

## Analysis of Physico-chemical Water parameters of Angoori Barrage Head, Datia (M.P.) India

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### ABSTRACT

The present research work was carried out to explore the diversity in various physical and chemical water parameters of Angoori Barrage Head in the Datia district of Madhya Pradesh. The mean range of selected water parameters like pH  $7.5 \pm 0.22$  and  $7.5 \pm 0.20$ , temperature  $24.3 \pm 3.2$  and  $24.1 \pm 3.7$ , EC  $258 \pm 38.6$  and  $266 \pm 41.8$ , DO  $6.0 \pm 1.2$  and  $5.7 \pm 1.3$ , BOD  $1.9 \pm 0.5$  and  $2.7 \pm 1.0$ , COD  $16.9 \pm 5.5$  and  $21.2 \pm 6.5$ , chlorides  $32.5 \pm 10.4$  and  $41.6 \pm 14.0$ , nitrates  $1.0 \pm 0.4$  and  $0.9 \pm 0.4$ , phosphates  $0.5 \pm 0.2$  and  $0.6 \pm 0.3$ , TA  $139 \pm 25.7$  and  $141 \pm 22.9$ , TH  $138 \pm 20.0$  and  $138 \pm 25.2$ , water transparency  $146.5 \pm 29.9$  and  $136.8 \pm 29$ , water turbidity  $6.5 \pm 3.3$  and  $6.6 \pm 3.7$  and TDS  $131 \pm 16.2$  and  $134 \pm 15.7$  were analyzed regularly for two years from October 2020 to September 2022. The result indicates that the water is experiencing an anthropogenic pollution load from the surrounding catchment area and is not suitable for direct drinking purposes; however, this water can be used properly for fisheries purposes and for irrigation.

Figure : 00

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Tables : 04

KEY WORDS : Angoori Barrage, Madhya Pradesh, Physico-chemical, Water diversity

### Introduction

The physical and chemical water parameters have a key influence on assessing the quantitative and qualitative composition of the aquatic biota. Understanding such characteristics is essential for determining a water body's fitness and health.

Angoori Barrage is a significant major water body that is located in the district Datia of Madhya Pradesh, India. It is situated near the Gwalior-Jhansi national highway and the Delhi-Mumbai-South railway track. The construction of this reservoir was started in the year 1992- 93 across the river, Angoori, which is a tributary of the river Pahuj. This water body was completed in the year 2004. This barrage is approximately 25 km. away from Jhansi city. Angoori Barrage is a project of the Rajghat reservoir of Lalitpur, which is a joint project of both the Uttar Pradesh and Madhya Pradesh state Governments. This barrage has been constructed with the help of J.B.I.C. Japan. The GPS coordinates of this water body are  $25.5891^\circ$  N,  $78.4768^\circ$  E. This Barrage has provided a new life to the population of Datia district through irrigation and drinking water supply. Besides

irrigation and drinking water supply for the surrounding area, this Barrage is also used for composite fish culture.

### Material and Methods

The collection of water samples was done every month for a regular two-year period from October 2020 to September 2022 in the morning hours of the day. The water samples were collected in clean plastic containers covered with airtight caps. Electrical conductivity, temperature, transparency, pH, and TDS are unstable water parameters that were measured at the sampling stations, while the other parameters were examined at the research centre lab of Bipin Bihari College in Jhansi. The analysis of the collected water samples was carried out according to the standard guidelines<sup>1,2,25</sup>.

### Result and Discussion

**Electric Conductivity (EC):** It varies from 202 to 328  $\mu\text{m}/\text{cm}$ . EC shows a significant positive correlation with temperature, total dissolved solids, pH, BOD and COD while negatively correlated with DO and water transparency. Temperature plays a deciding role in

TABLE -1: Physico-chemical water parameters of Barrage Head Oct. 2020 to Sept. 2021

S.N.	Parameters	Oct.20	Nov.20	Dec.20	Jan.21	Feb.21	Mar.21	Apr.21	May21	Jun.21	Jul.21	Aug.21	Sep21	Mean $\pm$ S.D.
1	Colour	T	T	T	T	T	T	T	T	M	M	M	T	
2	pH	7.8	7.4	7.5	7.3	7.1	7.4	7.6	7.9	7.7	7.5	7.6	7.4	7.5 $\pm$ 0.22
3	Temperature ( $^{\circ}$ C)	23.1	21.9	20.7	19.3	21.5	23.4	25.7	28.6	29.8	27.3	26.8	24.5	24.3 $\pm$ 3.2
4	Transparency (cm)	135.6	142.4	163.7	180.3	195.2	188.7	150.8	134.6	120.1	104.3	110.8	132.5	146.5 $\pm$ 29.9
5	Turbidity (NTU)	6.8	5.1	3.6	2.2	1.9	3.9	5.7	7.3	10.3	12.2	10.6	8.7	6.5 $\pm$ 3.3
6	TDS (mg/l)	120	113	110	115	121	132	145	150	158	149	127	138	131 $\pm$ 16.2
7	E.C. ( $\mu$ m/cm)	234	221	208	210	240	270	297	315	310	298	260	240	258 $\pm$ 38.6
8	DO (mg/l)	5.5	7.1	7.8	8.1	6.9	6.3	5.1	4.6	4.2	5.2	5.8	6.1	6.0 $\pm$ 1.2
9	TA (mg/l)	120	111	106	109	138	159	173	178	169	146	128	135	139 $\pm$ 25.7
10	TH (mg/l)	131	118	98	121	140	131	149	167	160	151	159	138	138 $\pm$ 20.0
11	Chloride (mg/l)	27.60	23.18	24.02	18.27	26.50	31.06	35.60	40.12	56.30	44.18	33.56	30.70	32.5 $\pm$ 10.4
12	BOD (mg/l)	2.0	1.6	1.4	1.2	1.5	1.4	1.9	2.8	3.1	2.4	2.1	1.8	1.9 $\pm$ 0.5
13	COD (mg/l)	19.1	12.5	11.7	10.4	12.2	11.8	19.3	22.3	28.9	20.6	18.8	16.2	16.9 $\pm$ 5.5
14	Nitrate (mg/l)	0.96	0.51	0.31	0.39	0.48	0.86	1.22	1.50	1.67	1.58	1.40	1.31	1.0 $\pm$ 0.4
15	Phosphate (mg/l)	0.41	0.36	0.29	0.25	0.35	0.54	0.67	0.79	1.18	0.91	0.84	0.60	0.5 $\pm$ 0.2

TABLE-2: Correlation matrix Table of sampling station ( Barrage-Head) Oct. 2020 to September 2021

Parameters	pH	Temp.	Transp.	Turb.	TDS	E.C.	DO	TA	TH	Chlod.	BOD	COD	Nitrate	Phosp.
pH	1													
Temp.	0.656*	1												
Transp.	-0.621*	-0.729**	1											
Turb.	0.530	0.821**	-0.947**	1										
TDS	0.475 (ns)	0.9.6**	-0.513 (ns)	0.663*	1									
E.C.	0.541	0.910**	-0.456 (ns)	0.589*	0.942**	1								
DO	-0.709**	-0.938**	0.640*	-0.724	-0.886**	-0.9.3**	1							
TA	0.411 (ns)	0.766**	-0.167 (ns)	0.327 (ns)	0.885**	0.933**	-0.808**	1						
TH	0.456 (ns)	0.875**	-0.526 (ns)	0.642*	0.824**	0.859**	-0.851**	0.773**	1					
Chlod.	0.522 (ns)	0.932**	-0.611*	0.743**	0.914**	0.886**	-0.883**	0.754**	0.759**	1				
BOD	0.724**	0.934**	-0.735**	0.765**	0.821**	0.814**	-0.900**	0.644*	0.793**	0.9.9**	1			
COD	0.729**	0.919**	-0.737**	0.773**	0.829**	0.799**	-0.925**	0.643*	0.776**	0.915**	0.968**	1		
NO <sub>3</sub>	0.615*	0.957**	-0.777**	0.886**	0.900**	0.850**	-0.918**	0.701*	0.869**	0.870**	0.866**	0.881**	1	
Phosp.	0.524	0.964**	-0.716**	0.842**	0.890**	0.863**	-0.866**	0.697*	0.826**	0.960**	0.890**	0.898**	0.932**	1

Note: Level of Significance- \* P = 0.01; ns (not significant)

determining the EC of the water body. It was recorded minimum during the winter season in the month of December due to low ion dissociation while maximum during the summer season in the month of May due to high dissolution of ionic concentrations of various domestic waste effluents and agricultural runoff from the Barrage catchment area. Some workers reported the highest EC during the summer season in urban water bodies in Karnataka<sup>26</sup>, while other report stated in several lakes located in Haryana<sup>16</sup>.

**Water pH:** It was observed between 7.1 - 8.1. It was recorded minimum during the winter season, while maximum in the summer season. The pH shows a positive correlation with temperature, EC, TDS, TA, TH, BOD, COD, phosphates and nitrates while it is negatively correlated with the dissolved oxygen level and water transparency. The high and low variation level in water pH in different seasons may be due to concentration of carbonates, bicarbonates as well as carbon dioxide level in the water body. This type of pattern was also reported in some research works<sup>9,18,21,22</sup>.

**Water Temperature:** The water temperature fluctuated from 18.8°C to 29.9°C It was recorded minimum during the winter season while maximum during the summer season. The Pearson correlation analysis of water temperature shows that it was positively correlated with pH, EC, TDS, TA, TH, BOD and COD parameters while negatively correlated with the DO level of the water body. The fluctuation in water temperature may also be due to seasonal variations as well as atmospheric conditions. Similar findings were noticed in some investigations<sup>12,13</sup>.

**Water Transparency:** The water transparency of the research area was observed between 98.8 cm and 195.2 cm. It was recorded minimum during the rainy season in the month of July, while maximum during the winter season in the month of February. The water transparency showed a negative correlation with turbidity, EC, TDS, BOD and COD while being positively correlated with the DO.

**Water Turbidity:** The water turbidity was observed between 1.9 NTU and 14.6 NTU. It was recorded minimum during the winter season in the month of February, while maximum during the rainy season in the month of July due to various clay, silt and undesired particles of soil erosion suspended in the water body. The value of water turbidity shows a positive correlation with most of the selected water parameters and is negatively correlated with DO. This type of effect on water turbidity was also recorded at Sion Lake<sup>10</sup>.

**Total Dissolved Solids (TDS):** The TDS of the water body was observed between 106 and 158 mg/l. The value of TDS shows a positive correlation with EC,

temperature, pH, BOD, COD, TA, TH and chloride parameters. It was observed minimum during the winter season in the month of January while, maximum during the summer season in the month of June due to the increase in rate of dissolution of waste water contamination, fertilizers, garbage and also due to organic waste mixing of sewage from surrounding areas of villages.

**Dissolved Oxygen (DO):** It was observed 3.8 to 8.1 mg/l. The dissolved oxygen showed a positive correlation with water transparency and negative correlation with temperature, BOD, COD, nitrates and phosphates ranges. It was recorded minimum during the summer season in the month of May due to high atmospheric temperature along with increased metabolic rate of organisms while, maximum during the winter season in the month of January due to low atmospheric temperature and high photosynthesis by aquatic plants. The findings are supported by the studies of many researchers<sup>8,9,12,16,24</sup>.

**Total Alkalinity (TA):** It was observed from 106 to 180 mg/l. The total alkalinity was positively correlated with temperature, hardness, EC, BOD, COD, nitrates and phosphates. It was recorded minimum during the winter season while maximum during the summer season in June. The variation in TA may be due to the dissolution of land salt concentrations and the liberation of carbon dioxide through the decomposition of waste materials. Similar type of findings were also observed by the research work in the Yamuna River<sup>15</sup> and Sahastradhara water body<sup>23</sup>.

**Total Hardness (TH):** It ranges between 96 to 173 mg/l. The total hardness was also positively correlated with temperature, alkalinity, EC, nitrates and phosphates. It was observed minimum during the winter season in the month of January while maximum during the summer season in the month of June due to the addition of sedimentary rocks, sewage, the use of detergents and soaps in the washing of clothes and bathing, and large-scale human activity.

**Chloride:** The value of Chloride ranges from 18.27 to 62.06 mg/l. The chloride content showed a positive correlation with TDS, hardness, alkalinity, EC, temperature, BOD, COD, nitrates and phosphates. In the study period, it was observed minimum during the winter season, while maximum during the summer season due to through-home waste discharge, leaching, and municipal discharge. Some investigations reported higher chloride concentrations in the summer season<sup>7</sup>, brought on by higher temperatures, a higher rate of evaporation, and a lower level of water and sewage mixing.

TABLE-3 : Physico-chemical water parameters of Barrage-Head Oct.2021 to Sept.2022

S.N.	Parameters	Oct.21	Nov.21	Dec.21	Jan.22	Feb.22	Mar.22	Apr.22	May22	Jun.22	Jul.22	Aug.22	Sep22	Mean $\pm$ S.D.
1	Colour	T	T	T	T	T	T	T	T	M	M	M	M	
2	pH	7.4	7.6	7.3	7.2	7.5	7.7	7.6	7.8	8.1	7.4	7.3	7.5	7.5 $\pm$ 0.2
3	Temperature ( $^{\circ}$ C)	22.7	20.8	19.7	18.8	20.1	24.6	27.3	29.9	29.1	27.3	24.6	25.2	24.1 $\pm$ 3.7
4	Transparency (cm)	120.2	135.7	148.2	126.8	164.9	185.3	180.4	156.7	112.3	98.8	103.6	108.7	136.8 $\pm$ 29.9
5	Turbidity (NTU)	6.5	4.3	4.8	3.6	3.1	2.3	5.1	5.8	8.8	14.6	12.2	8.3	6.6 $\pm$ 3.7
6	TDS (mg/l)	122	120	116	106	127	137	140	157	148	145	143	150	134 $\pm$ 15.7
7	E.C. ( $\mu$ m/cm)	240	238	210	202	234	267	285	328	317	291	280	310	266 $\pm$ 41.8
8	DO (mg/l)	5.8	6.7	7.2	7.9	6.3	4.7	4.1	3.8	4.0	6.1	6.8	5.9	5.7 $\pm$ 1.3
9	TA (mg/l)	140	119	132	110	117	139	154	168	180	170	144	120	141 $\pm$ 22.9
10	TH (mg/l)	136	105	108	96	136	142	168	162	173	158	129	147	138 $\pm$ 25.2
11	Chloride (mg/l)	31.16	24.81	20.18	29.87	32.65	46.22	38.88	50.16	62.06	60.72	48.12	55.10	41.6 $\pm$ 14.0
12	BOD (mg/l)	2.6	2.1	1.6	1.4	1.8	2.3	2.9	5.2	3.0	3.8	3.5	2.8	2.7 $\pm$ 1.0
13	COD (mg/l)	20.5	18.4	12.3	10.8	13.5	19.8	24.8	30.4	25.6	28.2	28.6	22.1	21.2 $\pm$ 6.5
14	Nitrate (mg/l)	0.81	0.52	0.35	0.51	0.42	0.66	0.87	1.30	1.72	1.60	1.45	1.12	0.9 $\pm$ 0.4
15	Phosphate (mg/l)	0.43	0.30	0.21	0.49	0.62	0.65	0.79	0.96	1.20	1.08	0.82	0.60	0.6 $\pm$ 0.3

TABLE-4 : Correlation matrix table of Barrage-Head Oct.2021 to September2022

Parameters	pH	Temp.	Transp.	Turb.	TDS	E.C.	DO	TA	TH	Chlod.	BOD	COD	Nitrate	Phsp.
pH	1													
Temp.	0.673*	1												
Transp.	0.219 (ns)	-0.076 (ns)	1											
Turb.	-0.079 (ns)	0.483 (ns)	-0.782**	1										
TDS	0.585*	0.916**	-0.106 (ns)	0.509 (ns)	1									
E.C.	0.659*	0.950**	-0.161 (ns)	0.495 (ns)	0.978**	1								
DO	-0.842**	-0.846**	-0.366 (ns)	0.008 (ns)	-0.734**	-0.771**	1							
TA	0.599*	0.875**	-0.130 (ns)	0.538 (ns)	0.695*	0.722**	-0.717**	1						
TH	0.678*	0.908**	0.059 (ns)	0.368 (ns)	0.852**	0.860**	-0.880**	0.798**	1					
Chlod.	0.502 (ns)	0.832**	-0.373 (ns)	0.654*	0.863**	0.874**	-0.552 (ns)	0.681**	0.774**	1				
BOD	0.389 (ns)	0.856**	-0.176 (ns)	0.546 (ns)	0.839**	0.835**	-0.607*	0.742**	0.674*	0.672*	1			
COD	0.439 (ns)	0.906**	-0.263 (ns)	0.672*	0.877**	0.884**	-0.635*	0.794**	0.747**	0.766**	0.923**	1		
NO <sub>3</sub>	0.424 (ns)	0.835**	-0.567 (ns)	0.824**	0.797**	0.832**	-0.469 (ns)	0.798**	0.701*	0.900**	0.767**	0.871**	1	
Phosp.	0.564 (ns)	0.850**	-0.219 (ns)	0.579*	0.783**	0.800**	-0.629*	0.822**	0.820**	0.891**	0.704*	0.768**	0.877*	1

Note: Level of Significance- \* P&lt; 0.05; \*\*P&lt; 0.01; ns (not significant)

**Biological Oxygen Demand (BOD):** The BOD was observed 1.2 to 5.2 mg/l. The BOD content showed a significant positive correlation with temperature, TDS, alkalinity, hardness, EC, COD, nitrates and phosphates while it is negatively correlated with transparency and DO level. It was observed at its minimum during the winter season, while maximum during the summer season in the month of May. High BOD levels in the summer season could be related to a high rate of organic decomposition as well as the entry of sewage into the water body. Similar findings were also reported in some other lakes<sup>12,20,24</sup>.

**Chemical Oxygen Demand (COD):** The COD was observed 10.4 to 30.4 mg/l. The COD content showed a significant positive correlation with pH, temperature, TDS, alkalinity, hardness, EC, BOD, nitrates and phosphates while it is negatively correlated with transparency and DO level and was minimum during the winter season, while maximum during the summer season. Similar results also reported in the Ramsagar reservoir of Datia<sup>11</sup> and wetlands of the west Garo hills in Meghalaya<sup>3</sup>.

**Nitrate:** Nitrate ranges from 0.31 to 1.72 mg/l. The nitrates show a positive correlation with temperature, chloride, TDS, alkalinity, hardness, EC, BOD, COD and phosphates while a negative correlation with transparency and DO level. It was recorded minimum during the winter season and maximum during the summer season. The seasonal fluctuation of nitrate concentration was observed maximum in summer due to high water temperatures, which leads to accelerate oxidation of untreated domestic waste and nitrogenous organic materials present in the water body while low

nitrate concentrations were observed in the winter due to low water temperatures and low rate of decomposition of nitrogenous organic matter in the water. Similar findings were reported by various workers<sup>12,17</sup>.

**Phosphate:** The phosphates were observed 0.21 to 1.20 mg/l. The phosphate was positively correlated with pH, TDS, temperature, chloride, alkalinity, hardness, EC, BOD, COD and nitrates while it was negatively correlated with water transparency and DO. It was recorded minimum during the winter while maximum during the summer season. The main fluctuating source of phosphate in the research area may be the use of chemical fertilizers on agricultural land and waste effluents that leach out from the surrounding catchment area. The work at Kangsabati reservoir<sup>5</sup> and Sarkhej Roza Lake<sup>19</sup> also observed similar findings with a negative correlation of phosphate content with the DO of water and water transparency. (Tables 1-4)

### Conclusion

The analysis of the physical and chemical parameters of water samples from the Angoori Barrage in the current investigation revealed that the water body was completely alkaline, which is a good indication for the fisheries sector and agriculture purposes. Most of the selected parameters were within the permissible limit, however, the content of dissolved oxygen level and load of anthropogenic activities are matters of concern. Hence, to improve the quality of water suitability for human consumption, management and execution of aquatic awareness programs between the local people living close to the affected area are necessary, along with routine testing of water parameters at the regional level by the responsible authorities.

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