https://doi.org/10.33451/florafauna.v26i2pp309-319
FLORA AND FAUNA ISSN 2456 - 9364 (Online)
2020 Vol. 26 No. 2 PP 309-319 ISSN 0971 - 6920 (Print)

Comparative Assessment of Physico-Chemical Parameters of Lotic and Lentic Zone of River Betwa in Jhansi (U.P.), India

***Umesh Kumar Mishra and Vijay Kumar Yadav**

Department of Zoology
Bipin Bihari (P.G.) College,
JHANSI (U.P.) INDIA
*Corresponding Author
E-mail : umeshbetwa@gmail.com

Received **:** 28.09.2020; ***Revised*** **:** 15.10.2020; ***Accepted*** : 29.10.2020

ABSTRACT

Water is the most precious natural gift given by God to human race. Its purity is also important for everyone. For the present study two sampling stations, Baratha village and Parichha dam head were selected for comparative assessment of physico-chemical parameters of lotic and lentic zones on Betwa river. Both these sampling stations are located at Jhansi (UP) India. Samples were collected regularly for one complete year from July 2018 to June 2019. Eighteen water parameters and four hundred thirty two samples were analysed. The overall mean ranges of these parameters at Baratha village and Parichha dam head were notified as electric conductivity (518.66±43.47) and (528.75±59.65), pH (8.09±0.36) and (8.14±0.26), water temperature (24.37±4.14) and (23.78±4.12), transparency (54.91±4.97) and (41.61±3.83), turbidity (30±12.38) and (35.25±16.38), TDS (265.33±16.74) and (267.66±25.42), TSS (66.5±12.52) and (69.83±14.45), TS (331.83±28.76) and (337.5±39.04), DO (6.76±0.68) and (6.72±0.86), total alkalinity (141.58±22.74) and (142.25±29.37), total hardness (150.08±22.70) and (153.66±20.55), Ca (29.04±2.32) and (29.84±5.38), Mg (13.51±2.01) and (14.32±2.20), chloride (24.77±3.29) and (26.85±3.99), BOD (4.08±0.71) and (4.15±1.16), COD (11.64±1.02) and (12.82±1.20), NO_3 (1.64±0.37) and (1.93±0.59), PO_4 (0.46±0.21) and (1.33±0.29). All these findings concluded that the lentic zone (Parichha) is more polluted than the lotic zone (Baratha). However all the observed values are in the range of permissible limits, so both zones can be used for irrigation and fisheries sector.

Figures : 18 References : 17 Tables : 04
KEY WORDS : Jhansi, Lentic, Lotic, Water parameters.

Introduction

Rivers are the largest source of inland water. Inland water resources have always been known as an essential catalyst that plays a dominant role in irrigation, industrial needs and drinking purpose.

Working area. The Baratha village is situated in Jhansi district along the bank of Betwa river. It is about 15 kilometer away from Jhansi city and GPS coordinates are 25° 28' 59.7396'' N, 78° 43' 49.2096'' E. It is a gram panchayat village with total population of approximately 3,835 people. The other selected sampling station, Parichha dam head is very well famous landing spot situated about 25 kilometer away from Jhansi city on Jhansi-Kanpur National highway number 25. It is located along the bank of Betwa river with total population of approximately 7,840 people. There is a very popular active thermal power plant which is used for electricity generation. The GPS coordinates of this location are 25° 28' 45.48'' N, 78° 42' 39.24'' E.

Both the above reported sampling stations are actively used for irrigation, fisheries, drinking, industrial and other domestic purposes. Physico-chemical ranges of any water plays a deciding factor whether water is suitable or not for different purposes. Hence testing of water is very important to check the purity and quality of any aquatic zone, whether it is lotic or lentic. In Bundelkhand region, many workers have done their work on the water of Betwa River[5,6,8,10,12,17].

Systematic Profile of Sampling Stations.

Name of Sampling Station	Stream	Status	City/ District
(A)- Baratha Village	Upstream	Lotic	Jhansi
(B)- Parichha dam Head	Downstream	Lentic	Jhansi

Material and Methods

Sample collection and analytical technique

The water samples were collected during morning

TABLE-1 : Physico-chemical water parameters of sampling station (A)- Baratha from July-2018 –June-2019

S. N.	Parameters	Jul. 18	Aug. 18	Sept. 18	Oct. 18	Nov. 18	Dec. 18	Jan. 19	Feb. 19	Mar. 19	Apr. 19	May 19	Jun. 19	Mean ±S.D.
1	E.C. (µm/cm)	568	550	529	518	480	442	459	493	510	538	557	580	518.66±43.47
2	pH	8.5	8.3	8.1	8.2	7.8	7.6	7.5	7.7	8.1	8.3	8.6	8.4	8.09±0.36
3	Temperature (°C)	27.5	26.8	24.6	23.7	22.4	18.3	16.6	21.3	24.8	27.6	29.2	29.7	24.37±4.14
4	Transparency (cm)	44.7	50.2	50.9	55.6	54.6	60.2	61.3	58.5	59.8	58.3	52.8	52.1	54.91±4.97
5	Turbidity (NTU)	55	48	40	26	28	17	15	22	20	24	30	35	30±12.38
6	TDS (mg/l)	280	276	272	264	250	230	244	258	270	275	280	285	265.33±16.74
7	TSS (mg/l)	82	79	69	62	55	48	52	56	62	70	78	85	66.5±12.52
8	TS (mg/l)	362	355	341	326	305	278	296	314	332	345	358	370	331.83±28.76
9	DO (mg/l)	6.5	6.7	7.0	6.9	7.2	7.5	7.7	7.4	6.8	6.3	5.4	5.8	6.76±0.68
10	TA (mg/l)	171	160	134	140	121	115	109	127	132	150	181	159	141.58±22.74
11	TH (mg/l)	165	172	150	133	127	103	138	155	142	162	184	170	150.08±22.70
12	Ca (mg/l)	30.42	31.65	28.33	26.81	26.53	26.20	27.44	28.80	27.60	29.80	33.54	31.40	29.04±2.32
13	Mg (mg/l)	15.20	15.80	13.52	11.25	10.81	10.44	12.31	13.74	12.80	14.61	16.20	15.55	13.51±2.01
14	Chloride (mg/l)	29.30	26.80	28.14	22.70	24.64	20.61	19.34	21.40	23.52	26.31	25.72	28.80	24.77±3.29
15	BOD (mg/l)	4.6	4.3	3.8	4.0	3.6	3.2	3.0	3.4	4.1	4.8	5.2	5.0	4.08±0.71
16	COD (mg/l)	12.2	11.8	11.2	11.4	11.0	10.4	10.2	10.8	11.6	12.5	13.4	13.2	11.64±1.02
17	Nitrate (mg/l)	1.75	1.69	1.49	1.55	1.40	1.22	1.16	1.35	1.60	1.89	2.38	2.21	1.64±0.37
18	Phosphate (mg/l)	0.60	0.55	0.34	0.41	0.30	0.20	0.18	0.26	0.49	0.68	0.80	0.74	0.46±0.21

TABLE-2 : Correlation Matrix for Physico-chemical water parameters of sampling station Baratha 2018-2019.

Para-meters	E.C.	pH	Temp.	Transp.	Turb.	TDS	TSS	TS	DO	TA	TH	Ca	Mg	Chlo-ride	BOD	COD	Nitr-ate	Phos
E.C.	1																	
pH	0.941	1																
Temp.	0.952	0.957	1															
Transp.	-0.752	-0.704	-0.656	1														
Turbidity	0.735	0.663	0.626	-0.971	1													
TDS	0.974	0.912	0.937	-0.657	0.654	1												
TSS	0.979	0.917	0.920	-0.789	0.783	0.929	1											
TS	0.993	0.930	0.946	-0.726	0.722	0.987	0.976	1										
DO	-0.850	-0.907	-0.920	0.489	-0.405	-0.822	-0.837	-0.843	1									
TA	0.912	0.955	0.908	-0.725	0.684	0.857	0.918	0.899	-0.898	1								
TH	0.861	0.769	0.798	-0.559	0.563	0.880	0.856	0.885	-0.770	0.841	1							
Ca	0.812	0.773	0.786	-0.556	0.544	0.778	0.854	0.825	-0.834	0.891	0.939	1						
Mg	0.849	0.754	0.785	-0.572	0.601	0.844	0.878	0.874	-0.757	0.846	0.969	0.960	1					
Chloride	0.876	0.815	0.863	-0.851	0.841	0.831	0.886	0.870	-0.688	0.752	0.651	0.617	0.674	1				
BOD	0.906	0.952	0.965	-0.548	0.497	0.880	0.884	0.897	-0.976	0.925	0.786	0.816	0.779	0.759	1			
COD	0.887	0.918	0.947	-0.513	0.444	0.859	0.869	0.878	-0.991	0.905	0.794	0.836	0.784	0.728	0.990	1		
Nitrate	0.849	0.887	0.913	-0.469	0.388	0.821	0.837	0.842	-0.997	0.889	0.791	0.852	0.776	0.671	0.968	0.991	1	
Phos-phate	0.889	0.932	0.947	-0501	0.461	0.869	0.877	0.882	-0.973	0.916	0.803	0.838	0.801	0.720	0.994	0.987	0.969	1

TABLE-3 : Physico-chemical water parameters of sampling station (B)- Parichha dam head from July-2018 –June-2019

S. N.	Parameters	Jul. 18	Aug. 18	Sept. 18	Oct. 18	Nov. 18	Dec. 18	Jan. 19	Feb. 19	Mar. 19	Apr. 19	May 19	Jun. 19	Mean ±S.D.
1	E.C. (µm/cm)	590	579	558	510	460	432	451	488	538	554	570	615	528.75±59.65
2	pH	8.3	8.2	8.0	8.3	8.1	7.5	7.9	8.0	8.3	8.2	8.4	8.5	8.14±0.26
3	Temperature (°C)	28.7	26.2	25.4	22.5	20.3	17.8	17.2	20.6	23.8	25.8	27.6	29.5	23.78±4.12
4	Transparency (cm)	34.5	37.4	38.1	39.2	44.6	45.9	47.3	45.2	42.8	41.6	42.1	40.7	41.61±3.83
5	Turbidity (NTU)	70	64	40	38	25	20	17	24	28	32	30	35	35.25±16.38
6	TDS (mg/l)	298	293	275	255	235	225	246	250	270	278	283	304	267.66±25.42
7	TSS (mg/l)	78	72	69	65	52	47	56	61	75	80	88	95	69.83±14.45
8	TS (mg/l)	376	365	344	320	287	272	302	311	345	358	370	399	337.5±39.04
9	DO (mg/l)	6.5	6.8	7.0	7.1	7.3	7.4	7.7	7.3	7.1	6.4	5.1	5.0	6.72±0.86
10	TA (mg/l)	169	138	125	151	130	98	107	121	157	135	180	196	142.25±29.37
11	TH (mg/l)	161	170	158	143	125	119	135	167	155	148	176	187	153.66±20.55
12	Ca (mg/l)	35.83	28.51	32.44	24.13	23.44	21.60	24.52	29.31	31.72	34.60	36.83	35.24	29.84±5.38
13	Mg (mg/l)	16.60	16.82	14.54	12.22	11.43	10.36	13.84	14.10	13.18	15.82	16.23	16.74	14.32±2.20
14	Chloride (mg/l)	31.56	29.45	26.32	22.77	24.25	21.83	20.44	25.34	29.80	27.66	32.62	30.24	26.85±3.99
15	BOD (mg/l)	4.4	4.1	3.9	3.8	3.4	3.1	2.9	3.3	3.6	4.6	6.3	6.5	4.15±1.16
16	COD (mg/l)	13.6	13.2	12.8	12.6	11.8	11.5	11.2	11.6	12.4	13.8	14.6	14.8	12.82±1.20
17	Nitrate (mg/l)	2.50	1.70	2.65	1.54	1.50	1.48	1.20	1.57	1.60	1.77	2.78	2.92	1.93±0.59
18	Phosphate (mg/l)	1.68	1.57	1.41	1.30	1.26	1.10	0.68	1.13	1.24	1.39	1.48	1.80	1.33±0.29

TABLE-4 : Correlation Matrix for Physico-chemical water parameters of sampling station Parichha 2018-2019.

Para-meters	E.C.	pH	Temp.	Transp.	Turb.	TDS	TSS	TS	DO	TA	TH	Ca	Mg	Chlo-ride	BOD	COD	Nitr-ate	Phos
E.C.	1																	
pH	0.793	1																
Temp.	0.981	0.795	1															
Transp.	-0.780	-0.534	-0.782	1														
Turbidity	0.682	0.422	0.671	-0.930	1													
TDS	0.983	0.769	0.948	-0.753	0.703	1												
TSS	0.924	0.842	0.918	-0.529	0.399	0.910	1											
TS	0.982	0.813	0.957	-0.686	0.605	0.988	0.963	1										
DO	-0.765	-0.700	-0.816	0.353	-0.234	-0.731	-0.890	-0.805	1									
TA	0.810	0.914	0.845	-0.524	0.403	0.777	0.883	0.833	-0.851	1								
TH	0.852	0.717	0.802	-0.485	0.435	0.849	0.850	0.868	-0.743	0.739	1							
Ca	0.862	0.682	0.873	-0.521	0.405	0.851	0.903	0.888	-0.765	0.724	0.795	1						
Mg	0.868	0.650	0.822	-0.584	0.606	0.923	0.827	0.907	-0.678	0.611	0.844	0.829	1					
Chloride	0.871	0.734	0.900	-0.598	0.565	0.849	0.852	0.868	-0.762	0.804	0.783	0.878	0.761	1				
BOD	0.780	0.724	0.825	-0.377	0.247	0.744	0.898	0.817	-0.997	0.857	0.748	0.760	0.687	0.749	1			
COD	0.898	0.769	0.936	-0.597	0.466	0.863	0.939	0.910	-0.943	0.853	0.745	0.829	0.774	0.825	0.951	1		
Nitrate	0.788	0.544	0.834	-0.563	0.393	0.739	0.775	0.768	-0.813	0.727	0.716	0.798	0.643	0.725	0.835	0.825	1	
Phos-phate	0.873	0.672	0.993	-0.784	0.698	0.811	0.753	0.807	-0.748	0.774	0.675	0.671	0.637	0.800	0.752	0.852	0.774	1

hours in each month throught the year. Airtight plastic containers were used to collect samples from both lentic as well as lotic sampling sites. Some sensitive and unstable parameters were tested at the sampling sites, while other parameters examined at the departmental laboratory of Bipin Bihari College, Jhansi with the help of standard authentic volumetric methods[1,3,13].

Observation

During the working, many ups and downs were observed in the water quality parameters of Betwa River. Due to environmental fluctuating conditions, during summer period most of the water parameters increased while other parameters decreased in winter because environmental condition acts as a driving catalyst for natural inland water (Tables 1-3).

Result and Discussion

Electrical conductivity, Temperature and pH

Electric conductivity is representative parameter of overall ionic potential present in aquatic body. The conductivity range (Fig.1) of lotic zone was recorded maximum in June (580 µm/cm) and minimum in December (442 µm/cm) with their mean and standard deviation range (518.66±43.47), while conductivity range of lotic zone was recorded maximum also in June (615 µm/cm) and minimum in December (432 µm/cm) with their mean and standard deviation range (528.75±59.65).The rapid increase in electric conductivity indicates greater amount of ionic concentration present in aquatic body[13].

Temperature is the prime regulator parameter for every aquatic life. Water temperature range (Fig.3) of lotic zone was recorded maximum in June (29.7°C) and minimum in January (16.6°C) with their mean and standard deviation range (24.37 ±4.14), while water temperature range of lentic zone was recorded maximum also in June (29.5°C) and minimum in January (17.2°C) with their mean and standard deviation range (23.78±4.12). It shows negative correlation with dissolved oxygen[16].

The pH range (Fig.2) of lotic zone was recorded maximum in May (8.6) and minimum in January (7.5) with their mean and standard deviation range (8.09±0.36), while pH range of lentic zone was recorded maximum in June (8.5) and minimum in December (7.5) with their mean and standard deviation range (8.14±0.26). The pH shows positive correlation with electrical conductivity, alkalinity and chloride[14].

Transparency and Turbidity

The transparency range (Fig.4) of lotic zone was recorded maximum in January (61.3 cm) and minimum in July (44.7c.m) with their mean and standard deviation range (54.51 ±4.97), while transparency range of lentic zone was recorded maximum in January (47.3 c.m) and minimum in July (34.5 c.m) with their mean and standard deviation range (41.61±3.83). The turbidity range of lotic zone was recorded maximum in July (55 NTU) and minimum in January (15 NTU) with their mean and standard deviation range (30±12.38), while turbidity range of lotic zone was recorded maximum in July (70 NTU) and minimum in January (17 NTU) with mean and standard deviation range (35.25±16.38). In our findings both these parameters are inversely correlated[2,7].

TDS, TSS and TS

The TDS range (Fig.6) of lotic zone was recorded maximum in June (285 mg/l) and minimum in December (230 mg/l) with their mean and standard deviation range (265.33±16.74), while TDS range of lotic zone was recorded maximum in June (304 mg/l) and minimum in December (225 mg/) with their mean and standard deviation range (267.66±25.42). The TSS range (Fig.7) of lotic zone was recorded maximum in June (85mg/l) and minimum in December (48 mg/l) with their mean and standard deviation range (66.5±12.52), while TSS range of lentic zone was recorded maximum in June (95 mg/l) and minimum in December (47 mg/l) with their mean and standard deviation range (69.83±14.45).The TS range (Fig.8) of lotic zone was recorded maximum in June (370 mg/l) and minimum in December (278 mg/l) with their mean and standard deviation range (331.83±28.76), while TS range of lentic zone was recorded maximum in June (399 mg/l) and minimum in December (272 mg/l) with mean and standard deviation range (337.5±39.04).

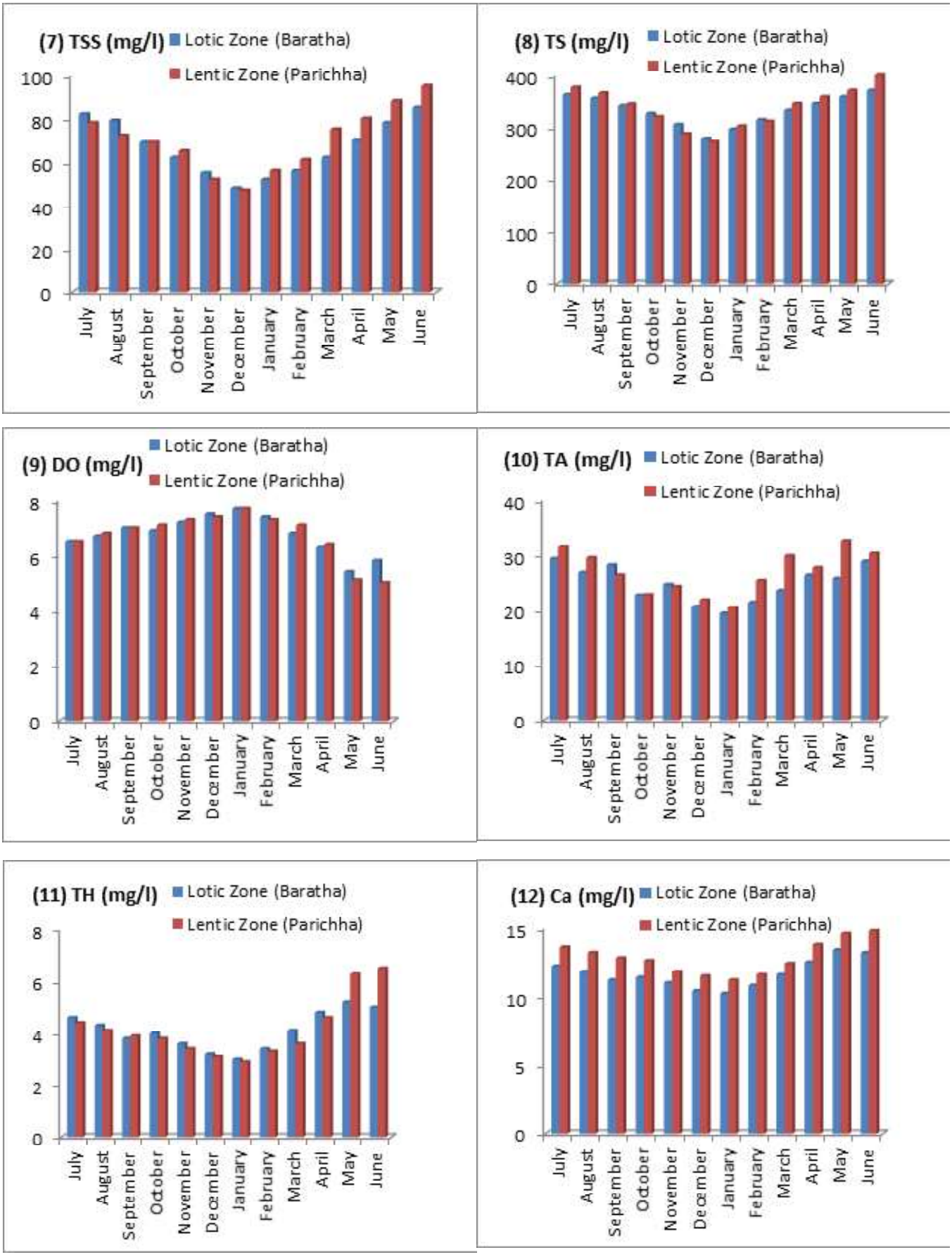
Dissolved Oxygen

Dissolved oxygen is most fundamental driver parameter for regulating the all activities of aquatic biodiversity. The dissolved oxygen range (Fig.9) of lotic zone was recorded maximum in January (7.7 mg/l) and minimum in May (5.4 mg/l) with their mean and standard deviation range (6.76±0.68), while dissolved oxygen range of lentic zone was recorded maximum also in January (7.7 mg/l) and minimum in June (5.0 mg/l) with their mean and standard deviation range (6.72±0.86). In our findings dissolved oxygen is inversely correlated with temperature because solubility of gases decreases as temperature rises[11].

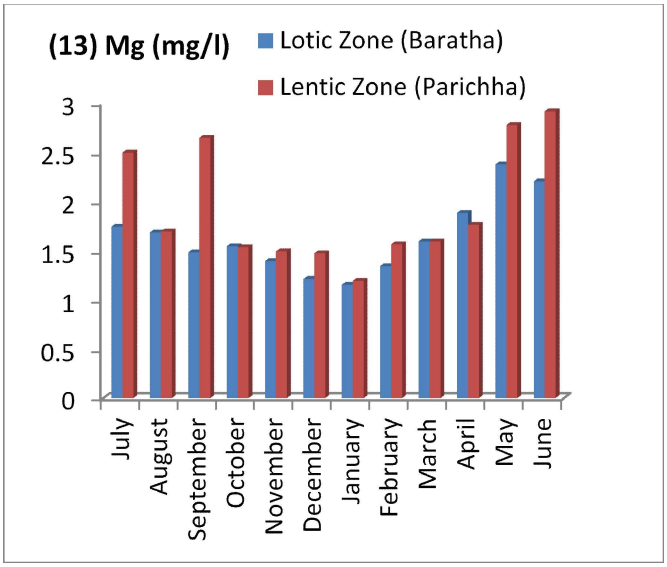
TA and TH

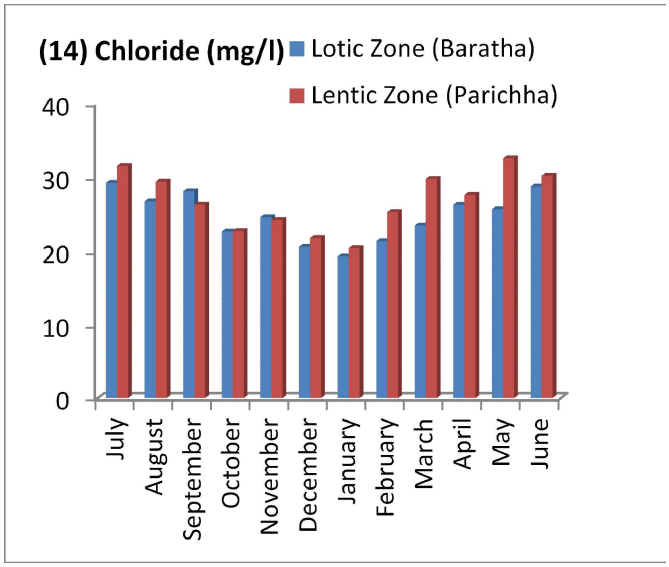
The total alkalinity range (Fig.10) of lotic zone was recorded maximum in May (181 mg/l) and minimum in January (109 mg/l) with their mean and standard deviation range (141.58±22.74), while total alkalinity range of lentic zone was recorded maximum in June (196 mg/l) and minimum in December (98 mg/l) with their mean and

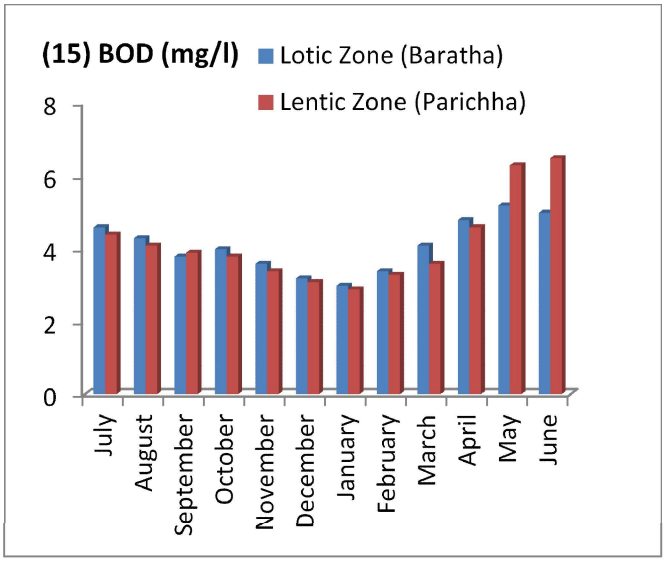
Figs : 1,2,3,4,5 and 6, comparative presentation of physico-chemical parameters of Lotic and Lentic Zones

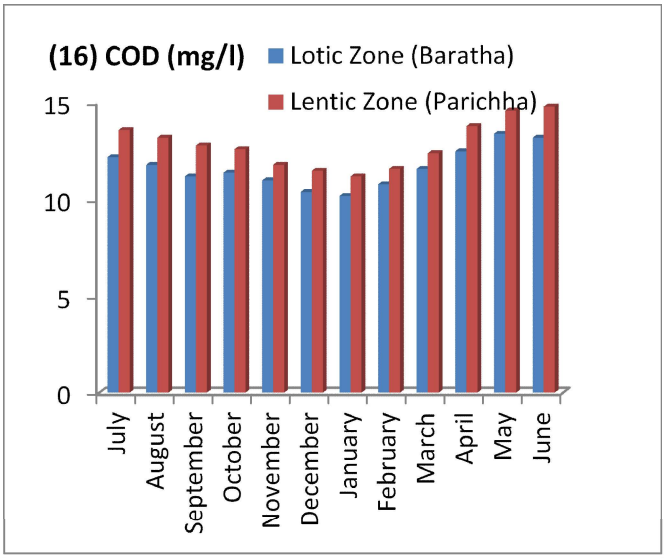


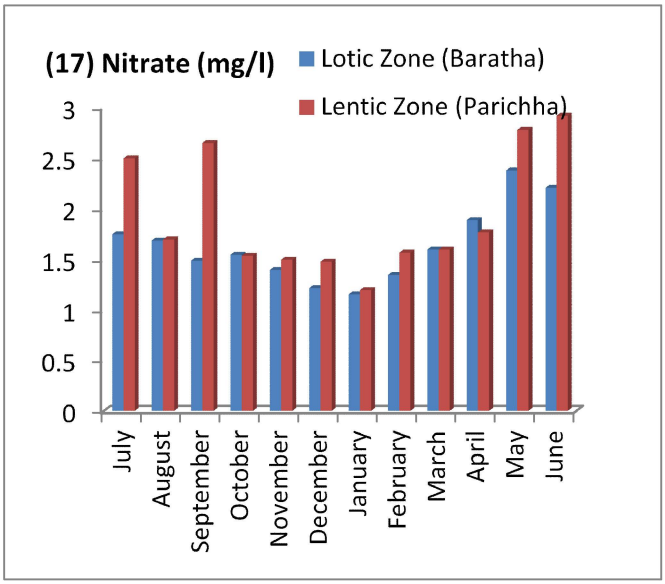
Figs : 7,8,9,10,11 and 12, comparative presentation of physico-chemical parameters of Lotic and Lentic Zones

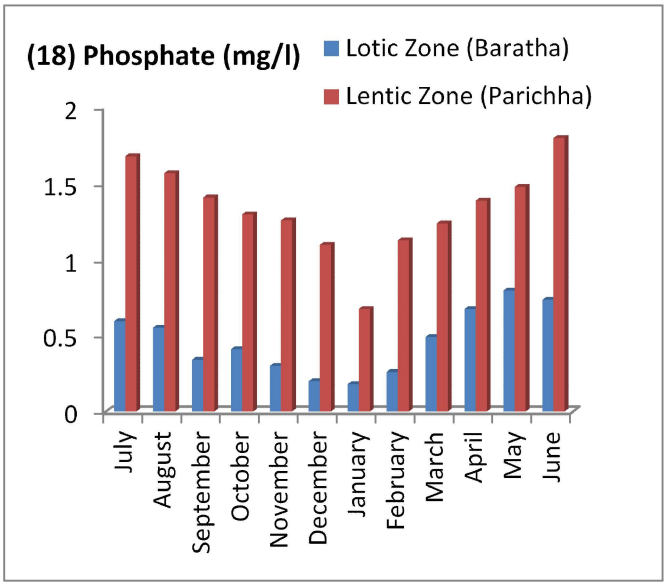












Figs : 13,14,15,16,17 and 18, comparative presentation of physico-chemical parameters of Lotic and Lentic Zones

standard deviation range (142.25±29.37). The total hardness range (Fig.11) of lotic zone was recorded maximum in May (184mg/l) and minimum in December (103mg/l) with their mean and standard deviation range (150.08±22.70), while total hardness range of lentic zone was recorded maximum in June (187 mg/l) and minimum in December (119 mg/l) with their mean and standard deviation range (153.66±20.55).

Ca, Mg and Chloride

The calcium range (Fig.12) of lotic zone was recorded maximum in May (33.54 mg/l) and minimum in December (26.20 mg/l) with their mean and standard deviation range (29.04±2.32), while calcium range of lentic zone was recorded maximum in May (36.83 mg/l) and minimum in December (21.60 mg/l) with their mean and standard deviation range (29.84±5.38). The magnesium range of lotic zone was recorded maximum in May (16.20 mg/l) and minimum in December (10.44 mg/l) with their mean and standard deviation range (13.51±2.01), while magnesium range (Fig.13) of lentic zone was recorded maximum in June (16.74 mg/l) and minimum in December (10.36 mg/l) with their mean and standard deviation range (14.32±2.20).The chloride range (Fig.14) of lotic zone was recorded maximum in June (28.80 mg/l) and minimum in January (19.34 mg/l) with their mean and standard deviation range (24.77±3.29), while chloride range of lentic zone was recorded maximum in May (32.62 mg/l) and minimum in January (20.44 mg/l) with their mean and standard deviation range (26.85±3.99). Calcium, magnesium and chloride express their positively correlation with EC, pH and temperature[4].

BOD and COD

BOD and COD parameters are considered as water pollution touchstone of any aquatic belt. The BOD range (Fig.15) of lotic zone was recorded maximum in May (5.2 mg/l) and minimum in January (3.0 mg/l) with their mean and standard deviation range (4.08±0.71), while BOD range of lotic zone was recorded maximum in June (6.5mg/l) and minimum in January (2.9 mg/l) with their mean and standard deviation range (4.15±1.16). The COD range (Fig.16) of lotic zone was recorded maximum in May (13.4mg/l) and minimum in January (10.2 mg/l) with their mean and standard deviation range (11.64±1.02),while COD range of lentic zone was recorded maximum in June (14.8 mg/l) and minimum in January (11.2 mg/l) with their mean and standard deviation range (12.82±1.20). Our findings are also accordance with several workers[9,15].

Nitrate and Phosphate

The nitrate range (Fig.17) of lotic zone was recorded maximum in May (2.38 mg/l) and minimum in December (1.22 mg/l) with their mean and standard deviation range (1.64±0.37), while nitrate range of lentic zone was recorded maximum in June (2.92 mg/l) and minimum in January (1.20 mg/l) with their mean and standard deviation range (1.93±0.59). The phosphate range (Fig.18) of lotic zone was recorded maximum in May (0.80 mg/l) and minimum in January (0.18 mg/l) with their mean and standard deviation range (0.46±0.21),while phosphate range of lentic zone was recorded maximum in June (1.80 mg/l) and minimum in January (0.68 mg/l) with their mean and standard deviation range (1.33±0.29).

Conclusion

Water of both zones *i.e.* lotic and lentic were found completely alkaline. Most of the water parameters like electrolytes, alkalinity, hardness, calcium, magnesium, chloride, BOD, COD and TDS were found higher in lentic zone than lotic zone due to stagnancy of natural flow of river water.The main cause of slightly polluted lentic zone (Parichha) is due to onthropogonic activities such as bathing in the river, washing clothes, household and agricultural waste runoff that were vigorously operated in the lotic zone (Baratha). Apart from this, the discharge effluent of the power plant situated at Parichha dam is also a valuable listed reason for the partial increased water pollution in the lentic zone. Hence in our research finding, lentic zone found to be slightly polluted compared to lotic zones of selected sampling station. However most of the ranges of water parameters found to be under the permissible limit hence both zones can be directly used for irrigation and fisheries sector but not for drinking purpose. To use it as drinking purpose, it must first be completely treated with standardized treatment, and only then can be used as drinkable water.

References

1. Adoni AD. Workbook on Limnology, Published by Pratibha Publication, Sagar, Madhya Pradesh. 1985; pp. 1-216.
2. Alam SK. Hydrobiological and physico-chemical analysis of the river Yamuna at Kalpi, district Jalaun, U.P. India. Ph.D. Thesis (Zoology), Bundelkhand University, Jhansi. 2013.
3. APHA. American Public Health Association, standards methods for the examination of water and waste water, Washington, D.C. 1998; **20** ed.

4. Arya S, Devi A and Kumar VA. Comparative Study of Water quality Assessment of Parichha and Sukma Dukma Dams, Jhansi, India, *International Journal of Advanced Engineering Technology*. 2013; **4**(4): 45-50.
5. Hussain G, Tharani M, Hussain A and Ahmad Y. Studies of Physico-chemical characteristics of river Betwa (M.P.), *Indo American Journal of Pharmaceutical Sciences*. 2017; **2**(5):881-885.
6. Kulshrestha M, Singh B and Pani S. Impact of Industrial Effluents on water quality of Betwa river near Mandideep, Raisen, *International Journal of Advanced Research in Biological Sciences*. 2017; **4**(4):169-181.
7. Kumar M, Singh R, Chaurasia S and Khare PK. Physico-chemical examination of Lotic water of River Yamuna at Kalpi, district Jalaun, Uttar Pradesh, India, *Journal of Environmental Research and Development.* 2016; **10**(3):529-536.
8. Mishra A, Tripathi S, Kumar V, Pandey HC and Sharma KK. Analysis of Physico-chemical properties of river water at Bundelkhand region of India, *Agricultural Science Research Journal*. 2016; **6**(1):6-11.
9. Murhekar GH. Determination of Physico-chemical parameters of Surface water samples in and around Akot city, *International research Journal in Chemistry and Environment*. 2011; **1**(2):183-187.
10. Patel A and Datar M. Seasonal variation of Physico-chemical characterstics of River Betwa in Vidisha District, *International Journal of Science, Environment*. 2014; **3**(6):2205-2214.
11. Perlman,H. Water Density, In the USGS Water Science School, Retrieved from http://water.usgs.gov/edu/density.html. 2013.
12. Tripathi DM and Tripathi S. Ecological assessment of water quality of Betwa River in Jhansi District, *Environmental Pollution and Protection*. 2017; **2**(1):1-5.
13. Trivedi RK and Goel PK. Chemistry and Biological methods for water pollution studies, Published by Environmental Publication, Kerad.1986;pp.1-246.
14. Verma S. Seasonal Variation of Water quality in Betwa River at Bundelkhand Region, India, *Global Journal of Environmental Research.* 2009; **3**(3):164-168.
15. Vishwakarma S, Verma A and Saxena G. Assessment of water quality of Betwa river, Madhya Pradesh, India, *International Journal of Water resources and Environmental Engineering*. 2013; **5**(4):217-222.
16. Zaidi J and Pal A. Influence of temperature on Physico-chemical properties of fresh water ecosystem of Bundelkhand region of Uttar Pradesh, India, *International Journal of Current Research in Chemistry and Pharmaceutical Sciences.* 2015; **2**(3):1-8.
17. Zaidi J, Ganesh S and Pal A. (2011) Assessment of water quality in river Betwa and Pahuj around Jhansi city, Uttar Pradesh, India, *International Journal of Current Research*. 2011; **3**(5):027-031.