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Analysis of Physico-Chemical Water Parameters of Angoori Barrage, Datia (Madhya Pradesh)

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Abstract: *Both the chemical and physical properties of water's environment play an essential role in determining the aquatic biota's quantitative and qualitative composition. Evaluating the abundant resources and healthiness of a water body requires an awareness of these features. The primary objective of the current study was to investigate the variability of several chemical as well as physical water parameters at Angoori Barrage located in Datia district of the Madhya Pradesh region. The mean range of chosen water characteristics, such as temperature, pH, EC, DO, BOD,*
TH, TA, COD, chlorides, water transparency, water turbidity, nitrates, phosphate etc were routinely examined between October 2020 and September 2022, a period of two years. According to the results, the water body is not acceptable for direct drinking due to the manmade pollution that comes from the surrounding region of catchment. Still, it can be used appropriately for the irrigation of crops as well as for fishing purpose.

Keywords: Physico-chemical, water parameters, Angoori Barrage, Madhya Pradesh

I. INTRODUCTION

The Angoori Barrage is a prominent source of water situated in the Madhya Pradesh region of India's district Datia. The beginning of the constructive work of this barrage was undertaken in 1992–93 over the Angoori River, which was a tributary of the Pahuj River. The year 2004 marked the completion of this water body. Jhansi city is almost 25 kilometers away from this barrage. The J.B.I.C. Japan financing assistance was used to build this barrage. Angoori barrage is a project of Rajghat reservoir of Lalitpur which is a joint project of both Uttar Pradesh and Madhya Pradesh state Government. In addition to being used for composite fish culture, this barrage has supplied water for irrigation purposes for the local area.

II. MATERIAL AND METHODS

Collection of water samples and their analysis: Sampling stations namely Gangwari and Pahadi Lamacha were chosen for the current research work. During a typical two-year period of time, from October 2020 to September 2022, the water samples were collected monthly during the morning hours of the day. All of the water samples were taken and placed in sterile containers made of plastic with an airtight lid. Dynamic water characteristics, such as pH, TDS, temperature, water clarity, and electrical conductivity, were determined at the sample stations; the remaining parameters were investigated at the research center laboratory of Bipin Bihari College in Jhansi. Following the usual procedures advised by APHA (1998), Adoni (1985), Trivedy and Goel (1986), were used for analyzing the collected water samples.

III. RESULT AND DISCUSSION

Tables 1-8 provide an overview of the various water parameters results for the present study.

Water pH: The water pH was observed between 7.4±0.1 to 7.7±0.3. The lowest recorded value occurred in the winter, and the highest during the summer. Temperature, EC, TDS, TA, TH, BOD, COD, phosphates, and nitrates all exhibit positive correlations with water pH, whereas the dissolved oxygen level and water transparency exhibit negative

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correlations with it. The total amount of carbonates, bicarbonates, and carbon dioxide in the water body may be the cause of both the elevated and decreased variation levels in water pH that occur in different seasons. The studies by Kaur H. Dhillon et al. (1997) and Solanki et al. (2005) additionally documented this type of pattern. Sakhare and Joshi (2002) also noted that an increased amount of evaporation would be the reason for the summer's alkaline pH level.

Water Temperature: The water temperature was observed from 23.9±4.4°C to 24.8±4.2°C The lowest recorded value occurred in the winter and the highest during the summer. According to a Pearson correlation analysis, water temperature was shown to be negatively connected with the DO level of the water body and favorably correlated with the pH, EC, TDS, TA, TH, BOD, and COD parameters. In addition to seasonal variations, meteorological conditions can also be the cause of water temperature fluctuations. The works of Ghude and Halwe (2018), Jamdade and Gawande (2017), and Sharma et al. (2011) also noted our findings

Water Transparency: The water transparency was observed from 109±26.1cm to 115±23.7cm. It reached its lowest point in July, during the wet season, and reached its highest point in February, during the cold season. The water transparency is positively connected with the (DO) and negatively correlated with the water parameters, turbidity, EC, TDS, BOD, and COD.

Water Turbidity: The water turbidity was recorded 9.6±5.7 NTU to 11.3±5.6 NTU. Due to different types of silt, clay, and unwanted soil erosion particles suspended in the water body, it was observed at its lowest point during the colder months and at its highest point during the period of rainfall in July. The majority of the chosen water parameters and the water turbidity had positive correlations; DO and the water turbidity had negative correlations. In Sion Lake, Nirbhavane and Khobragade's (2017) assessment study also found a similar type of effect on water turbidity.

Total Dissolved Solids (TDS): The TDS was observed 128±18.2 mg/l to 140±22.9 mg/l. The parameters of EC, temperature, pH, BOD, COD, TA, TH, and chlorides showed a positive correlation with TDS. It was found to be lowest in January during the colder seasons and at its highest in the course of the summer as a result of an upsurge in the rate at which fertilizers, waste products, and organic waste mixed with sewage from nearby communities.

Electric Conductivity (EC): The range of EC was observed between 254±31.5 to 285±42.9 µm/cm. Temperature, total dissolved solids, pH, BOD, and COD all significantly demonstrate a positive correlation with EC, whilst DO and water transparency show a negative correlation. EC of the water body was greatly influenced by its temperature.. It was measured at the lowest level during the colder months of the year due to low ion dissociation and at highest level during the warmer months in May due to the increased dissolution of ionic concentrations of various home waste effluents and water from farming mixing in the Barrage catchment region. Yogendra and Puttaiah [2008] recorded the highest levels of EC in urban water bodies in Karnataka during the summer season, similarly did Kumar et al. [2018] in various lakes in Haryana.

Dissolved Oxygen (DO): The DO level in the research area was observed from 6.1±1.1mg/l to 6.7±1.1 mg/l. Water transparency and dissolved oxygen had a positive correlation, while temperature, BOD, COD, nitrates, and phosphates had a negative correlation with it. It was observed at its lowest point in May during the warmer months because of high air temperatures and enhanced organism metabolic rates, and at its highest point in the colder months because of low atmospheric temperatures accompanied by elevated aquatic plant photosynthesis. The research work of Desai (2014), Kini et al. (2016), Krishna and Kumar (2017), Tichkule and Bakare (2017), Ghude and Halwe (2018), and others supports our conclusions.

Total Alkalinity (TA): The TA range was observed 142±19.1 mg/l to 144±18.4 mg/l. The correlation that existed between temperature, hardness, EC, BOD, COD, nitrates, and phosphates and total alkalinity was positive. It was recorded at its lowest point in the coldest month and at its highest point in June of summer time. The dissolving of land salts and the release of carbon dioxide from the breakdown of waste products could be the cause of the change in TA. Similar findings were additionally identified by Tewari and Mittal (2020) in the Sahastradhara water body and Kumar et al. (2016) in the Yamuna riverbed.

Total Hardness (TH): The TH range of the research area was observed 121±22.8 mg/l to 136±29.3 mg/l. The temperature, alkalinity, EC, nitrates, and phosphates all exhibited positive correlations with total hardness. Because of sedimentary materials, waste products, detergent and soap use for bathing and laundry, and extensive human activity, it was found to be lowest in the cooler months in the January and to be at its highest in the summer in the month of June.

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Chloride: Chloride range was observed 29.9±8.5 mg/l to 36±12.7 mg/l. The TDS, hardness, alkaline content, EC, temperature, BOD, COD, nitrates, and phosphates all have positive correlations with the chloride level. Due to leaching, municipal discharge, and residential waste discharge, it was found to be lowest during the colder months and highest during the summer. According to Bhatnagar and Devpooja (2013) an elevated temperatures, a faster rate of evaporation, and a reduced amount of water level as well as sewage mixing have all been linked to increased chloride concentrations in the summer,

Biological Oxygen Demand (BOD): The range of BOD level was observed 3.5±1.4 mg/l to 4.4±1.5 mg/l. Water temperature, TDS, alkalinity, hardness, EC, COD, nitrates, and phosphates are all significantly positively associated with the BOD content; in contrast, transparency and DO level are negatively correlated with it. High BOD levels in the warmer months could be attributed to the elevated rate of organic decomposition as well as the presence of sewage in the water body. It was recorded minimal during the colder months and highest during the summertime in the month of May. Tichkule and Bakare (2017), Ghude and Halwe (2018), and Kumar et al (2018) all have found similar findings in the water body of Haryana region.

Chemical Oxygen Demand (COD): The COD range of the research area was noticed 18.7±6.4 mg/l to 22.1±8.7 mg/l . The COD concentration was inversely connected with water transparency and DO level, and it was lowest in the cooler months and highest in the summer. It also has a substantial positive correlation with pH, temperature, TDS, alkalinity, hardness, EC, BOD, nitrates, and phosphates. Similar findings were also reported by Berman et al. (2015) in the wetlands and Garg et al. (2010) in Datia's Ramsagar Reservoir.

Nitrate: Nitrate level of the research area was noticed 0.88±0.4 mg/l to 1.1±0.5 mg/l. Water temperature, chloride, TDS, alkalinity, hardness, EC, BOD, COD, and phosphates are all favorably correlated with nitrates; on the other hand, transparency and DO level are inversely correlated, with minimal levels occurring in the winter and highest levels in the summer. The oxidation of untreated household waste and nitrogenous organic materials present in water bodies is accelerated by the seasonal variation of nitrate concentration, which reaches its maximum in summer due to high water temperature and decreases in winter due to low water temperature and slow decomposition of water's nitrogenous organic matter. Our results are corroborated by workers Mahananda et al. (2010) in the Bargarh district, Bhalla and Waykar (2013), and Ghude and Halwe (2018).

Phosphate: The phosphate level of the selected water body was observed 0.9±0.4 mg/l to 1.0±0.5 mg/l. Phosphate had a negative correlation with DO and water transparency and a positive correlation with pH, TDS, temperature, chloride, alkalinity, hardness, EC, BOD, and COD. The winter months experienced the lowest observed values, and the summer months showed the greatest spikes. The usage of fertilizers made from chemicals on agricultural land and waste effluents that released out from the surrounding catchment region may be the primary variable that produces phosphate in the research area. The same conclusions about a negative association between phosphate content and water transparency and DO were additionally found in studies by Qureshimatva et al. (2015) in Sarkhej Roza Lake and Bera et al. (2014) in Kangsabati Reservoir.

IV. CONCLUSION

The Angoori Brrage was found to be entirely alkaline by the physical and chemical examination of water samples collected for the current study. This finding is encouraging for the agricultural and fishery sectors. The majority of the chosen parameters were within acceptable bounds, but the amount of dissolved oxygen and the amount of anthropogenic activity are concerningly high. As a result, in order to improve the water's compatibility for human consumption, aquatic education campaigns must be managed and carried out by the locals who live near the affected area, and those who are accountable must also regularly test the water's parameters at the regional level.

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Table: 01- Physico-chemical water parameters of sampling station- Gangwari - 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 ±S.D.
1	Colour	T	T	T	T	T	T	T	T	M	M	M	M	
2	pH	7.3	7.2	7.1	7.2	7.5	7.6	7.5	7.8	7.9	7.7	7.8	7.6	7.5±0.2
17.83	Temperature (°C)	23.1	20.6	17.8	19.4	20.8	23.5	25.7	28.6	30.4	29.2	27.8	25.4	24.3±4.1
4	Transparency (cm)	108.2	115.7	122.4	133.5	149.8	138.1	127.6	118.4	92.8	82.3	89.5	97.3	114±21.0
5	Turbidity (NTU)	12.6	10.8	6.4	3.2	1.5	2.8	4.7	10.2	14	17.8	15.3	16.5	9.6±5.7
6	TDS (mg/l)	123	116	103	127	132	138	141	148	155	150	138	131	133±14.8
7	E.C. (µm/cm)	242	229	202	216	234	251	259	282	302	298	276	262	254±31.5
8	DO (mg/l)	6.3	6.8	7.2	7.9	7.5	6.1	6.5	5.0	4.1	4.9	5.2	5.8	6.1±1.1
9	TA (mg/l)	130	119	98	126	141	158	149	163	176	151	165	147	143±22.1
10	TH (mg/l)	108	102	97	80	116	135	140	157	151	148	129	115	123±24.0
11	Chloride (mg/l)	32.12	27.54	21.18	16.10	20.26	35.46	41.80	47.96	54.22	50.18	46.34	39.70	36±12.7
12	BOD (mg/l)	3.7	3.5	2.8	1.3	1.7	2.3	2.8	3.8	6.2	6.0	4.1	3.9	3.5±1.4
13	COD (mg/l)	14.5	12.2	11.5	10.9	11.8	17.6	26.7	25.9	32.3	28.7	21.1	16.4	19.1±7.5
14	Nitrate (mg/l)	1.16	0.76	0.46	0.33	0.51	0.56	0.81	1.29	1.65	1.58	1.50	1.47	1.0±0.4
15	Phosphate (mg/l)	0.83	0.61	0.37	0.24	0.30	0.72	1.26	1.35	1.80	1.63	1.45	1.39	0.9±0.5

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Table: 02 Correlation matrix table of sampling station (C- Gangwari) Oct.-2020 to September-2021

Parameters	pH	Temp.	Transp.	Turb.	TDS	E.C.	DO	TA	TH	Chlod.	BOD	COD	Nitrate	Phsp.
pH	1													
Temp.	0.923$^{□□}$	1												
Transp.	-0.467 (ns)	-0.671$^{□}$	1											
Turb.	0.447 (ns)	0.640$^{□}$	-0.969$^{□□}$	1										
TDS	0.903$^{□□}$	0.893$^{□□}$	-0.341 (ns)	0.295 (ns)	1									
E.C.	0.928$^{□□}$	0.990$^{□□}$	-0.662$^{□}$	0.636$^{□}$	0.909$^{□□}$	1								
DO	-0.860$^{□□}$	-0.938$^{□□}$	0.757$^{□□}$	-0.730$^{□□}$	-0.744$^{□□}$	-0.933$^{□□}$	1							
TA	0.961$^{□□}$	0.883$^{□□}$	-0.347 (ns)	0.318 (ns)	0.932$^{□□}$	0.884$^{□□}$	-0.779$^{□□}$	1						
TH	0.871$^{□□}$	0.881$^{□□}$	-0.357 (ns)	0.333 (ns)	0.850$^{□□}$	0.882$^{□□}$	-0.830$^{□□}$	0.822$^{□□}$	1					
Chlod.	0.869$^{□□}$	0.974$^{□□}$	-0.712$^{□□}$	0.675$^{□}$	0.802$^{□□}$	0.957$^{□□}$	-0.963$^{□□}$	0.812$^{□□}$	0.887$^{□□}$	1				
BOD	0.609$^{□}$	0.788$^{□□}$	-0.891$^{□□}$	0.862$^{□□}$	0.533 (ns)	0.805$^{□□}$	-0.887$^{□□}$	0.487	0.618$^{□}$	0.830$^{□□}$	1			
COD	0.808$^{□□}$	0.922$^{□□}$	-0.547 (ns)	0.459 (ns)	0.864$^{□□}$	0.911$^{□□}$	-0.857$^{□□}$	0.774$^{□□}$	0.900$^{□□}$	0.925$^{□□}$	0.752$^{□□}$	1		
NO_3	0.753$^{□□}$	0.882$^{□□}$	-0.892$^{□□}$	0.907$^{□□}$	0.620$^{□}$	0.873$^{□□}$	-0.907$^{□□}$	0.653$^{□}$	0.639$^{□}$	0.881$^{□□}$	0.898$^{□□}$	0.179 (ns)	1	
Phosp.	0.829$^{□□}$	0.958$^{□□}$	-0.794$^{□□}$	0.759$^{□□}$	0.759$^{□□}$	0.939$^{□□}$	-0.935$^{□□}$	0.761$^{□□}$	0.797$^{□□}$	0.976$^{□□}$	0.859$^{□□}$	0.894$^{□□}$	0.929$^{□□}$	1

Note: Level of Significance- $^{□}P \leq 0.05$; $^{□□}P \leq 0.01$, *ns (not significant).*

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Table: 03- Physico-chemical water parameters of sampling station-Gangwari- 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 ±S.D.
1	Colour	T	T	T	T	T	T	T	T	M	M	M	M	
2	pH	7.5	7.4	7.3	7.2	7.3	7.7	7.6	7.8	7.5	7.3	7.2	7.6	7.4±0.1
3	Temperature (°C)	22.4	20.5	18.2	17.3	19.5	23.8	27.9	30.3	29.8	27.4	26.1	24.7	23.9±4.4
4	Transparency (cm)	90.7	105.3	113.7	126.8	132.4	147.2	141.6	128.2	102.5	71.3	80.7	75.4	109±26.1
5	Turbidity (NTU)	15.4	12.7	10.3	6.1	3.5	1.8	4.2	10.9	14.8	17.6	20.3	18.5	11.3±6.2
6	TDS (mg/l)	132	119	106	95	114	127	130	165	142	140	129	138	128±18.2
7	E.C. (µm/cm)	242	237	215	209	249	253	276	305	291	285	273	260	257±29.5
8	DO (mg/l)	6.7	7.8	8.0	8.2	7.6	6.4	5.1	4.3	4.7	5.4	5.9	6.1	6.3±1.3
9	TA (mg/l)	148	139	126	105	134	166	160	172	150	142	136	156	144±18.4
10	TH (mg/l)	115	110	88	103	120	131	153	165	158	148	141	139	130±23.8
11	Chloride (mg/l)	30.17	26.37	21.54	18.33	20.16	35.64	39.71	48.41	56.76	50.14	42.16	36.53	35.4±12.5
12	BOD (mg/l)	3.4	2.8	1.2	1.8	2.2	3.1	3.9	6.4	6.2	4.1	4.7	3.8	3.6±1.5
13	COD (mg/l)	14.8	14.3	11.9	10.2	12.8	20.8	26.7	30.5	25.6	21.4	19.3	16.5	18.7±6.4
14	Nitrate (mg/l)	0.86	0.71	0.55	0.48	0.39	0.45	0.62	1.36	1.58	1.41	1.19	0.96	0.88±0.4
15	Phosphate (mg/l)	0.92	0.67	0.49	0.31	0.28	0.53	1.18	1.79	1.91	1.65	1.47	1.18	1.0±0.5

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Table: 04 Correlation matrix table of sampling station (C- Gangwari) Oct.2021 to September-2022

Parameters	pH	Temp.	Transp.	Turb.	TDS	E.C.	DO	TA	TH	Chlod.	BOD	COD	Nitrate	Phsp.
pH	1													
Temp.	0.558 (ns)	1												
Transp.	0.336 (ns)	0.170 (ns)	1											
Turb.	-0.202 (ns)	0.330 (ns)	-0.952□□	1										
TDS	0.690□	0.901□□	-0.233 (ns)	0.390 (ns)	1									
E.C.	0.502 (ns)	0.965□□	-0.157 (ns)	0.298 (ns)	0.909□□	1								
DO	-0.589□	-0.992□□	0.124 (ns)	-0.281 (ns)	-0.902□□	-0.956□□	1							
TA	0.908□□	0.745□□	0.129 (ns)	-0.002 (ns)	0.834□□	0.724□□	-0.751□□	1						
TH	0.540 (ns)	0.962□□	-0.085 (ns)	0.217 (ns)	0.858□□	0.968□□	-0.961□□	0.714□□	1					
Chlod.	0.418 (ns)	0.960□□	-0.310 (ns)	0.445 (ns)	0.841□□	0.919□□	-0.939□□	0.622□	0.896□□	1				
BOD	0.506 (ns)	0.938□□	-0.215 (ns)	0.415 (ns)	0.847□□	0.922□□	-0.926□□	0.649□	0.910□□	0.914□□	1			
COD	0.669□	0.942□□	0.131 (ns)	0.054 (ns)	0.845□□	0.911□□	-0.950□□	0.786□□	0.915□□	0.862□□	0.867□□	1		
NO_3	0.157 (ns)	0.790□□	-0.593□	0.726□□	0.762□□	0.772□□	-0.763□□	0.339 (ns)	0.705□	0.881□□	0.858□□	0.623□	1	
Phosp.	0.325 (ns)	0.926□□	-0.452 (ns)	0.610□	0.848□□	0.886□□	-0.907□□	0.520	0.848□□	0.950□□	0.926□□	0.800□□	0.950□□	1

Note: Level of Significance- □*P≤0.05*; □□*P≤0.01, ns (not significant)*

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Table: 05- Physico-chemical water parameters of sampling station - Pahadi Lamacha- 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 ±S.D.
1	Colour	T	T	T	T	T	T	T	T	M	M	M	M	
2	pH	7.6	7.7	7.4	7.3	7.5	7.8	7.7	8.1	7.9	7.6	7.7	7.4	7.6±0.2
3	Temperature (°C)	21.2	20.8	17.6	19.4	21.6	24.3	27.7	29.6	30.5	27.5	26.4	24.8	24.2±4.1
4	Transparency (cm)	119.5	123.7	129.2	132.6	138.8	143.9	139.6	102.7	89.4	74.2	81.7	109.3	115±23.7
5	Turbidity (NTU)	12.3	10.6	7.8	2.4	1.8	1.4	8.4	11.6	16.3	17.8	16.9	15.8	10.2±5.9
6	TDS (mg/l)	136	129	109	117	128	132	148	154	169	161	157	141	140±18.2
7	E.C. (µm/cm)	278	246	221	230	251	268	297	329	346	339	318	303	285±42.9
8	DO (mg/l)	6.7	7.3	7.9	8.5	8.2	7.7	6.6	5.7	5.2	5.4	5.8	6.2	6.7±1.1
9	TA (mg/l)	152	128	117	102	131	140	149	166	161	154	158	146	142±19.1
10	TH (mg/l)	124	117	89	78	102	113	129	140	153	146	137	131	121±22.8
11	Chloride (mg/l)	27.83	21.60	19.21	17.22	21.68	30.65	33.81	38.95	42.65	40.26	29.83	35.21	29.9±8.5
12	BOD (mg/l)	3.7	3.1	2.3	1.2	2.8	3.6	4.7	5.8	5.6	5.1	4.7	4.2	3.9±1.3
13	COD (mg/l)	16.5	14.2	12.8	10.4	12.1	19.2	24.1	26.8	35.4	30.3	24.6	18.9	20.4±7.8
14	Nitrate (mg/l)	0.86	0.41	0.29	0.65	0.79	1.12	1.56	1.80	1.72	1.63	1.48	1.41	1.1±0.5
15	Phosphate (mg/l)	0.70	0.38	0.31	0.23	0.62	0.95	1.28	1.39	1.55	1.40	1.31	1.27	0.9±0.4

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Table: 06 Correlation matrix table of sampling station- Pahadi Lamacha- Oct.-2020 to September-2021

Parameters	pH	Temp.	Transp.	Turb.	TDS	E.C.	DO	TA	TH	Chlod.	BOD	COD	Nitrate	Phsp.
pH	1													
Temp.	0.738$^{\square\square}$	1												
Transp.	-0.295 (ns)	-0.581$^{\square}$	1											
Turb.	0.254 (ns)	0.543 (ns)	-0.889$^{\square\square}$	1										
TDS	0.647$^{\square}$	0.941$^{\square\square}$	-0.758$^{\square\square}$	0.725$^{\square\square}$	1									
E.C.	0.617$^{\square}$	0.941$^{\square\square}$	-0.780$^{\square\square}$	0.752$^{\square\square}$	0.979$^{\square\square}$	1								
DO	-0.580 (ns)	-0.847$^{\square\square}$	0.847$^{\square\square}$	-0.895$^{\square\square}$	-0.930$^{\square\square}$	-0.955$^{\square\square}$	1							
TA	0.739$^{\square\square}$	0.857$^{\square\square}$	-0.619$^{\square}$	0.675$^{\square}$	0.889$^{\square\square}$	0.908$^{\square\square}$	-0.891$^{\square\square}$	1						
TH	0.671$^{\square}$	0.883$^{\square\square}$	-0.732$^{\square\square}$	0.800$^{\square\square}$	0.951$^{\square\square}$	0.951$^{\square\square}$	-0.960$^{\square\square}$	0.942$^{\square\square}$	1					
Chlod.	0.639$^{\square}$	0.933$^{\square\square}$	-0.632$^{\square}$	0.654$^{\square\square}$	0.907$^{\square\square}$	0.952$^{\square\square}$	-0.900$^{\square\square}$	0.877$^{\square\square}$	0.919$^{\square\square}$	1				
BOD	0.766$^{\square\square}$	0.933$^{\square\square}$	-0.654$^{\square}$	0.697	0.927$^{\square\square}$	0.946$^{\square\square}$	-0.931$^{\square\square}$	0.963$^{\square\square}$	0.963$^{\square\square}$	0.940$^{\square\square}$	1			
COD	0.674$^{\square}$	0.931$^{\square\square}$	-0.726$^{\square\square}$	0.684$^{\square}$	0.949$^{\square\square}$	0.942$^{\square\square}$	-0.911$^{\square\square}$	0.829$^{\square\square}$	0.902$^{\square\square}$	0.933$^{\square\square}$	0.961$^{\square\square}$	1		
NO_3	0.604$^{\square}$	0.965$^{\square\square}$	-0.598$^{\square}$	0.554 (ns)	0.912$^{\square\square}$	0.945$^{\square\square}$	-0.836$^{\square\square}$	0.845$^{\square\square}$	0.842$^{\square\square}$	0.926$^{\square\square}$	0.897$^{\square\square}$	0.881$^{\square\square}$	1	
Phosp.	0.605$^{\square}$	0.957$^{\square\square}$	-0.642$^{\square}$	0.648$^{\square}$	0.933$^{\square\square}$	0.962$^{\square\square}$	-0.891$^{\square\square}$	0.897$^{\square\square}$	0.910$^{\square\square}$	0.954$^{\square\square}$	0.942$^{\square\square}$	0.914$^{\square\square}$	0.971$^{\square\square}$	1

Note: Level of Significance- $^{\square}P\leq0.05$; $^{\square\square}P\leq0.01$, *ns (not significant)*

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Table: 07- Physico-chemical water parameters of sampling station- Pahadi Lamacha- Oct.-2021 to September-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 ±S.D.
1	Colour	T	T	T	T	T	T	T	T	M	M	M	M	
2	pH	7.5	7.6	7.3	7.2	7.7	7.8	7.9	8.2	8.3	8.1	7.9	7.6	7.7±0.3
3	Temperature (°C)	23.8	20.5	18.2	19.6	21.2	24.6	27.4	29.7	30.8	29.1	27.3	25.8	24.8±4.2
4	Transparency (cm)	108.7	113.4	128.1	133.8	145.6	130.2	118.3	105.9	81.7	78.6	90.5	103.2	111±21.0
5	Turbidity (NTU)	13.6	10.2	6.8	3.4	1.6	7.3	10.5	14.3	16.8	19.3	17.6	15.1	11.3±5.6
6	TDS (mg/l)	129	119	103	113	126	139	146	160	178	165	158	150	140±22.9
7	E.C. (µm/cm)	261	245	211	234	253	276	290	323	267	358	346	331	282±46.9
8	DO (mg/l)	6.8	7.2	7.8	8.3	7.5	7.1	6.5	5.2	4.9	5.4	5.9	6.3	6.5±1.0
9	TA (mg/l)	130	142	108	105	138	148	159	165	168	162	156	140	143±20.8
10	TH (mg/l)	122	116	93	85	129	141	163	176	172	159	149	133	136±29.3
11	Chloride (mg/l)	28.34	23.16	20.93	19.61	26.86	31.72	37.18	41.55	48.31	44.63	38.12	36.46	33±9.4
12	BOD (mg/l)	4.5	3.8	3.1	1.8	2.7	3.5	4.9	5.7	6.8	6.3	5.6	5.2	4.4±1.5
13	COD (mg/l)	19.7	16.3	13.5	11.4	12.8	18.6	20.9	32.1	38.3	33.7	26.2	22.1	22.1±8.7
14	Nitrate (mg/l)	0.95	0.65	0.37	0.55	0.69	0.87	1.46	1.86	1.73	1.59	1.51	1.33	1.1±0.5
15	Phosphate (mg/l)	0.83	0.70	0.43	0.31	0.53	0.69	1.12	1.59	1.68	1.45	1.34	1.16	0.9±0.4

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Table-08 Correlation matrix table of sampling station - Pahadi Lamacha-Oct.-2021 to September-2022

Parameters	pH	Temp.	Transp.	Turb.	TDS	E.C.	DO	TA	TH	Chlod.	BOD	COD	Nitrate	Phsp.
pH	1													
Temp.	0.914**	1												
Transp.	-0.649*	-0.767**	1											
Turb.	0.636*	0.788**	-0.970**	1										
TDS	0.912**	0.978**	-0.794**	0.788**	1									
E.C.	0.624*	0.767**	-0.676*	0.756**	0.774**	1								
DO	-0.913**	-0.952**	0.858**	-0.867**	-0.949**	-0.731**	1							
TA	0.962**	0.902**	-0.643*	0.665*	0.895**	0.696*	-0.883**	1						
TH	0.967**	0.944**	-0.607*	0.644*	0.911**	0.690*	-0.903**	0.970**	1					
Chlod.	0.924**	0.980**	-0.793**	0.793**	0.985**	0.754**	-0.961**	0.895**	0.929**	1				
BOD	0.834**	0.913**	-0.919**	0.935**	0.909**	0.723**	-0.972**	0.833**	0.839**	0.932**	1			
COD	0.893**	0.929**	-0.881**	0.851**	0.934**	0.659*	-0.976**	0.823**	0.845**	0.947**	0.945**	1		
NO_3	0.880**	0.979**	-0.769**	0.800**	0.952**	0.801**	-0.951**	0.873**	0.921**	0.954**	0.910**	0.910**	1	
Phosp.	0.894**	0.959**	-0.859**	0.871**	0.951**	0.756**	-0.992**	0.875**	0.899**	0.960**	0.970**	0.962**	0.973**	1

Note: Level of Significance- $^{*}P\leq0.05$; $^{**}P\leq0.01$; *ns (not significant)*