

## Seasonal Variation of Water Quality in Betwa River at Bundelkhand Region, India

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**Abstract:** The present study objectively analysis the physicochemical parameters in Betwa River in Bundelkhand region. Water samples were collected from 19<sup>th</sup> different point from Betwa River starting from Orchha to Parichha in the month of January 2006 winter and May 2006 summer for the analyzing different physicochemical parameters of water. Total 15 different physicochemical parameters were analyzed. Correlation and the average chemical composition of major Indian Rivers and other world Rivers. The analyzed parameters are pH, EC, alkalinity, hardness, Cl, SO<sub>4</sub>, PO<sub>4</sub>, NO<sub>3</sub>, NH<sub>4</sub>, F<sup>-</sup>, Na, K, Ca, Mg and H<sub>4</sub>SiO<sub>2</sub>. The water of Betwa River slightly alkaline in nature, the range varies from 7.5 to 8.7 and 7.4 to 8.9 during winter and summer season respectively. Betwa River water is very pricey in Bundelkhand region. The concentration of silica bicarbonate, calcium, magnesium are quit highly the relative abundance of ions in water of Betwa River collected during winter are as follows HCO<sub>3</sub><sup>-</sup> > Na<sup>+</sup> > Mg<sup>2+</sup> > Ca<sup>2+</sup> > K<sup>+</sup> > H<sub>4</sub>SiO<sub>4</sub> > Cl<sup>-</sup> > NO<sub>3</sub><sup>-</sup> > PO<sub>4</sub><sup>3-</sup> > F<sup>-</sup> ammonia and sulphate are found to be below the detectable limit. The relative abundance of ions in the water of Betwa River collected during summer are as follows HCO<sub>3</sub><sup>-</sup> > Mg<sup>2+</sup> > Na<sup>+</sup> > Ca<sup>2+</sup> > H<sub>4</sub>SiO<sub>4</sub> > K<sup>+</sup> > Cl<sup>-</sup> > NO<sub>3</sub><sup>-</sup> > F<sup>-</sup> ammonia and phosphate are mostly found to equal concentration in the River water.

**Key word:** Betwa River • Water quality Parameters • Correlation • Chemical composition

### INTRODUCTION

The Bundelkhand region of the central India fall politically the region is divided between the Uttar Pradesh and Madhya Pradesh. the present catchments area of Jhansi does not cover the entire Bundelkhand region. The district Jhansi lies between 24° 11'N, 25° 57'N latitude, 78°10' E and 79°23' E longitude and the form the southwestern part of Uttar Pradesh. The Betwa or Vetrawati is a river of great antiquity and immense mythological and region values for the people of the Malwa region of Madhya Pradesh for hundred of year. during the course of its flows Betwa River 14 tributaries of which as many as 11 are located in the Madhya Pradesh after a course of 96 kms. from Jhirri it enters vidisha district and flows in it for a course of about 112 kms. The important tributaries of the Betwa include Kaliasot, Ajnar, Bes, Bah, Newon, Parasari, Sagar, Naren, Kaithan, Bina, Jimni and Dhasan among these Bes, Baha, Newon, Kaithan and Bina flow in the Vidisha district. The river Betwa is the lifeline for the region through which it flows and has an important role to play in the all round growth and development of the region the important river flowing

through the region is Betwa with its tributaries Chureigaura, Bhakha, Barva, Dhasan and Jamini. The Betwa has been dammed at Matatila and multipurpose interstate Rajghat Dam has been recently built for generation of electricity as well as irrigation and Uttar Pradesh and Madhya Pradesh. Seasonal variation in precipitation surface run off interflow ground water flow and pumped in and outflows have a strong effect on river pollutants in River Water [1]. The Betwa river water is polluted by industrial and munisple discharges at one point would seriously affecting the down stream. It is the measure source of irrigation for the area known for the production of high quality wheat, gram and soybean in the country.

The annual precipitation and evaporation rate of river Betwa are 1138 mm, 787mm. respectively and mean and annual runoff is 351mm [2] Winkler' Iodometric method was used APHA, AWWA add WPCF 1985.

The purpose of the study was to investigate the water quality of the Betwa River and try to examine the physicochemical composition of Betwa River and to find out seasonal and spatial variation in water chemistry.

## MATERIEL AND METHODS

**Study Area:** The Betwa river is located in the east region. It flows for an estimated total length of 573 Km. of which 216 Km in M.P. and 98 Km in U.P. The river has a huge catchments area at of around 46580 Sq.Kms. There are three types of soil are found in this region which is a dark soil, Mar, Kabar. The annual runoff 351mm.

**Sampling and Preservation:** The water samples from nine stations located along the Betwa River starting from Orchha to Parichha (About 25 Km stretch) to get representative samples. Water samples were collected from Jan 2006 winter and May 2006 summer. And Monsoon season to see seasonal variation. The station included upstream and down stream points of the river. Surface water samples were collected about 10 cms.

Below the water surface using glass water standard procedure were followed for the collection of water samples for chemical analysis. The samples for physiochemical analysis were placed an ice box and transported to the laboratory for immediate analysis. Surface water was collected was each station in 1 liter. Polythene bottle which were thoroughly washed thrice with the water to be analyzed. The temperatures were recorded at the site itself with the help of thermometer in °C. The oxygen was foxed by addition of  $MnSO_4$  and alkaline iodide simultaneously while collecting in BOD bottles. At the site itself and brought to the laboratory for its estimation. And hardness was determined by acid titration, phosphate, fluoride by SPANDS methods nitrate, chloride, sulphate, ammonium and silicon by sector photometric techniques. Na and K have been determined flame photometric methods.

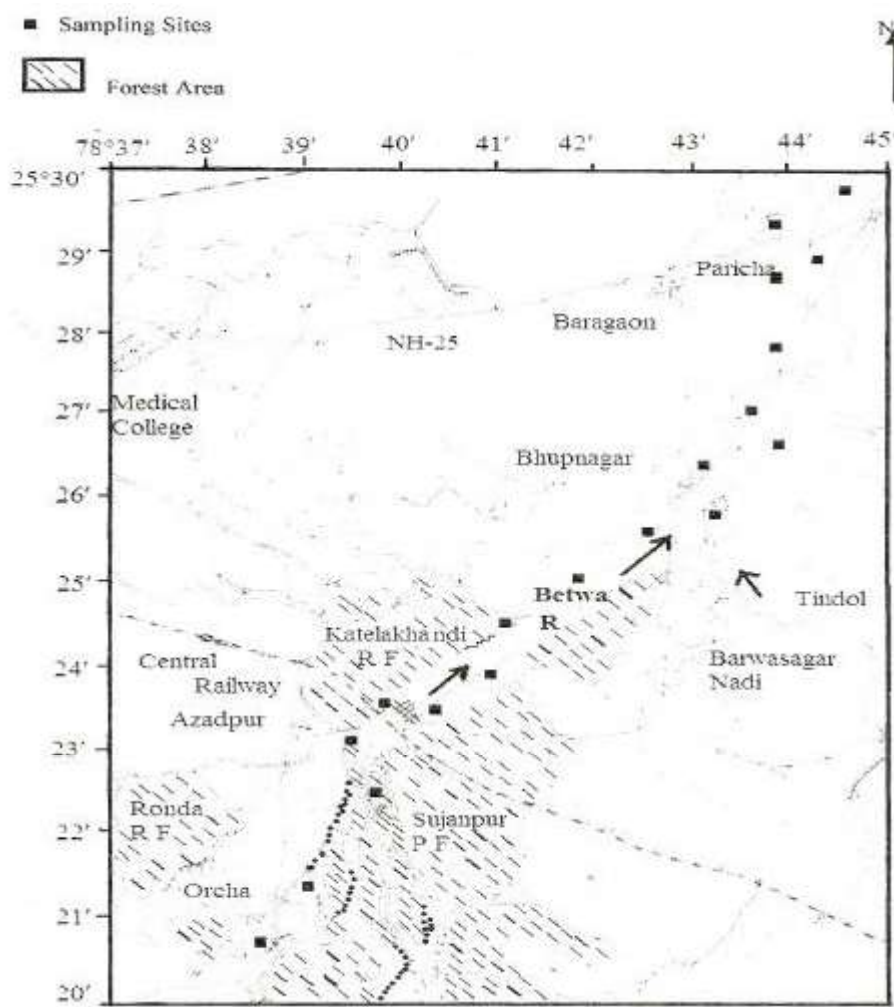


Fig. 3.1: Showing the sampling site of the Betwa River during study

The samples were collected in 1 liter polythene bottle. Which were thoroughly washed thrice with the water to be analyzed. Nineteen water samples have been collected from Betwa river starting from Orcha to Paricha (about 25 Km stretch) to get representative samples. Water samples were collected from January 2006 winter and May 2006 summer to see seasonal variation. The temperature of water samples were recorded at the site itself with the help of thermometer in °C. The oxygen was fixed by addition of  $\text{MnSO}_4$  and alkaline iodide simultaneously while collecting water sample in BOD bottles at the site itself and brought to the laboratory for its estimation [3,4] Nitrate, Chloride, Ammonia Silicon [5].

## RESULT AND DISCUSSION

The water quality parameters are summarized in table 4.1 and 4.2. The mean value of physical and chemical parameters of river Betwa the water quality parameters are summarized in table 4.1 and 4.2 pH is very important parameter in water quality analysis. The pH varies from 7.5 to 8.7 and 7.4 to 8.9 in the water sample. The average values are 8.2 and 8.5 and the concentration of EC varies from 196 to 730  $\mu\text{S}/\text{cm}$  and 549 to 684  $\mu\text{S}/\text{cm}$  in Betwa River. The average values of EC are 338  $\mu\text{S}/\text{cm}$  and 617  $\mu\text{S}/\text{cm}$  in the river. Bicarbonate is the major ions in water bodies the concs of bicarbonates in this river vary from 75 to 140  $\text{mg}/\text{l}$  and 160 to 200  $\text{mg}/\text{l}$  in winter and summer respectively. The average values are also higher in the water collected during summer 120.8  $\text{mg}/\text{l}$  the winter 176.8  $\text{mg}/\text{l}$ . The hardness of analysis water samples varies from 102 to 120  $\text{mg}/\text{l}$  and 113 to 143  $\text{mg}/\text{l}$  in winter.

The conc. of chloride varies from 1.06 to 4.54  $\text{mg}/\text{l}$  in winter samples whereas it varies from 5.88 to 7.84  $\text{mg}/\text{l}$  in case of summer sample. The conc. of Phosphate in the Betwa River varies from 0.01 to 0.63  $\text{mg}/\text{l}$  and 0.063 to 0.12  $\text{mg}/\text{l}$  in winter and summer samples. The conc. of Ammonia in Betwa River is in detectable range during winter whereas it is detectable during summer the range varies from 0.04 to 0.07  $\text{mg}/\text{l}$  which is pretty low. The presence of fluoride above 1  $\text{mg}/\text{l}$  in drinking water is known to cause endemic fluorosis without adverse effect on health. The conc. of fluoride varies from 0.02 to 0.061  $\text{mg}/\text{l}$  and 0.35 to 0.56  $\text{mg}/\text{l}$  in winter and summer samples. The conc. of sodium in Betwa River ranges from 21 to 88  $\text{mg}/\text{l}$  during winter whereas the ranges are 27 to 47  $\text{mg}/\text{l}$  during summer. The conc. of Potassium of Betwa River sample varies from 11 to 32  $\text{mg}/\text{l}$  and 6 to 12  $\text{mg}/\text{l}$  in winter and summer sample. Berner and Berner [6] reported that only 15 % of the transport of Potassium is in the dissolved form. The conc. of calcium of Betwa River varies from 5.61 to 28.06  $\text{mg}/\text{l}$  and 16.11 to 29.66  $\text{mg}/\text{l}$  in winter and summer sample. The main source of calcium is disposal of sewage and industrial wastes. The conc. of magnesium varies from 18.53 to 26.74  $\text{mg}/\text{l}$  and 32.62 to 44.54  $\text{mg}/\text{l}$  during winter and summer in river Betwa. The conc. of silica varies from 12.92 to 15.5  $\text{mg}/\text{l}$  and 12.95 to 19.35  $\text{mg}/\text{l}$  in winter and summer sample in Betwa River.

**Co-Relation:** Co-relation results have been shown in the table 4.3 and 4.4. There are no such evident correlations between different chemical parameters of river Betwa during summer season (Table 4.4) but in case of water sample collected during winter season there are some correlation with same parameters. EC has positive

Table no. 4.2. Showing chemical properties of river Betwa during summer season

Sl No.	pH	EC	Alkalinity	Hardness	Cl	SO4	PO4	NO3	NH4	F	Na	K	Ca	Mg	H4SiO2
1	8.1	582	190	126	6.55	ND	ND	0.36	0.07	0.35	28	6	25.65	40.10	14.86
2	7.4	640	180	143	6.94	ND	0.07	0.91	0.06	0.41	32	9	29.66	36.68	16.03
3	8.2	588	180	138	5.77	ND	0.11	1.37	0.06	0.36	27	7	24.05	38.05	12.95
4	8.2	581	170	137	7.04	ND	0.12	1.82	0.06	0.46	33	7	19.24	36.79	13.94
5	8.5	578	160	125	7.05	ND	0.10	1.28	ND	0.42	43	11	16.11	35.11	15.62
6	8.8	623	170	139	6.85	ND	0.07	1.15	ND	0.54	36	12	19.55	36.71	19.25
7	8.3	549	160	113	6.43	ND	0.06	1.27	0.05	0.56	33	8	21.22	33.86	16.38
8	8.4	580	180	126	6.19	ND	0.09	1.34	0.04	0.43	38	12	23.45	38.20	19.35
9	8.3	620	180	132	5.88	ND	0.11	1.56	0.06	0.43	35	6	24.50	37.94	15.28
10	8.6	637	190	121	6.89	ND	0.09	1.34	0.08	0.38	42	9	22.43	40.89	14.68
11	7.9	552	170	131	7.22	ND	0.09	1.73	0.08	0.47	39	9	21.56	36.22	16.72
12	8.5	590	170	138	7.84	ND	0.06	1.35	0.06	0.44	33	10	21.60	36.21	17.37
13	8.6	640	160	127	7.74	ND	0.11	1.64	0.07	0.46	38	11	25.34	32.86	18.55
14	8.8	650	160	118	7.50	ND	0.12	1.52	ND	0.44	42	9	26.31	32.62	19.32
15	8.9	630	180	130	7.39	ND	0.1	1.28	ND	0.39	44	8	21.78	38.61	16.38
16	8.5	640	190	133	7.29	ND	0.11	1.11	0.04	0.41	46	9	18.94	41.74	17.36
17	8.9	679	200	137	7.36	ND	0.12	1.43	0.05	0.45	38	10	17.45	44.54	16.39
18	8.8	684	190	129	6.90	ND	0.09	1.62	0.05	0.53	34	12	21.34	41.15	16.26
19	8.9	680	180	136	7.72	ND	0.11	1.43	0.07	0.53	47	11	20.58	38.90	18.55
Average	8.5	617.0	176.8	130.5	7.0	NA	0.1	1.3	0.1	0.4	37.3	9.3	22.1	37.7	16.6

ND: Not Detectable, NA: Not applicable; all value expressed in  $\text{mg}/\text{l}$  except pH and EC, EC expressed in  $\mu\text{S}/\text{cm}$

Table no. 4.1. Showing chemical properties of river Betwa during winter season

Sl No	pH	EC	Alkalinity	Hardness	Cl	SO <sub>4</sub>	PO <sub>4</sub>	NO <sub>3</sub>	NH <sub>4</sub>	F	Na	K	Ca	Mg	H <sub>2</sub> SiO <sub>2</sub>
1	8.0	202	130	114	1.13	ND	0.63	0.70	ND	0.28	25	14	24.05	21.95	13.84
2	8.0	202	120	112	1.06	ND	0.58	0.75	ND	0.24	26	15	12.83	24.20	14.61
3	8.1	196	130	110	1.20	ND	0.57	0.80	ND	0.28	23	13	24.85	20.78	14.33
4	8.1	203	130	112	1.16	ND	0.61	1.06	ND	0.24	21	15	20.84	22.24	14.08
5	8.0	196	120	112	1.20	ND	0.57	0.80	ND	0.30	25	13	14.43	23.81	14.54
6	7.5	205	120	110	1.13	ND	0.58	0.71	ND	0.27	24	13	15.23	23.12	14.76
7	8.1	203	130	112	1.20	ND	0.59	0.80	ND	0.30	25	12	16.03	23.42	14.30
8	8.4	395	115	108	1.16	ND	0.03	0.46	ND	0.12	25	14	25.65	20.09	15.50
9	8.4	386	130	108	1.41	ND	0.04	0.35	ND	0.27	24	12	16.83	22.24	14.79
10	8.3	379	155	104	1.65	ND	0.05	0.69	ND	0.02	25	12	28.06	18.53	14.58
11	8.3	392	75	106	1.23	ND	0.04	0.59	ND	0.23	25	12	15.23	22.15	15.11
12	8.7	730	120	120	4.54	ND	0.01	0.67	ND	0.61	88	20	10.42	26.74	14.69
13	8.2	388	130	108	1.27	ND	0.03	0.74	ND	0.23	23	11	23.25	20.68	15.11
14	8.2	376	105	104	1.27	ND	0.04	0.36	ND	0.10	23	14	12.02	22.44	13.63
15	7.5	410	140	108	1.16	ND	0.05	1.67	ND	0.19	30	12	7.21	24.59	12.92
16	8.3	413	140	108	1.65	ND	0.02	1.45	ND	0.17	29	32	15.23	22.64	15.92
17	8.4	388	105	108	1.20	ND	0.02	0.72	ND	0.03	27	12	5.61	24.98	14.93
18	8.5	375	95	102	1.23	ND	0.03	0.98	ND	ND	26	12	11.22	22.15	15.29
19	8.3	385	105	106	1.48	ND	0.04	0.99	ND	0.12	26	14	10.42	23.32	15.11
Average	8.2	338	120.8	109.1	1.4	NA	0.2	0.8	NA	0.2	28.4	14.3	16.3	22.6	14.6

ND: Not Detectable, NA: Not applicable; all value expressed in mg/l except pH and EC, EC expressed in  $\mu\text{S}/\text{cm}$ 

Table no. 4.3. Showing the correlations between different chemical parameters of water samples collected during winter season from river Betwa

	pH	EC	Alkalinity	Hardness	Cl	PO <sub>4</sub>	NO <sub>3</sub>	F	Na	K	Ca	Mg	H <sub>2</sub> SiO <sub>2</sub>
pH	1												
EC	0.59	1											
Alkalinity	-0.28	-0.13	1										
Hardness	-0.09	0.04	0.25	1									
Cl	0.48	0.78	0.06	0.54	1								
PO <sub>4</sub>	-0.56	-0.82	0.22	0.49	-0.31	1							
NO <sub>3</sub>	-0.41	-0.01	0.32	-0.02	-0.06	0.00	1						
F	-0.07	0.17	0.13	0.89	0.62	0.55	-0.10	1					
Na	0.36	0.75	0.00	0.62	0.97	-0.25	-0.01	0.66	1				
K	0.16	0.30	0.22	0.23	0.38	-0.14	0.40	0.19	0.34	1			
Ca	0.05	-0.31	0.44	0.00	-0.18	0.26	-0.30	0.00	-0.29	-0.09	1		
Mg	-0.09	0.29	-0.24	0.54	0.45	0.04	0.25	0.48	0.58	0.21	-0.84	1	
H <sub>2</sub> SiO <sub>2</sub>	0.54	0.23	-0.27	-0.19	0.10	-0.34	-0.14	-0.16	0.03	0.39	0.10	-0.19	1

Table no. 4.4. Showing the correlations between different chemical parameters of water samples collected during summer season from river Betwa

	pH	EC	Alkalinity	Hardness	Cl	PO <sub>4</sub>	NO <sub>3</sub>	NH <sub>4</sub>	F	Na	K	Ca	Mg	H <sub>2</sub> SiO <sub>2</sub>
pH	1													
EC	0.52	1												
Alkalinity	0.08	0.47	1											
Hardness	-0.28	0.24	0.32	1										
Cl	0.37	0.40	-0.17	0.10	1									
PO <sub>4</sub>	0.38	0.37	-0.07	0.12	0.16	1								
NO <sub>3</sub>	0.28	0.10	-0.30	-0.01	0.19	0.77	1							
NH <sub>4</sub>	-0.41	-0.07	0.30	0.14	-0.08	-0.15	0.10	1						
F	0.50	0.13	-0.33	-0.08	0.21	0.10	0.41	-0.07	1					
Na	0.53	0.39	-0.03	-0.20	0.33	0.49	0.24	-0.31	0.13	1				
K	0.43	0.36	-0.11	0.05	0.40	0.15	0.21	-0.26	0.51	0.39	1			
Ca	-0.50	0.04	-0.05	-0.04	-0.21	-0.29	-0.27	0.25	-0.33	-0.39	-0.50	1		
Mg	0.21	0.44	0.07	0.32	-0.10	0.01	-0.22	0.22	-0.23	0.08	-0.02	-0.31	1	
H <sub>2</sub> SiO <sub>2</sub>	0.39	0.28	-0.29	-0.12	0.47	0.06	0.08	-0.35	0.48	0.49	0.68	0.02	-0.28	1

Table 4.5. Average chemical composition of major Indian rivers and other world rivers

Rivers	Discharge	HCO <sub>3</sub>	Cl	SO <sub>4</sub>	H <sub>2</sub> SiO <sub>4</sub>	Na	K	Ca	Mg	TDS	References
Achankovil	14,800	134	23.58	0.6	6.85	3.27	0.96	2.69	1.18	53.54	Prasad and Ramanathan (2005)
Cauvery	21,000	135	20	13	23	43	4	21	9	272	Ramanathan et al (1994)
Krishna	29,000	178	38	49	24	30	2.4	29	8	360	Ramesh and Subramanian (1988)
Godavari	92,000	105	17	8	17	14	8.3	22	5	181	Biksham and Subramanian (1988)
Mahanadi	66,000	122	23	3	17	14	8.3	24	13	224	Chakrapani and Subramania (1990)
Narmada	40,750	225	20	5	9	27	2	14	20	322	Subramanian (1983)
Periyar	48,700	15.7	5.75	3.8	6.41	3.9	0.39	3.3	2.4	46.8	Bajpayee and Verma (2001)
Ganges	468,700	128	10	11	18	11	3	25	8	214	Subramanian (1983)
Kelani	-	42.5	1.8	-	-	2.1	0.7	3.36	1.45	-	Ell. Silva (1998)
Amazon	5,500,500	23	4	3	11	3	1	7	1	53	Gibbs (1970)
India rivers (avg.)	-	74	15	13	7	12	3	30	7	159	Subramanian (1983)
World rivers (avg.)	-	62	4	9	12	4.4	1.5	16	4	155	Sarin and Subramanian (1984)

Units: Discharge 10<sup>6</sup>m<sup>3</sup>/and all are in mg/l

correlation with chloride and sodium whereas its show negative correlation with phosphate hardness and chloride show strong positive correlations with fluoride and sodium respectively which indicate that is one parameter will raise the other dependent will be also increased calcium shows a strong negative correlation with magnesium.

### CONCLUSION

A detailed physicochemical study on the water quality of the Betwa River over a period of two season elucidated the following the water of Betwa river is slightly alkaline in nature. The Betwa river water is very pricey in this region. The range varies 7.4-8.9. The Betwa River a non perennial river. The main source of pollutants generating both organic and inorganic waste was found to originate from illegal logging agriculture activity unsustainable development and household activities of indigenous people. These waste materials were ultimately contaminating the river water. The river water should be properly treated besides to get the safe and sound water supply in this region.

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