lowest value of 109 ppm was recorded at sample site S2 Surface in the post monsoon season of the year 2015 which are summarized in (Table 1 & Figure 3). Moreover the low value of total dissolved solids in summer and high in rainy season was also observed (Trivedy, *et al*. 1984) [16].

3.5 Turbidity

Turbidity values ranged from 2 NTU - 80 NTU (Mean ± SD = 23.64 ± 20.09). The minimum value of turbidity was 2 NTU which was recorded at the surface of S2 and surface S5 sampling sites in the season of winter (January, 2016) while the maximum 80 NTU was observed at the bottom of S2 sampling site in the season of monsoon (July 2016), which are summarized in (Table 1 & Figure 3). Verma and Saksena (2010) [19] found the lowest and highest range of turbidity of river Kalpi of Gwalior, Madhya Pradesh as 1.2 NTU to 110.7 NTU respectively.

3.6 Dissolved Oxygen (DO)

The dissolved oxygen content was ranging from 7.2 mg/l – 13.2 mg/l (Mean ± SD = 9.6 ± 1.3). The maximum value of dissolved oxygen content was 13.2 mg/l which was recorded at bottom of S5 (Pool) sampling site in season of winter (January, 2017) and the minimum value of dissolved oxygen content was 7.2 mg/l which was recorded at bottom of S4 & S5 surface sampling sites in the season of summer (October, 2015), which are given in (Table 1 & Figure 2). The seasonal fluctuation of dissolved oxygen in water bodies and the pattern of DO in the present study is very similar to the findings of Singh and Singh (1990) [15] in Narmada River.

3.7 Free Carbon dioxide (Free CO_2)

Free carbon-di-oxide showed a significant variation from the surface to bottom zone. During most of the study period, free CO_2 was totally absent on the surface and sometimes it was present on the bottom. No definite trend in the distribution of free carbon-di-oxide was observed in the river during the entire two year study period. The free CO_2 values ranged from 0.2 mg/l – 3.2 mg/l (Mean ± SD = 0.8 ± 1.4). The minimum free CO_2 0.2 mg/l was recorded at the bottom of S4 sampling site in the post monsoon season 2016 and summer season in 2017 whereas maximum value was 3.2 mg/l which was observed at the bottom of S4 sampling site in the monsoon season, which are given in (Table1 & Figure 5). Similar observations have been reported by Hynes (1970) [5] and Qadri and Yousuf (1978) [9].

3.8 Total Alkalinity

Total alkalinity values ranged from 13mg/l - 66 mg/l (Mean ± SD = 39.86 ± 9.89). The highest value of alkalinity was recorded 66 mg/l at bottom of S4 sampling site in the season of post monsoon (October 2015). The lowest alkalinity as 13 mg/l was observed at bottom of S2 sampling site in season of post monsoon (October 2016), which is given in (Table 1 & Figure 4). During the summer season the higher values of hardness were observed and lower values during winter season (Ugale and Hiware, 1999 and Pratibha, *et al.* 2005) [16, 8].

3.9 Chloride

The chloride varied between 7.5 mg/l and 34 mg/l (Mean ± SD = 18.17 ± 4.44). The minimum chloride value was 7.5 mg/l which was observed at the surface of S1 sampling site in the season of monsoon (July, 2016) while the maximum chloride value was 34 mg/l which was measured at the bottom of S3 sampling site in the season of monsoon (July 2016), which is given in (Table 1 & Figure 4). Several authors have reported chloride within the close ranges (Ray and David, 1966; Chattopadhyaya *et al.*, 1984; Unni, 1996; Johal, 2002) [10, 3, 18, 6] from the Narmada, Chambal, Ganga, Kaveri riverine system and Hillstreams of Himachal Pradesh and Garhwal region.

3.10 Total Hardness

The total hardness content values ranged from 44 mg/l - 110 mg/l (Mean ± SD = 67.96± 13.01). The maximum value of total hardness content was 110 mg/l which was recorded at the surface of S5 (Run) sampling site in the season of post monsoon (October, 2015) and the minimum value of total hardness content was 44 mg/l which was recorded at the surface of S2 sampling site in the season of winter (January 2016), which are given in (Table 1 & Figure 4). Similar observation was noted by (Ray and David, 1966; Chattopadhya *et al.*, 1984; Shukla *et al.*, 1989) [10, 3, 13].

3.11 Nitrate

The nitrate values varied between 0.08 mg/l to 1.42 mg/l (Mean ± SD = 0.32 ± 0.24). The lowest Nitrate value of 0.08 mg/l was recorded at the surface of S2 (Pool) sampling site in the season of winter (January, 2016) while highest nitrate value of 1.24 mg/l was recorded at the bottom of S5 sampling site in the season of (post monsoon, 2015), which are given (Table 1 & Figure 5). Similar findings were observed by (Singh, 1993; Unni, 1996; Johal, 2002; Nath and Shrivastava, 2001) [14, 18, 6, 7].

3.12 Orthophosphate

The orthophosphate values ranged from 0.01 mg/l – 0.78 mg/l (Mean ± SD = 0.18± 0.14). The highest value of orthophosphate was recorded 0.78 mg/l at the bottom of S5 sampling site in the season of monsoon (July, 2015). The lowest orthophosphate value was 0.01 mg/l was observed at the surface of S1 sampling site in season of summer (April, 2017), which is shown in (Table 1 & Figure 5). Similar trends were observed by (Singh, 1993; Unni, 1996; Johal, 2002; Nath and Shrivastava, 2001) [14, 18, 6, 7].

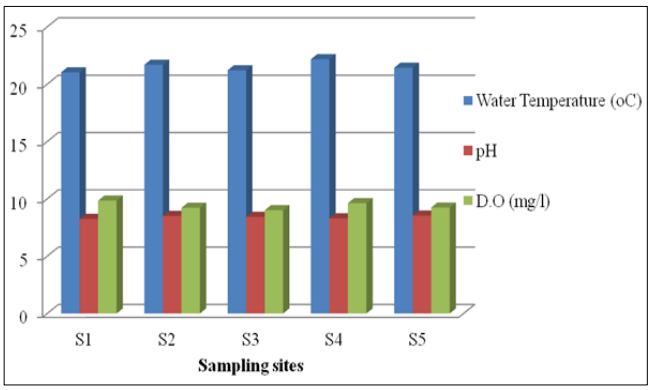


Fig 2: Graph showing variation in WT, pH & DO (mean) at different sampling sites.

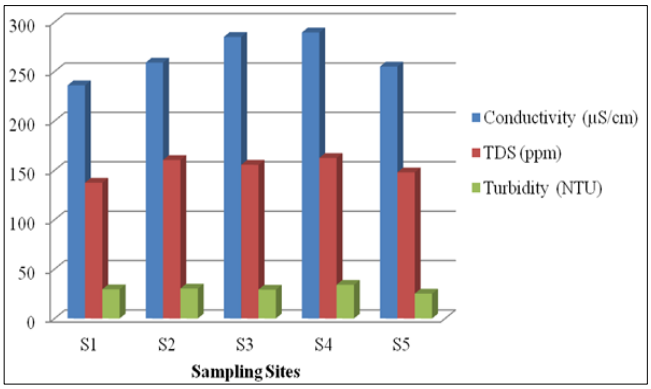


Fig 3: Graph showing variation in conductivity, TDS & Turbidity (Mean) at different sampling sites.

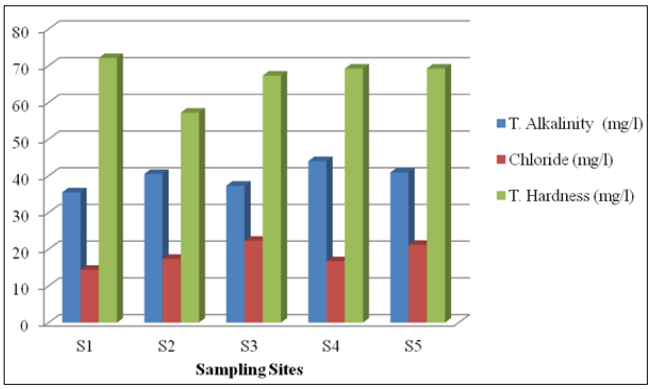


Fig 4: Graph showing variation in TA, chloride & TH (mean) at different sampling sites.

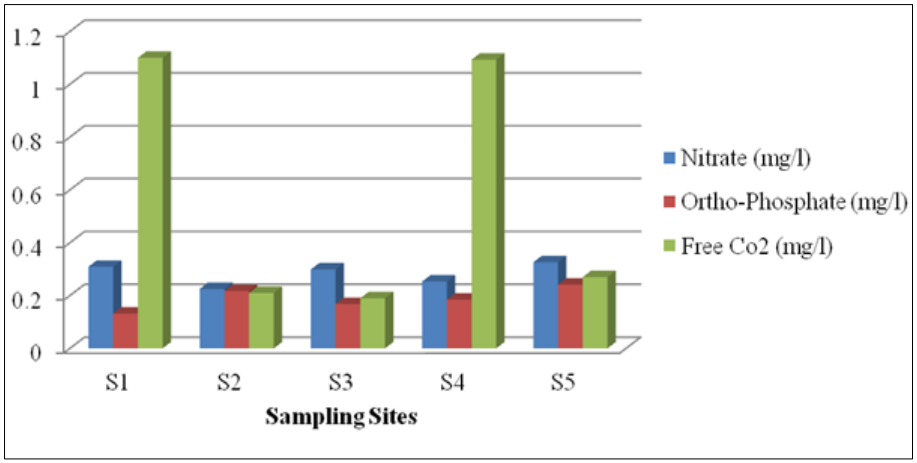


Fig 5: Graph showing variation in Nitrate, OP & CO_2 (mean) at different sampling sites.

Table 1: Physico-chemical properties at different sampling sites of Narmada River (2015-2017)

S. No.	Parameters	S1				S2				S3				S4				S5			
		Mean	**Min.**	**Max.**	**SD**	**Mean**	**Min.**	**Max.**	**SD**	**Mean**	**Min.**	**Max.**	**SD**	**Mean**	**Min.**	**Max.**	**SD**	**Mean**	**Min.**	**Max.**	**SD**
1.	Water Tem.ºC	21.03	18.2	24.4	2.149	21.69	19.2	25.4	1.784	21.21	19.2	23.3	0.44	22.17	18.1	25.5	2.837	21.43	18.2	24.5	2.256
2.	pH	8.25	7.5	8.8	0.433	8.5	7.8	8.9	0.316	8.423	8.1	8.9	0.097	8.3	7.8	8.8	0.359	8.54	7.9	8.9	0.291
3.	Conductivity (µS/cm)	236	180	340	43.385	259	185	410	76.696	285	240	420	16.882	289.5	180	480	94.235	255	210	300	35.04
4.	TDS (ppm)	137.4	110	180	20.812	160.4	109	230	44.378	155.5	110	250	13.913	162.5	110	240	52.876	147.9	110	180	23.704
5.	Turbidity (NTU)	29.5	3	80	25.008	30.3	2	80	31.188	29.2	4	60	6.779	34.1	12	75	19.757	25.1	2	55	20.963
6.	D.O mg/l	9.84	8.4	11.2	0.778	9.21	7.8	11.3	1.143	9	7.2	11.5	0.436	9.62	7.2	12.3	1.625	9.24	7.2	11.3	1.195
7.	Free Co2 (mg/l)	1.1	0	2.8	1.233	0.21	0	1.3	0.458	0.19	0	0.9	0.104	1.093	0	3.2	1.428	0.27	0	1.6	0.581
8.	T. Alkalinity (mg/l)	35.5	24	53	8.86	40.5	30	55	8.114	37.3	23	49	2.785	44	30	66	11.832	40.9	32	52	7.894
9.	Chloride (mg/l)	14.375	7.5	20.3	3.637	17.359	13.9	22.4	3.218	22.282	16.1	34	1.541	16.732	12	22.23	3.49	21.193	13.1	25.5	3.914
10.	T. Hardness (mg/l)	72.1	52	102	13.828	57.2	44	70	7.829	67.3	44	85	4.187	69.2	48	90	13.863	69.2	45	110	19.86
11.	Nitrate (mg/l)	0.309	0.178	0.47	0.098	0.225	0.082	0.356	0.091	0.299	0.11	0.888	0.074	0.253	0.106	0.403	0.095	0.326	0.102	1.42	0.394
12.	Ortho-Phosphate (mg/l)	0.132	0.018	0.278	0.07	0.217	0.016	0.623	0.189	0.168	0.058	0.342	0.029	0.184	0.032	0.372	0.107	0.241	0.028	0.782	0.249

4. Conclusion

This study provides an informative data and helps to understand the contamination of waste water in river Narmada and the influences the ecology of river Narmada. The major source of pollutants are local anthropogenic activities, agricultural runoff and by industrial effluent. In the present study it was found that physico- chemical characteristics of a few of the river water samples crossed the maximum permissible limit, due to heavy mixing of effluent waste and domestic sewage. If proper alternative arrangements like sewage treatment before discharge are not made then the situation may be alarming to the inhabitants in the study area and to the downstream as well. Thus, adequate attempts have to be made to treat the waste water before discharging it to the water bodies to keep the environment healthy.

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