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Full Length Research Paper

Assessment of water quality of Betwa River, Madhya Pradesh, India

Santosh Vishwakarma[1]*, Alok Varma[2]* and Geeta Saxena[1]

[1]Department of Zoology, Government Science and Commerce College, Benazeer, Bhopal, India.
[2]Department of Zoology, Government Raja Bhoj College, Mandideep Raisen, India.

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The present paper deals with the monthly interval variation of physico-chemical characteristics of River Betwa during October 2011 to August 2012. Five major sampling station (10 sites) were selected: station- I Jhirri (1 to 2 sites), station- II Nayapura (3 to 4 sites), station- III Mandideep (5 to 6 sites), station- IV Bhojpur (7 to 8 sites) and station- V Vidisha (9 to 10 sites). Various physico-chemical parameters like temperature, pH, hardness, dissolved oxygen (DO), biological oxygen demand (BOD) and chemical oxygen demand (COD) and correlation co-efficient were measured, and standard methods were applied in the present work. Studies revealed high values of hardness, BOD and COD at station II Nayapura and station III Mandideep, and low values of DO and pH at the station - station I Jhirri, IV Bhojpur, and Vidisha low values of hardness, BOD and COD. High value of hardness, BOD and COD indicate the river water polluted at station II Nayapura and station III Mandideep.

Key words: Betwa River, Mandideep, Nayapura, physico-chemical parameters.

INTRODUCTION

India is a land of many rivers. The total length of all our major rivers together with their tributaries is 27,359 km. From ancient time in India, the rivers are not only considered as a mass of flowing fresh water. According to Hindu mythology the water is believed to be one of the five essential ingredients of all the living beings, or the “Panch-Mahabhutas” ever since the Vedic times. Rivers have always been the most important fresh water resources and most developmental activities are still dependent upon them. Rivers play a major role in assimilating or carrying industrial and municipal waste water, manure discharge and runoff water from agricultural field, road ways and streets which are responsible for river pollution (Ward and Elliot, 1995). The River Betwa is a river in Northern India, and tributary of the Yamuna originating in the Kumra (Jhirri) village in Raisen dirtrict of Madhya Pradesh, India. The River Betwa plays a significant role in the human life of the villages villages located in Mandideep, Nayapura and Bhojpur areas. It has become polluted at some places of Mandideep due to industrial activities and the confluence of sewage, domestic wastes and industrial effluents of many big and small enterprises with various types of organic compounds and heavy metals deterioted to human health and aquatic organisms. Urban areas, farms, factories and individual households – all contribute to the contamination of this river. The water quality in the stretch of the River Betwa extending from its origin near Mandideep industrial area up to Bhojpur remains poor because of the regular inflow of domestic waste of the Bhopal city through the Kaliyasot River and industrial/domestic waters from Mandideep (Kori et al., 2006). Study of different physico-chemical parameter revealed that the intensity of pollution increased as the river was subjected to sewage and industrial waste. In order to manage the pollution load of River Betwa that pass nearby Mandideep and Nayapura, it is recommended that various methods of sewage industrial

*Corresponding author. E-mail: santy2510@yahoo.in.

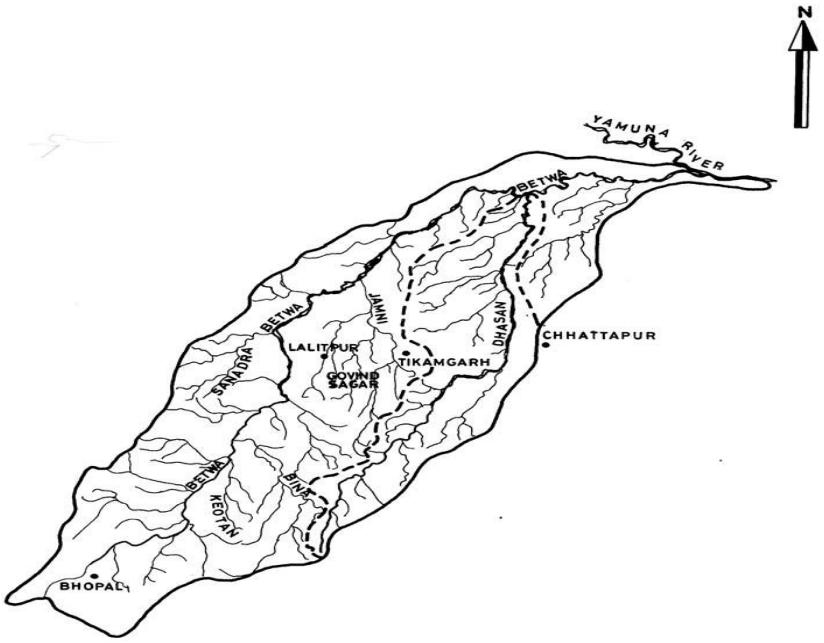


Figure 1. Betwa River Besin.

waste treatment should be used before disposal of effluents.This is a study to aware the people how they have contaminated the source of life. In view of increased demand of water due to expanding needs it seems evitable to study surface water bodies particularly river for proper utilization and conservation. For generation to come it becomes prime necessity to study River Betwa, of Madhya Pradesh which is facing many changes due to the development of urbanization and industrial evolution. The problem of resettlement of submergence, rehabilitation and change in ecosystem is creating major environmental impact as riverine ecosystem is being disturbed. The present work is aimed at understanding the following points:

1. Study of industrial pollution in River Betwa at Mandideep, and approximately 200 km of river stretch at 20 stations or sites.
2. To observe the impact of pollution on different sites of River Betwa, both biologically as well as chemically.
3. The analysis of water quality in terms of various selected physico-chemical parameters.

MATERIALS AND METHODS

Study area (sampling sites)

The river basin lies between the latitudes of 22* 54' N and 26*00, N and the longitudes of 77*10' E and 80*20' E. The total catchments area of the basin in 43895 Km^2 out of which 30217 Km^2 lies in Madhya Pradesh and the remaining 13678 Km lies in Uttar Pradesh (KBLP, 1995).

On the basis of the survey conducted and literature available, five stations and ten monitoring sites were selected to sample water.

The sites were selected mostly on the basis of various activities occurring on surrounding area of the river (Figure 1).

Samples were taken at the following points during alternate month

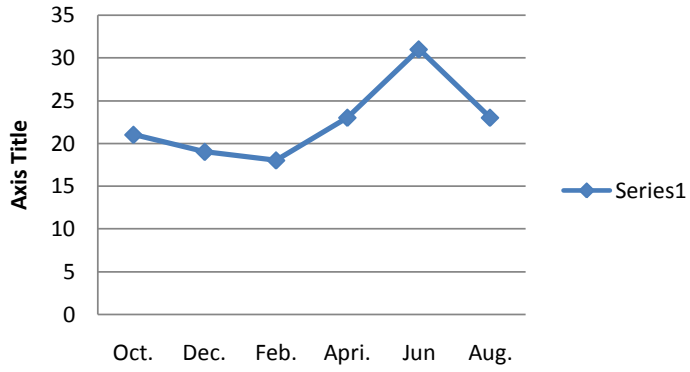
Station I: This station is located near village Jhirri. River Betwa originates from this point. It is fifteen kilometer away from Bhopal on Kolar Dam Road**,** touching the border of Ratapani sanctuary; home too many wildlife and birds (1 to 2 sites).

Station II: It is a village near Mandideep, the Betwa touches the boundary of this village near Road Bridge where it confluences with the Kaliyasot tributaries (3 to 4 sites).

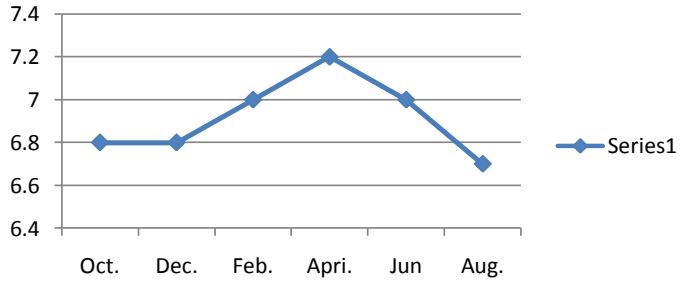
Station III: Mandideep is the municipality in Goharganj district Raisen in MP. Mandideep is 20 km away from Bhopal and popular as industrial township which came in to existence in late 1970s. It has an industrial area, the major industries that are closer are Hindustan Electro Graphite (HEG), Procter & Gamble, Eicher tracters Ltd, Lupin laboratories, and national and international level companies have their manufacturing units at Mandideep. It is located near River Betwa. River Betwa encircle this industrial area, thus, Mandideep was also selected as a study site in the present research work (5 to 6).

Station IV: Bhojpur is situated on the bank of Betwa River 28 km away from Bhopal, the state capital of MP. The site is located on sandstone ridges, typical of central India, next to a deep gorge through which the Betwa River follows (7 to 8).

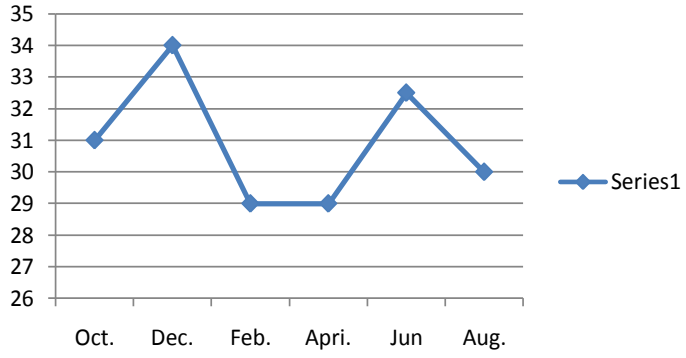
Station V: Vidisha is a city in the state of Madhya Pradesh, India located near the state capital Bhopal. The city was also known as Bhilsa during the medieval period. The town is situated east of Betwa River in the fork of the Betwa and Bes River, 10 km from Sanchi (9 to 10).



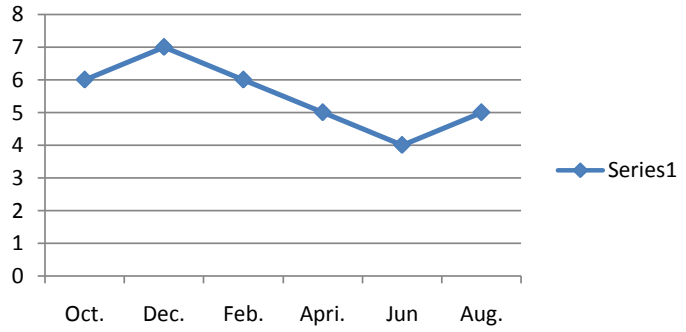
Graph I. Value of Temperature (°C) in different months.



Graph II. Value of pH in different months.



Graph III. Value of hardness (mg/L) in different months.



Graph IV. Value of Dissolved oxygen (mg/L) in different months.

Measurement of physico-chemical parameters

The physico-chemical parameters such as temperature, pH, dissolved oxygen, biological oxygen demand and chemical oxygen demand and hardness were measured as according to APHA (1976). The correlation between abiotic (physico-chemical) parameters was done by using coefficient of correlation Karl Pearson`s formula

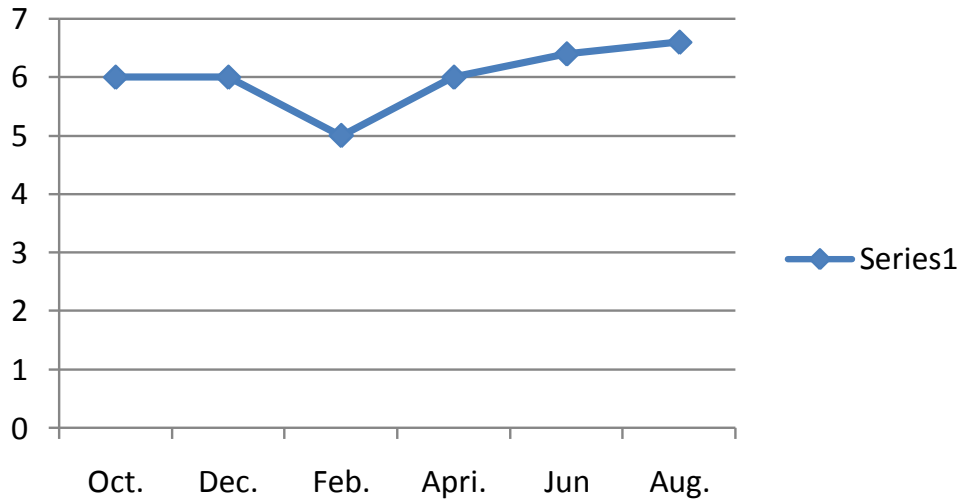
$$r = \frac{\sum d_x d_y}{\sqrt{\sum d_{x^2} \sum d_{y^2}}}$$

RESULTS

Temperature influences the life of all biological organisms. During the period of study temperature was recorded ranging from 16 to 31°C (Graph I). pH expresses the intensity of acidity or alkalinity of an aquatic environment. The pH ranged from 5 to 9.2, (Graph II) the water was acidic at station II Nayapura and station III Mandideep - the change in pH values of station II and III. It was observed that pH decreased. Hardness is often used to assess the quality of water. Hard water contains large concentrations of alkaline earths dissolved from the drainage of calcium deposits (Wetzel, 1975). In the present study the observed values ranged from 14.6 to 58.6 mg/L (Graph III). Dissolved oxygen is very crucial for the survival of aquatic organism, Yakub and Ugwvmba,(2009). The DO ranged from 2 to 12.3 mg/L. minimum DO was recorded at station II and III Nayapura and Mandideep (Graph IV), and negative relation showed with BOD (r = - 0210). BOD value of river water ranged from 2 to 15 mg/L (Graph V) and high value of BOD was recorded at station II and III; BOD showed a significant positive correlation with COD (r = 0.314). In the present study the value of COD varies from 8 to 81.5 mg/L.

DISCUSSION

The temperature variation is mainly related with the temperature of atmospheric and weather condition (Adebowale et al., 2008). The reduction in the pH of River Betwa could have been due to the discharged industrial effluents. This result agrees with the reports by previous scientist (Edema et al., 2006; Rim-Rukeh et al., 2006; Dhakyanika and Kumara, 2010). The increase in hardness can be attributed to the decrease in water volume in the rate of evaporation at high temperature, high loading organic substances, detergent, chlorides and other pollutants (Rajgopal et al., 2010; Eruola et al., 2011) (Table 1). Minimum dissolved oxygen due to



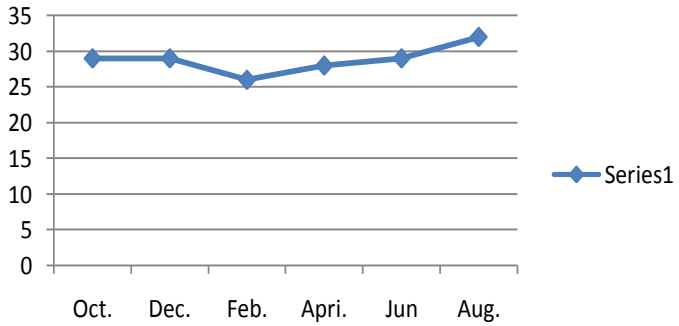
Graph V. Value of BOD (mg/L) in different months.

Table 1. Values of physico-chemical parameter at different sites of river.

Month	Site										
	1	2	3	4	5	6	7	8	9	10	M
						Temperature					
Oct.	21	20	20.5	21	21.4	22	20	21.1	22	22.4	21
Dec.	19	18	19.4	19	17.3	18.3	19.2	20	20.5	17.7	18.6
Feb.	16.3	17.5	17.2	18	16.5	18.5	19.2	17	19	18.5	17.5
Apri.	23	23.5	24.3	22	23	24	21	23	23.2	23.5	23
Jun.	30	30.2	31.3	29.5	32	31	31.6	30.2	32.2	31.2	31
Aug.	24	24.3	23	22	24	23	21	23.2	23	24.3	23.1
						pH					
Oct.	7.3	7.1	6.2	6.4	5.4	5.8	7.5	6.7	8.9	7	6.8
Dec.	7.4	7.8	5.5	6	5.8	6.3	7.4	8.3	6.8	7.5	6.8
Feb.	7.2	7	6.3	6.5	5.7	5.3	8.2	8	7.8	7.1	7
Apri.	8.1	8.4	6.2	6.1	6	5.5	7.6	6.7	7.3	8.2	7.2
Jun.	7	7.2	6.4	6.3	6.1	6	7.7	7.4	8.2	8.5	7
Aug.	8.8	8.4	5.6	5	5.3	5.5	8.1	7.4	6.8	7.2	6.7
						Hardness					
Oct.	16	16.2	40	40.4	52.4	50.5	20.2	20.5	22	22.6	30.8
Dec.	15	15.8	42.4	42.8	50.5	52.2	18.4	18.9	20.2	20.8	34
Feb.	14.2	14.8	38.2	36.8	48.4	48.6	20.4	20.6	24.5	24.4	29
Apri.	15.6	15.9	35.6	35.8	50.5	50.8	22.4	22.8	21.4	21.6	29.2
Jun.	18.4	18.8	36.2	36.5	58.4	58.6	24.4	24.6	24.8	24.9	32.5
Aug.	16	16.8	35.4	35.6	54.8	54.2	22	22.4	21.5	21.8	30
						Dissolved oxygen					
Oct.	8.4	8.2	2.1	2.2	2	1.8	7.6	8	8.2	7.5	5.6
Dec.	10.2	12.3	2.4	2	2.1	2.5	10	10.7	9.8	9.7	7
Feb.	8.8	9.9	2.2	2.	3	3.1	7.2	8.2	8	8.4	5.7
Apri.	7.1	7.2	2.4	2.3	2.4	2.1	7.8	8.3	7.5	7.1	5.4
Jun.	5.8	6.2	1.5	1.3	1.6	1.3	6.2	6.9	6.5	6.1	4.3
Aug.	6.8	6.5	2.2	2.4	3.2	3.4	7.6	7.8	6	6.5	5.2

Table 1. Contd.

Biological oxygen demand											
Oct.	2.4	2.5	7.4	7.5	12.3	14.6	2.5	2.4	4.2	3.4	6
Dec.	3.4	2.2	8	8.5	10.2	12.3	4.7	4.4	2.8	2.5	6
Feb.	2.5	2.9	8.5	8	9	11.5	2.1	2.3	2.4	2.5	5.1
Apri.	3.2	4.4	10.5	10.2	9.8	10.4	3.5	4.8	2.5	2.8	6.2
Jun.	4.4	4.2	11	10.5	10.6	11.8	2.1	3.8	2.5	3.5	6.4
Aug.	3.5	3.8	9.4	9.2	12.1	14.6	2.5	2.6	4.4	4.2	6.6
Chemical oxygen demand											
Oct.	10.1	11.4	42.3	42.2	70.5	71.2	12.5	12.2	11.6	11.5	29.5
Dec.	8.4	8.5	38.6	38.2	78.9	72.5	11.3	13.5	12.2	13.8	29.5
Feb.	9.5	9.8	39.2	40	60.6	64.2	10.6	10.5	10.8	10.4	26.5
Apri.	10.5	10.6	42.5	40.3	64.2	68.5	11.4	10.3	11.5	12.2	28.2
Jun.	12.5	12.2	43.3	41.4	82.5	82.2	10	10.4	11.5	12.4	28.8
Aug.	11.5	10.3	42.8	40.6	80.8	81.8	12.5	12.4	13.2	13.6	31.9



Graph VI. Value of COD (mg/L) in different months.and increase.

effluents discharge, as suggested by Emongor et al. (2005), and Agrawal and Saxena (2011), that the industries were releasing some organic substances that were of high oxygen demanding wastes. Biological oxygen demand is an important parameter which is widely used to determine the pollution load of waste water. The aim of BOD test is to determine the amount of bio-chemically oxidisable carbonaceous matter (Gupta et al., 2003; Azumi and Bichi, 2010). Values of BOD were due to higher rate of decomposition of organic matter at higher temperature, turbidity and less water current (Sanap et al., 2006). Chemical oxygen demand is a test which is used to measure pollution of domestic and industrial waste. This gives valuable information about the pollution potential of industrial effluents and domestic sewage (Gupta et al., 2003; Ijeoma and Achi, 2011). Highest value of COD indicates that most of the pollution in study zone in Betwa River is caused by industrial effluents discharged by industrial units. Similar results were also reported by Pande and Sharma (1998), Murhekar (2011) (Table 1, Graph VI).

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