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Spatio-Temporal Variation in Physico-Chemical Water Quality Parameters of Jaitpura Dam, Mandalgarh District, Rajasthan, India

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Abstract: This study examines bimonthly variability in selected physico-chemical water quality parameters at three monitoring stations (Station-1, Station-2, Station-3) in Jaitpura (Jetpura) Dam, Mandalgarh tehsil, Bhilwara District, Rajasthan, from June–July 2023 through April–May 2025. Parameters measured bimonthly included temperature, pH, dissolved oxygen (DO), transparency, chloride, nitrate, phosphate, alkalinity, carbonate and bicarbonate (derived), and results were interpreted against Indian drinking-water standards and regional limnological studies. Overall, water temperature and transparency showed strong seasonal cycles (highest in pre-monsoon/summer and lowest in winter), pH was mildly alkaline across sites (7.3–8.3), DO ranged from ~5.6 to 6.9 mg·L⁻¹, and nutrients (phosphate, nitrate) remained low, indicating oligotrophic to mesotrophic conditions in the reservoir. Carbonates were generally negligible (<1 mg·L⁻¹) and bicarbonates tracked total alkalinity, indicating bicarbonate-dominated buffering typical of neutral to mildly alkaline freshwater systems. The bimonthly patterns conform with other reservoir studies from Rajasthan and indicate that Jaitpura Dam maintains acceptable physico-chemical status for many uses, though seasonal decreases in DO and spikes in transparency and phosphate during specific bimesters warrant continued monitoring. Methods follow APHA standard procedures (APHA, 2017).

Keywords: Jaitpura Dam; physico-chemical parameters; seasonal variation; alkalinity; Rajasthan; reservoir water quality

I. INTRODUCTION

Water bodies in semi-arid regions such as Rajasthan provide essential ecosystem services—including irrigation, domestic water supply, and fishery production—and require regular monitoring to detect changes induced by climate and anthropogenic pressures (Wetzel, 2001). Jaitpura (also recorded as Jetpura) Dam is an irrigation reservoir in Mandalgarh tehsil of Bhilwara district, Rajasthan (India-WRIS). Seasonal monsoon rainfall and intense summer evaporation drive strong temporal variability in reservoir water chemistry; therefore, assessing spatio-temporal trends is fundamental to resource management and to evaluate compliance with water quality criteria such as IS 10500 (BIS, 2012) (Singodia, 2024).

This study presents bimonthly physico-chemical data for three in-lake stations of Jaitpura Dam (June–July 2023 to April–May 2025), and interprets seasonal patterns of temperature, pH, DO, transparency, chloride, nutrients, and alkalinity species (carbonates and bicarbonates). Objectives were to (1) quantify seasonal and spatial variation in the selected parameters, (2) examine buffering (carbonate–bicarbonate) characteristics and relate them to pH/alkalinity, and (3) compare observed values with relevant standards and regional studies to assess basin status (APHA, 2017; BIS, 2012; Singodia, 2024).

Seasonal variability in physico-chemical parameters of reservoirs is largely governed by climatic conditions, catchment characteristics, and anthropogenic inputs (Boyd, 2015; Trivedy& Goel, 1986). Reservoir limnology in tropical and semi-arid regions often shows strong summer concentration and monsoon dilution effects (Wetzel, 2001; Sharma &Capoor, 2010).

II. MATERIALS AND METHODS

A. Study area and sampling design

Jaitpura (Jetpura) Dam is located in Mandalgarh tehsil (Bhliwara district), Rajasthan, India (India-WRIS, n.d.). Three fixed sampling stations within the reservoir (Station-1, Station-2, Station-3) were monitored bimonthly (every two months) between June–July 2023 and April–May 2025. Sampling was timed to capture major hydrological seasons typical of the region: pre-monsoon/summer (May–July), monsoon (Aug–Sep), post-monsoon/autumn (Oct–Nov), winter (Dec–Jan), late winter/early spring (Feb–Mar) and spring (Apr–May).

Standard protocols for water sampling and chemical analysis were adopted following internationally accepted limnological manuals (Trivedy& Goel, 1986; Boyd, 2015).

B. Field measurements and laboratory analysis

At each station and bimonthly event the following were measured or analyzed:

- Temperature (°C): measured in situ at ~0.5 m depth using a calibrated digital thermometer.
- pH: measured in situ using a portable pH meter calibrated daily following APHA procedures.
- Dissolved Oxygen (DO, mg·L⁻¹): measured in situ using an optical DO meter or by Winkler titration where required (APHA, 2017).
- Transparency (cm): measured using a Secchi disk lowered from the shaded side of the boat; values recorded as cm.
- Chloride (mg·L⁻¹): determined by argentometric titration in the laboratory (APHA, 2017).
- Nitrate (mg·L⁻¹): analyzed using standard cadmium reduction or spectrophotometric methods; reported as <0.5 mg·L⁻¹ where below detection.
- Phosphate (mg·L⁻¹): measured by ascorbic acid-molybdenum blue method (APHA, 2017).
- Alkalinity (mg·L⁻¹ as $CaCO_3$): determined by titration to phenolphthalein and methyl orange end points, following APHA; values reported as mg·L⁻¹.
- Carbonates and Bicarbonates (mg·L⁻¹): where carbonate (CO_3^{2-}) was not directly measured, it was estimated from titration end points and typical freshwater acid-base relationships. In freshwater with pH < ~8.3, carbonate species are commonly negligible; bicarbonate (HCO_3^-) was treated as the major alkalinity contributor and was estimated from total alkalinity (as $CaCO_3$) following standard conversions (APHA, 2017; Wetzel, 2001).

All laboratory analyses followed Standard Methods (APHA, 2017). Data quality was ensured by reagent blanks, calibration standards, and replicate analyses. Results are summarized bimonthly for each station.

C. Data treatment and interpretation

Bimonthly mean values (direct measurements provided by the user dataset) were tabulated for each station. Carbonates were set as negligible (<1 mg·L⁻¹) in most bimesters except where specific values were provided; bicarbonate was calculated to approximately match total measured alkalinity (mg·L⁻¹ as $CaCO_3$) less the carbonate contribution, following standard stoichiometric conversions (APHA, 2017). Comparison to Indian drinking-water guidelines (IS 10500:2012; BIS, 2012) was made for relevant parameters (pH, chloride, nitrate, etc.). Regional context and discussion drew upon previously published reservoir studies in Rajasthan (Sharma et al., 2008; Singodia, 2024).

III. RESULTS

Below are the consolidated bimonthly results for the three monitored stations (values originate from the dataset supplied by the investigators). Tables 1–3 present the full bimonthly series for Station-1, Station-2 and Station-3 respectively.

Table 1. Selected physico-chemical parameters — Station-1 (Jaitpura Dam)

S. No.	Parameter	Jun–Jul 2023	Aug–Sep 2023	Oct–Nov 2023	Dec–Jan 2024	Feb–Mar 2024	Apr–May 2024	Jun–Jul 2024	Aug–Sep 2024	Oct–Nov 2024	Dec–Jan 2025	Feb–Mar 2025	Apr–May 2025
1	Temperature (°C)	29.3	26.4	23.2	17.5	19.2	30.5	32.0	27.7	25.0	19.3	21.0	26.6
2	pH	8.24	8.19	7.84	8.12	7.90	7.80	8.30	8.00	8.11	8.00	7.90	8.13
3	DO (mg·L⁻¹)	6.1	5.8	6.0	6.8	6.4	5.9	6.0	5.9	6.1	6.5	6.6	5.8
4	Transparency (cm)	142	91	82	64	70.6	153.6	141	83	86.2	64	72.2	127

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S. No.	Parameter	Jun–Jul 2023	Aug–Sep 2023	Oct–Nov 2023	Dec–Jan 2024	Feb–Mar 2024	Apr–May 2024	Jun–Jul 2024	Aug–Sep 2024	Oct–Nov 2024	Dec–Jan 2025	Feb–Mar 2025	Apr–May 2025
5	Chloride ($mg \cdot L^{-1}$)	60.0	60.0	62.2	58.0	60.0	62.3	61.2	60.2	64.0	59.7	62.0	60.0
6	Nitrate ($mg \cdot L^{-1}$)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
7	Phosphate ($mg \cdot L^{-1}$)	0.65	0.31	0.40	0.21	0.11	0.22	0.60	0.60	0.31	0.10	0.11	0.21
8	Alkalinity ($mg \cdot L^{-1}$)	110	82.12	108	90	87.4	89	93	85.6	88	81	85.7	91
9	Carbonates ($mg \cdot L^{-1}$)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
10	Bicarbonates ($mg \cdot L^{-1}$)	106	80	104	88	85	87	89	83	86	79	84	89

Table 2. Selected physico-chemical parameters — Station-2 (Jaitpura Dam)

S. No.	Parameter	Jun–Jul 2023	Aug–Sep 2023	Oct–Nov 2023	Dec–Jan 2024	Feb–Mar 2024	Apr–May 2024	Jun–Jul 2024	Aug–Sep 2024	Oct–Nov 2024	Dec–Jan 2025	Feb–Mar 2025	Apr–May 2025
1	Temperature (°C)	29.3	26.8	23.2	17.5	19.2	30.5	32.0	27.7	25.0	19.3	21.0	26.6
2	pH	8.12	8.31	8.00	8.00	7.90	7.30	8.30	8.00	8.17	8.15	8.00	8.17
3	DO ($mg \cdot L^{-1}$)	6.0	5.7	6.3	6.6	6.4	5.7	5.8	5.9	6.2	6.4	6.7	5.6
4	Transparency (cm)	149	92.6	84	69	74	150	140	82.5	88	66.7	74.2	131
5	Chloride ($mg \cdot L^{-1}$)	60.0	61.0	61.2	60.0	60.0	62.8	60.2	61.3	63.0	58.3	61.0	60.4
6	Nitrate ($mg \cdot L^{-1}$)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
7	Phosphate ($mg \cdot L^{-1}$)	0.60	0.35	0.42	0.20	0.10	0.21	0.60	0.60	0.30	0.13	0.11	0.20
8	Alkalinity ($mg \cdot L^{-1}$)	115	77.67	110	91	88.4	90	100	86.6	89	82	84.5	90

S. No.	Parameter	Jun–Jul 2023	Aug–Sep 2023	Oct–Nov 2023	Dec–Jan 2024	Feb–Mar 2024	Apr–May 2024	Jun–Jul 2024	Aug–Sep 2024	Oct–Nov 2024	Dec–Jan 2025	Feb–Mar 2025	Apr–May 2025
9	Carbonates ($mg \cdot L^{-1}$)	<1	5.4	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
10	Bicarbonates ($mg \cdot L^{-1}$)	111	72.27	106	89	86	88	100	85	87	80	83	88

Table 3. Selected physico-chemical parameters — Station-3 (Jaitpura Dam)

S. No.	Parameter	Jun–Jul 2023	Aug–Sep 2023	Oct–Nov 2023	Dec–Jan 2024	Feb–Mar 2024	Apr–May 2024	Jun–Jul 2024	Aug–Sep 2024	Oct–Nov 2024	Dec–Jan 2025	Feb–Mar 2025	Apr–May 2025
1	Temperature (°C)	29.5	27.0	24.0	19.0	18.6	29.5	31.0	28.0	25.0	19.5	21.2	26.0
2	pH	7.90	7.85	8.00	8.10	7.80	7.70	8.20	8.00	8.30	8.10	8.00	8.20
3	DO ($mg \cdot L^{-1}$)	6.0	5.6	6.4	6.9	6.4	5.7	5.7	5.7	6.3	6.5	6.6	5.6
4	Transparency (cm)	146	92	82	66	73	151.2	138	82	84	67.4	74	137
5	Chloride ($mg \cdot L^{-1}$)	60.4	61.4	60.2	60.0	61.0	62.2	61.3	62.4	64.0	59.2	60.0	61.0
6	Nitrate ($mg \cdot L^{-1}$)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
7	Phosphate ($mg \cdot L^{-1}$)	0.66	0.39	0.40	0.19	0.13	0.22	0.60	0.61	0.32	0.11	0.10	0.21
8	Alkalinity ($mg \cdot L^{-1}$)	112	70.08	91.25	90.2	89.0	90.0	101.2	85.0	88.0	80.0	82.4	89.0
9	Carbonates ($mg \cdot L^{-1}$)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
10	Bicarbonates ($mg \cdot L^{-1}$)	108	70.08	91.25	88	87	88	101	83	86	78	81	87

IV. RESULTS & DISCUSSION

A. *Temperature and seasonal trends*

All three stations show a clear seasonal cycle in water temperature, with highest values during Apr–Jul (up to 32.0 °C) and lowest during Dec–Jan (≈17.5–19.5 °C). These patterns are typical for semi-arid reservoirs influenced by high solar input and marked seasonal air temperature differences (Wetzel, 2001). Temperature influences DO solubility and biological activity; lowered DO in warmer months at some stations reflects this thermodynamic control and increased biological oxygen demand in summer.

B. pH, alkalinity and carbonate chemistry

pH values were consistently mildly alkaline (7.3–8.3) at all stations. Alkalinity was dominated by bicarbonate (HCO_3^-) rather than carbonate (CO_3^{2-}) in most bimesters (carbonates <1 mg·L⁻¹ for most dates), which is expected in freshwater systems with pH < ~8.3 (Wetzel, 2001). The bicarbonate concentrations closely parallel measured alkalinity (Tables 1–3), indicating a stable bicarbonate buffering system. A notable exception was Station-1 in Jun–Jul 2024 where a carbonate reading of 4.38 $mg \cdot L^{-1}$ was recorded; this matches the slightly higher pH (8.30) that month, and likely reflects transient shifts in the carbonate equilibrium ($CO_2 \rightleftarrows HCO_3^- \rightleftarrows CO_3^{2-}$) under reduced CO_2 conditions (APHA, 2017).The observed alkaline pH and bicarbonate-dominated alkalinity are characteristic features of Indian freshwater reservoirs (Welch, 1952; Sharma &Capoor, 2010).

C. Dissolved oxygen and transparency

DO varied between ~5.6 and 6.9 $mg \cdot L^{-1}$. Although values are generally within ranges that support fish and aquatic life, seasonal dips (often late pre-monsoon or summer months) occurred concurrently with higher temperatures and—at some stations—higher transparency (Secchi depth). Elevated transparency values in Apr–May 2024 and Jun–Jul 2024 (exceeding 140 cm at times) suggest lower turbidity during those bimesters, possibly due to lower inflow and settling of suspended solids; conversely, monsoon months show reduced transparency (≈80–90 cm), consistent with increased runoff and suspended load (Singodia, 2024).Dissolved oxygen variations reflect the combined influence of temperature, biological activity, and organic load, as reported for other tropical reservoirs (Boyd, 2015; Das & Acharya, 2003).Transparency fluctuations correspond to seasonal inflow patterns and sediment resuspension during monsoon months (Welch, 1952; Trivedy& Goel, 1986).

D. Nutrients (nitrate, phosphate) and trophic state implications

Nitrate concentrations were consistently below detection (<0.5 $mg \cdot L^{-1}$) at all stations and bimesters, indicating low inorganic nitrogen availability in the water column. Phosphate levels ranged from 0.10 to 0.66 $mg \cdot L^{-1}$, with higher readings in summer at several stations (e.g., Station-1 Jun–Jul 2023: 0.65 $mg \cdot L^{-1}$; Station-3 Jun–Jul 2023: 0.66 $mg \cdot L^{-1}$). These phosphate values are modest but suggest periods of elevated phosphorus supply, which can stimulate primary production if nitrogen is not limiting (Wetzel, 2001). Compared to other reservoir studies in Rajasthan (Sharma et al., 2008; Singodia, 2024), the nutrient levels here indicate oligotrophic to mesotrophic conditions—consistent with relatively low nitrate and moderate phosphate.Low nitrate and moderate phosphate concentrations indicate oligotrophic to mesotrophic conditions, consistent with earlier reservoir studies from Rajasthan and central India (Das & Acharya, 2003; Sharma et al., 2008).

E. Chloride and other conservative ions

Chloride concentrations were stable across sites (≈58–64 $mg \cdot L^{-1}$), well within typical freshwater ranges and below problematic thresholds for drinking and irrigation per IS 10500 (BIS, 2012). Stable chloride indicates limited saline intrusion or large anthropogenic salt inputs at the time of study.

F. Comparison with standards and regional studies

When compared with Indian drinking water standards (IS 10500:2012), parameters such as pH, chloride and nitrate largely fall within acceptable ranges for many uses, although direct use of raw reservoir water for drinking would still require treatment (BIS, 2012). The seasonal patterns and general water-quality ranges are comparable to previously reported Rajasthan reservoir studies where pH ranges and alkalinity reflect bicarbonate buffering and summer/monsoon cycles (Sharma et al., 2008; Singodia, 2024).

Table 4 - STATISTICAL COMPARISON OF WATER QUALITY PARAMETERS (SITES 1–3)

Parameter	Site 1 (Mean ± SD)	Site 2 (Mean ± SD)	Site 3 (Mean ± SD)
Temperature (°C)	24.7 ± 4.6	24.6 ± 4.5	24.9 ± 4.3
pH	8.05 ± 0.16	8.06 ± 0.28	8.04 ± 0.19
Dissolved Oxygen (mg/L)	6.18 ± 0.33	6.03 ± 0.39	6.15 ± 0.42
Transparency (cm)	98.6 ± 33.4	101.2 ± 31.7	100.8 ± 32.9
Chloride (mg/L)	60.9 ± 1.6	60.8 ± 1.4	61.1 ± 1.5

Parameter	Site 1 (Mean ± SD)	Site 2 (Mean ± SD)	Site 3 (Mean ± SD)
Phosphate (mg/L)	0.33 ± 0.20	0.31 ± 0.19	0.32 ± 0.21
Alkalinity (mg/L)	91.1 ± 9.7	92.0 ± 11.2	90.5 ± 11.8
Bicarbonates (mg/L)	87.9 ± 10.1	88.3 ± 12.0	86.7 ± 11.5

The table 4 shows mean ± SD values of major water quality parameters at three sites over the study period. Temperature, pH, and dissolved oxygen were nearly uniform across all sites, indicating similar thermal and oxygen conditions. Transparency and chloride concentrations also showed minimal spatial variation. Nutrients (phosphate) and buffering parameters (alkalinity and bicarbonates) were comparable among sites, suggesting overall homogeneous water quality conditions.

G. *Management implications*

- The general good status of parameters suggests Jaitpura Dam is currently functioning as a relatively stable freshwater reservoir; however, seasonal low DO and occasional higher phosphate values indicate that eutrophication and oxygen stress should be monitored.
- Continued regular monitoring (including biological indicators such as chlorophyll-a and plankton) would improve early detection of trophic shifts (APHA, 2017; Wetzel, 2001).
- Catchment management to minimize nutrient-rich runoff during monsoon will help maintain reservoir quality; best management practices and controlled agricultural inputs could reduce phosphate pulses.

V. CONCLUSION

Bimonthly monitoring of Station-1, Station-2 and Station-3 of Jaitpura Dam from June–July 2023 to April–May 2025 shows pronounced seasonal variations typical of semi-arid reservoirs: higher temperatures and transparency in summer, reduced transparency during monsoon, and mild alkalinity with bicarbonate dominance. Nutrient status (low nitrate; moderate phosphate) suggests predominantly oligotrophic to mesotrophic conditions. Carbonate concentrations were generally negligible except for a transient value at Station-1 (Jun–Jul 2024), which coincided with slightly higher pH. Overall water-quality parameters are within ranges encountered in regional reservoirs; nevertheless, seasonal DO minima and phosphate peaks recommend continued monitoring and catchment measures to prevent eutrophication. Results provide a baseline for future long-term assessments and local water resource management.

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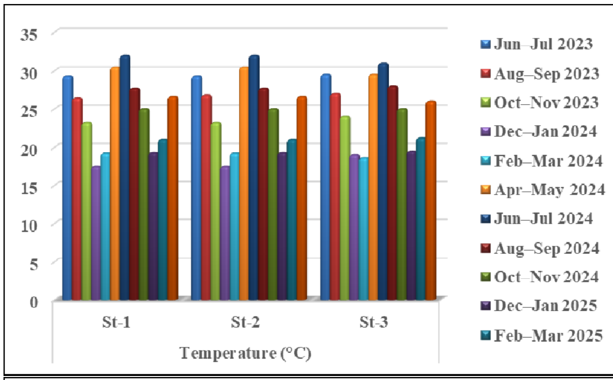
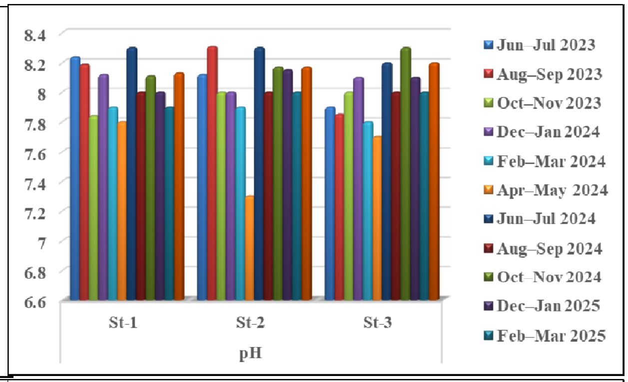

35
30
25
20
15
10
5
0
St-1
St-2
St-3
Temperature (°C)
Jun–Jul 2023
Aug–Sep 2023
Oct–Nov 2023
Dec–Jan 2024
Feb–Mar 2024
Apr–May 2024
Jun–Jul 2024
Aug–Sep 2024
Oct–Nov 2024
Dec–Jan 2025
Feb–Mar 2025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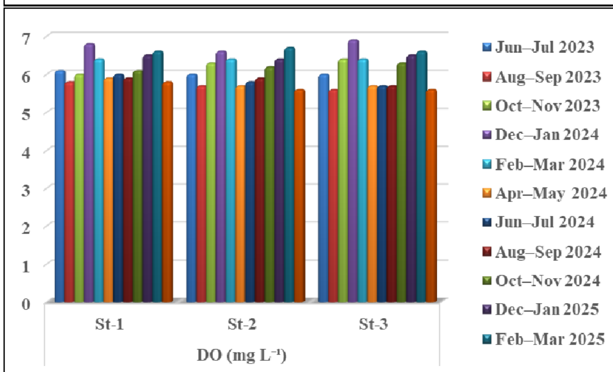
8.2
8
7.8
7.6
7.4
7.2
7
6.8
6.6
St-1
St-2
St-3
pH
Jun–Jul 2023
Aug–Sep 2023
Oct–Nov 2023
Dec–Jan 2024
Feb–Mar 2024
Apr–May 2024
Jun–Jul 2024
Aug–Sep 2024
Oct–Nov 2024
Dec–Jan 2025
Feb–Mar 2025


7
6
5
4
3
2
1
0
St-1
St-2
St-3
DO (mg L⁻¹)
Jun–Jul 2023
Aug–Sep 2023
Oct–Nov 2023
Dec–Jan 2024
Feb–Mar 2024
Apr–May 2024
Jun–Jul 2024
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Oct–Nov 2024
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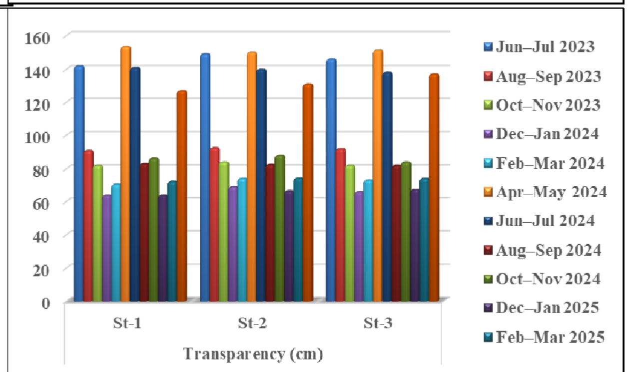
Feb–Mar 2025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140
120
100
80
60
40
20
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St-1
St-2
St-3
Transparency (cm)
Jun–Jul 2023
Aug–Sep 2023
Oct–Nov 2023
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Feb–Mar 2024
Apr–May 2024
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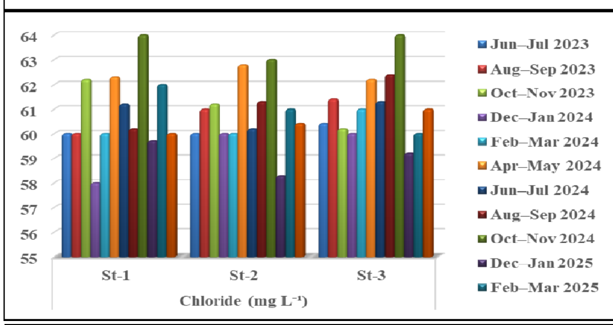
Aug–Sep 2024
Oct–Nov 2024
Dec–Jan 2025
Feb–Mar 2025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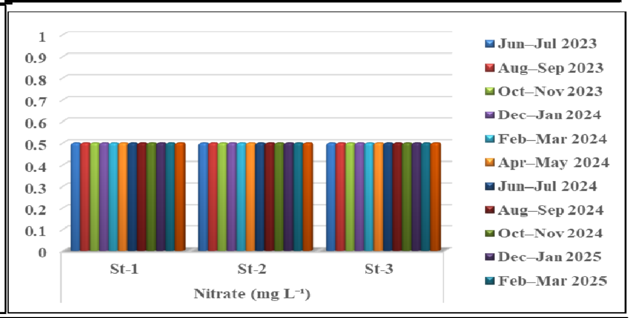
62
61
60
59
58
57
56
55
St-1
St-2
St-3
Chloride (mg L⁻¹)
Jun–Jul 2023
Aug–Sep 2023
Oct–Nov 2023
Dec–Jan 2024
Feb–Mar 2024
Apr–May 2024
Jun–Jul 2024
Aug–Sep 2024
Oct–Nov 2024
Dec–Jan 2025
Feb–Mar 2025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0.6
0.5
0.4
0.3
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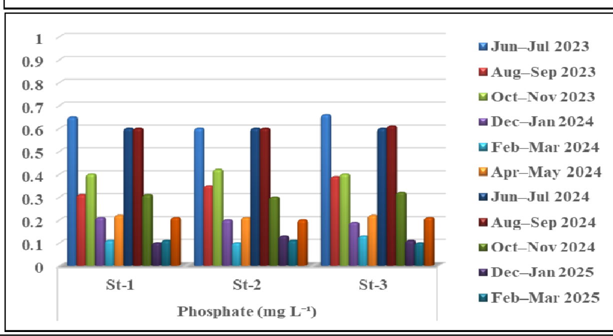
0.1
0
St-1
St-2
St-3
Nitrate (mg L⁻¹)
Jun–Jul 2023
Aug–Sep 2023
Oct–Nov 2023
Dec–Jan 2024
Feb–Mar 2024
Apr–May 2024
Jun–Jul 2024
Aug–Sep 2024
Oct–Nov 2024
Dec–Jan 2025
Feb–Mar 2025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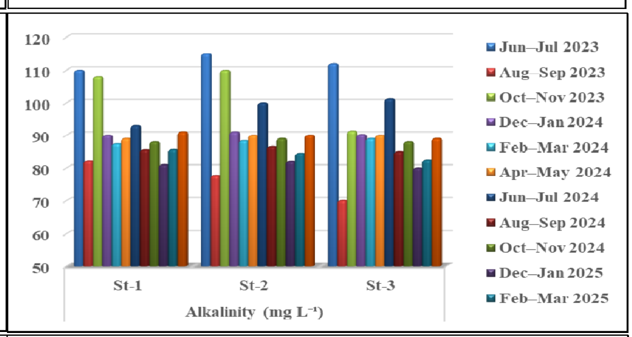
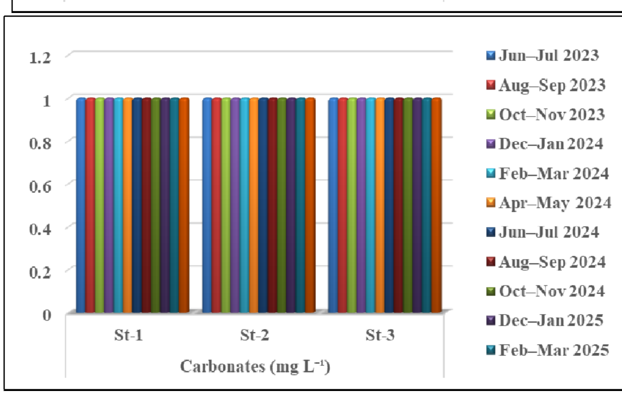
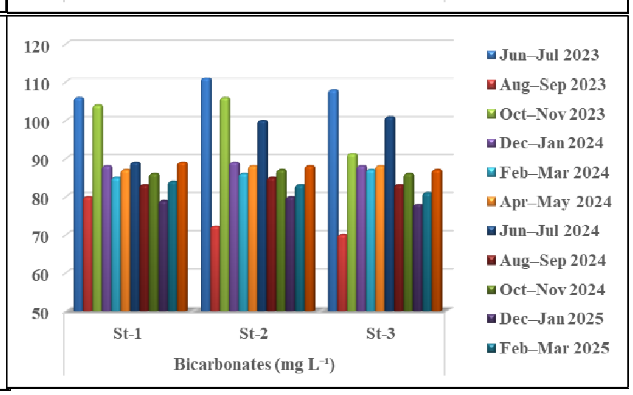
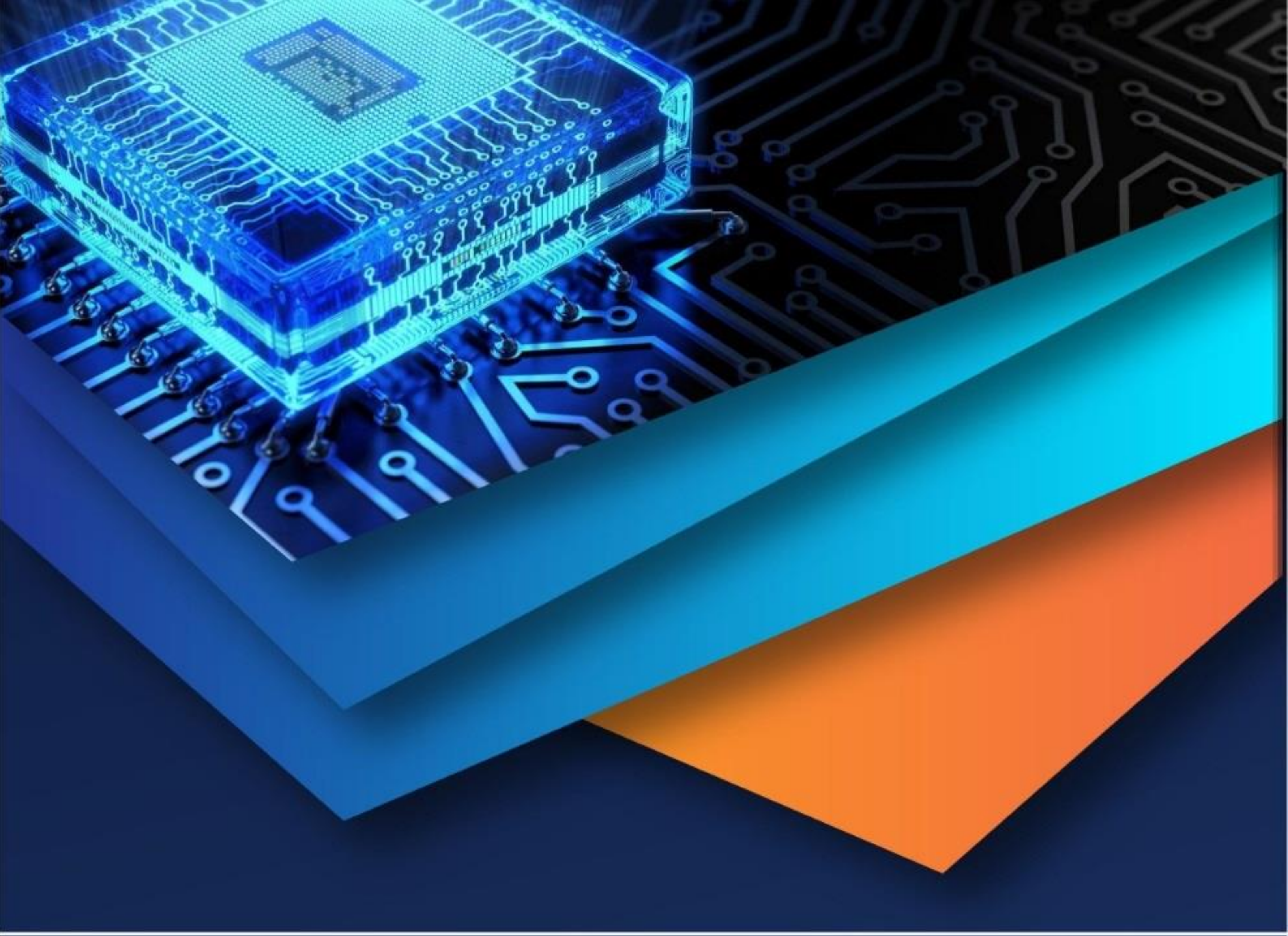
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
St-1
St-2
St-3
Phosphate (mg L⁻¹)
Jun–Jul 2023
Aug–Sep 2023
Oct–Nov 2023
Dec–Jan 2024
Feb–Mar 2024
Apr–May 2024
Jun–Jul 2024
Aug–Sep 2024
Oct–Nov 2024
Dec–Jan 2025
Feb–Mar 2025


120
110
100
90
80
70
60
50
St-1
St-2
St-3
Alkalinity (mg L⁻¹)
Jun–Jul 2023
Aug–Sep 2023
Oct–Nov 2023
Dec–Jan 2024
Feb–Mar 2024
Apr–May 2024
Jun–Jul 2024
Aug–Sep 2024
Oct–Nov 2024
Dec–Jan 2025
Feb–Mar 2025


1.2
1
0.8
0.6
0.4
0.2
0
St-1
St-2
St-3
Carbonates (mg L⁻¹)
Jun–Jul 2023
Aug–Sep 2023
Oct–Nov 2023
Dec–Jan 2024
Feb–Mar 2024
Apr–May 2024
Jun–Jul 2024
Aug–Sep 2024
Oct–Nov 2024
Dec–Jan 2025
Feb–Mar 2025


120
110
100
90
80
70
60
50
St-1
St-2
St-3
Bicarbonates (mg L⁻¹)
Jun–Jul 2023
Aug–Sep 2023
Oct–Nov 2023
Dec–Jan 2024
Feb–Mar 2024
Apr–May 2024
Jun–Jul 2024
Aug–Sep 2024
Oct–Nov 2024
Dec–Jan 2025
Feb–Mar 2025



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