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Water Quality Assessment of Bibinagar Lake by Physico-Chemical Parameters

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ABSTRACT

This study investigated the seasonal variations in physico-chemical parameters and their impact on phytoplankton diversity, community structure, and abundance in Bibinagar Lake from May 2021 to April 2022. Key parameters analyzed included temperature, turbidity, pH, electrical conductance, total dissolved solids (TDS), total hardness, dissolved oxygen (DO), biochemical oxygen demand (BOD), and chemical oxygen demand (COD). Significant seasonal fluctuations were observed, with temperature ranging from 16.2°C to 18.8°C, turbidity peaking during monsoon runoff, and variations in pH, conductance, and hardness. Elevated BOD and COD levels in late months indicated increased organic pollution. Despite these fluctuations, most parameters stayed within normal ranges, suggesting generally good water quality. The study underscores the dynamic nature of water quality and highlights the importance of continuous monitoring to manage pollution and protect aquatic ecosystems.

Keywords: *Water, Physico-chemical parameters, Environmental, Anthropogenic, Organic Pollution*

1. Introduction

Water is fundamental for sustaining life on Earth. However, its quality is increasingly threatened by anthropogenic activities such as construction, improper sewage disposal, and inadequate agricultural practices [1-2]. Environmental factors like soil erosion can alter physical landscapes and subsequently affect water bodies [3]. Traditional assessments of water quality typically focus on physico-chemical parameters such as turbidity, pH, and conductivity. While these metrics are crucial, they alone do not fully capture the complexities of water quality. Environmental variables, including topographical factors such as slope, aspect, and geological parameters, including lithology and soil type, also significantly influence water quality. These factors can have both direct and indirect effects on the overall condition of water bodies [4]. For instance, shallow water bodies and estuaries exhibit notable seasonal variations in water quality parameters, influenced by regional rainfall, tidal inflows, and various abiotic and biotic processes that play a substantial role in nutrient cycling [5]. Water quality is generally described through its physical, chemical, and biological characteristics. Rapid industrial development and the unregulated use of chemical fertilizers and pesticides have led to significant pollution in aquatic environments, resulting in deteriorated water quality and reduced aquatic biodiversity. The use of contaminated water poses serious health risks, leading to waterborne diseases among human populations. Therefore, regular monitoring of water quality is essential to safeguard public health and the environment.

The present study aims to analyze the water quality of Bibinagar Lake by examining physico-chemical parameters over a one-year period from May 2021 to April 2022. Previous research in India has extensively explored the physicochemical and biological characteristics of various water bodies, including reservoirs, rivers, and lakes [6]. This study builds on this body of work to provide a comprehensive assessment of the water quality of Bibinagar Lake, contributing valuable data for future environmental management and conservation efforts.

Materials and Methods

Surface water samples were collected from Bibinagar Lake at three sampling stations between 10:00 am and 11:00 am. Sampling was conducted monthly from May 2021 to April 2022, covering the monsoon, winter, and summer seasons. The samples were collected in sterilized plastic cans with a capacity of 2 litres.

At the sampling stations, measurements were taken for water temperature, pH, and turbidity. For unstable parameters such as temperature, electrical conductivity (EC), pH, and dissolved oxygen (DO), measurements were recorded on-site. Collected samples were promptly transported to the laboratory for further analysis of various physicochemical parameters, including conductivity, total solids, dissolved oxygen, total hardness, COD, and biochemical oxygen demand (BOD). The analyses were conducted following standard methods as outlined by [7-12]. Three replicates of each sample from each station were taken for each parameter, and statistical means were computed. Temperature was measured in situ using a centigrade thermometer (0–110°C). pH was measured with a portable Mac pH meter, turbidity was assessed using an Electronic India Digital Turbidity Meter (Model-331), and total dissolved solids (TDS) and electrical conductivity were recorded using the Toshcon Multipara meter Analyser. Dissolved oxygen and total hardness were estimated according to the methods described by [13-14].

Results and Discussion

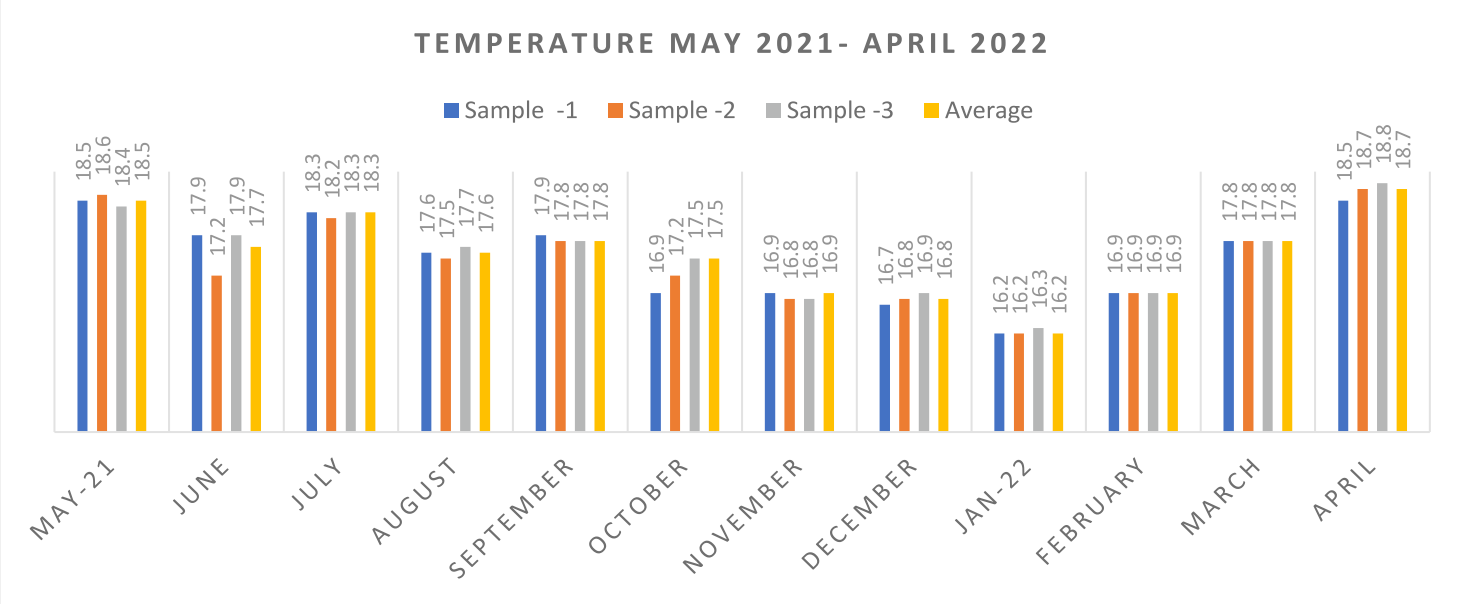
The study of Bibinagar Lake's water quality for the academic year 2021-22 revealed notable seasonal variations in key physicochemical parameters. Data were collected from three different sampling stations, focusing on temperature, turbidity, pH, electrical conductance, total dissolved solids (TDS), total hardness, dissolved oxygen (DO), biochemical oxygen demand (BOD), and chemical oxygen demand (COD).

Temperature

Water temperatures ranged from 16.2°C in January 2022 to 18.8°C in April 2022 (Table 1 and Graph 1). The highest average temperature of 18.7°C was recorded in April, while the lowest average of 16.2°C was observed in January. These temperature fluctuations are consistent with seasonal changes typically observed in temperate climates, where warmer temperatures occur during the spring and summer months [14-16].

Table 1. Monthly Water Temperature (°C) in Bibinagar Lake (2021-22)

S.NO.	Month	Sample -1	Sample -2	Sample -3	Average
1	May - 2021	18.5	18.6	18.4	18.5
2	June	17.9	17.2	17.9	17.7
3	July	18.3	18.2	18.3	18.3
4	August	17.6	17.5	17.7	17.6
5	September	17.9	17.8	17.8	17.8
6	October	16.9	17.2	17.5	17.5
7	November	16.9	16.8	16.8	16.9
8	December	16.7	16.8	16.9	16.8
9	January -2022	16.2	16.2	16.3	16.2
10	February	16.9	16.9	16.9	16.9
11	March	17.8	17.8	17.8	17.8
12	April	18.5	18.7	18.8	18.7



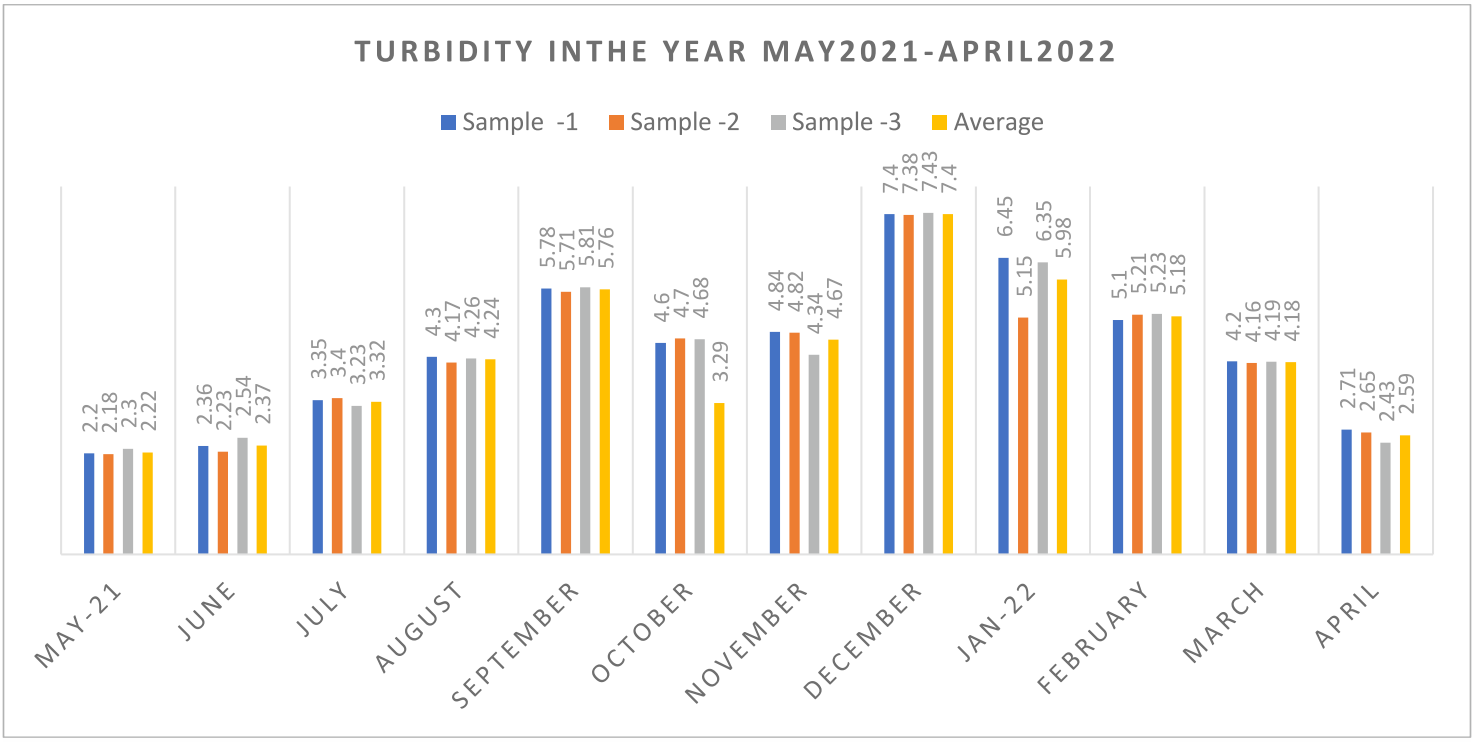
Graph 1.

Turbidity

Turbidity levels varied significantly throughout the year, peaking at an average of 7.40 NTU in December and dropping to 2.22 NTU in May 2021 (Table 2 and Graph 2). The elevated turbidity in December can be attributed to increased runoff and sedimentation from the monsoon rains, aligning with findings from similar studies [17].

Table 2. Monthly Variations in Turbidity of Water body in Bibinagar Lake (2021-22)

S.NO.	Month	Sample -1	Sample -2	Sample -3	Average
1	May-2021	2.2	2.18	2.3	2.22
2	June	2.36	2.23	2.54	2.37
3	July	3.35	3.4	3.23	3.32
4	August	4.3	4.17	4.26	4.24
5	September	5.78	5.71	5.81	5.76
6	October	4.60	4.7	4.68	3.29
7	November	4.84	4.82	4.34	4.67
8	December	7.4	7.38	7.43	7.40
9	January - 2022	6.45	5.15	6.35	5.98
10	February	5.10	5.21	5.23	5.18
11	March	4.2	4.16	4.19	4.18
12	April	2.71	2.65	2.43	2.59



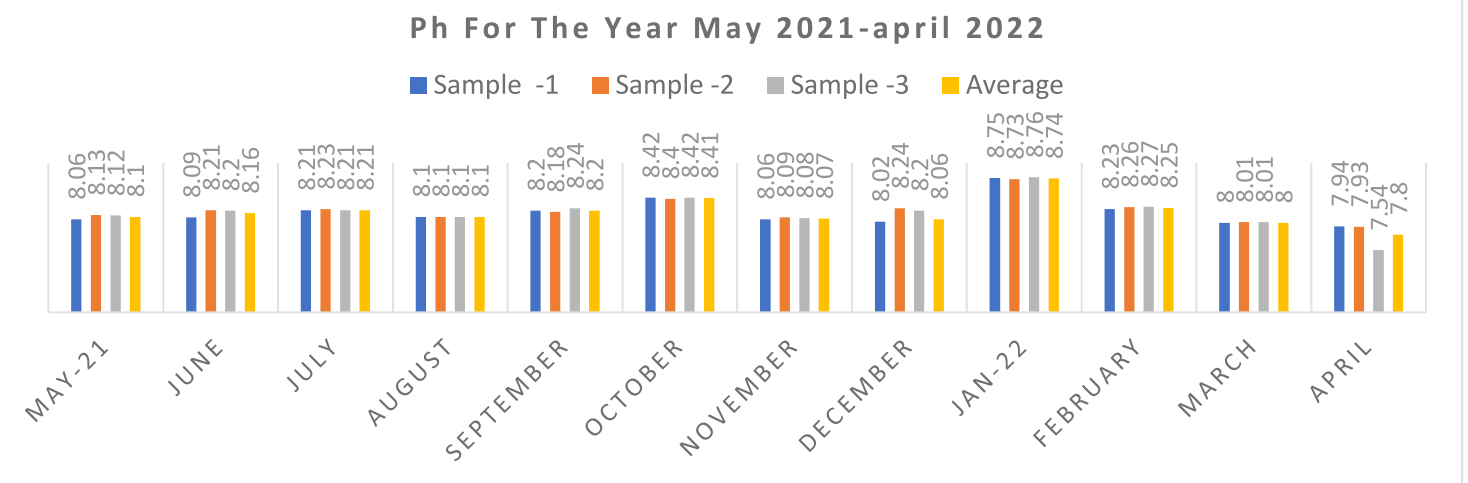
Graph 2.

pH

The pH values ranged from 7.80 in April to 8.74 in January 2022 (Table 3 and Graph 3). The highest average pH of 8.41 was recorded in October, while the lowest average pH of 8.00 was observed in March. These variations suggest a seasonal influence on water chemistry, with higher pH values potentially linked to reduced organic activity during cooler months [18].

Table 3. Monthly Variations in pH at 25°C in Bibinagar Lake (2021-22)

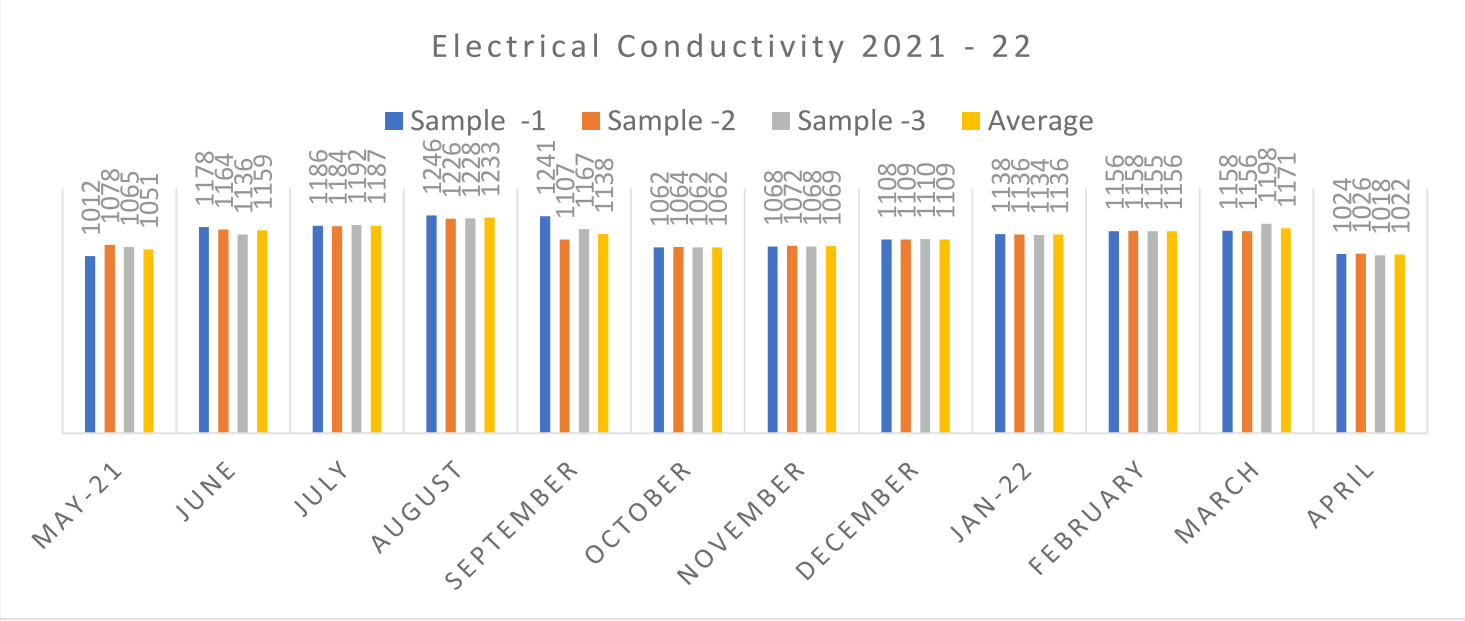
S.NO.	Month	Sample-1	Sample -2	Sample -3	Average
1	May-2021	8.06	8.13	8.12	8.10
2	June	8.09	8.21	8.20	8.16
3	July	8.21	8.23	8.21	8.21
4	August	8.10	8.10	8.10	8.10
5	September	8.2	8.18	8.24	8.20
6	October	8.42	8.40	8.42	8.41
7	November	8.06	8.09	8.08	8.07
8	December	8.02	8.24	8.20	8.06
9	January - 2022	8.75	8.73	8.76	8.74
10	February	8.23	8.26	8.27	8.25
11	March	8.	8.01	8.01	8.00
12	April	7.94	7.93	7.54	7.80



Graph 3.

Table 4. Monthly Variations in Electrical Conductance (µSiemens/cm) at Bibinagar Lake (2021-22)

S.NO.	Month	Sample -1	Sample -2	Sample -3	Average
1	May-2021	1012	1078	1065	1051
2	June	1178	1164	1136	1159
3	July	1186	1184	1192	1187
4	August	1246	1226	1228	1233
5	September	1241	1107	1167	1138
6	October	1062	1064	1062	1062
7	November	1068	1072	1068	1069
8	December	1108	1109	1110	1109
9	January - 2022	1138	1136	1134	1136
10	February	1156	1158	1155	1156
11	March	1158	1156	1198	1171
12	April	1024	1026	1018	1022



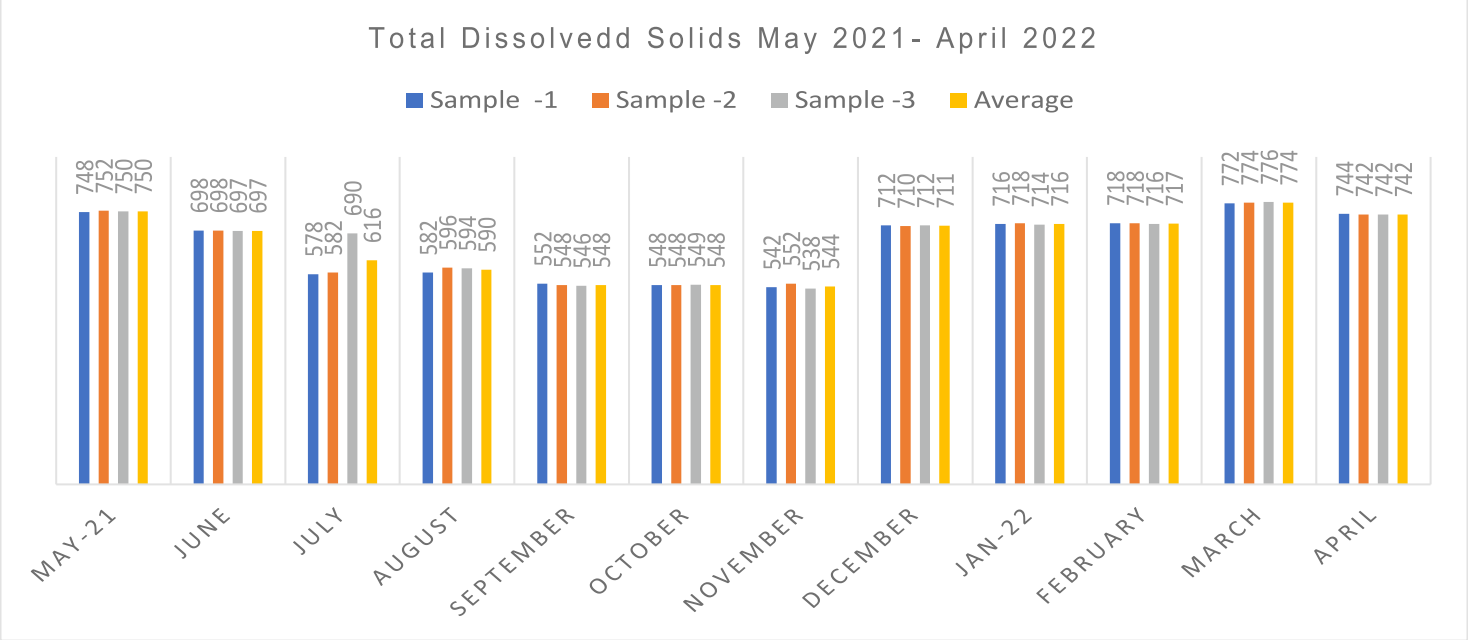
Graph 4.

Electrical Conductance

Electrical conductance ranged from 1,051 µS/cm in May 2021 to 1,233 µS/cm in August (Table 4 and Graph 4). The higher average conductance in August reflects increased ion concentration, likely due to higher water temperatures and increased evaporation rates during the summer months [19-21].

Table 5. Monthly Variations in Total dissolved solids (ppm) at Bibinagar Lake (2021-22)

S. NO.	Month	Sample -1	Sample -2	Sample -3	Average
1	May-2021	748	752	750	750
2	June	698	698	697	697
3	July	578	582	690	616
4	August	582	596	594	590
5	September	552	548	546	548
6	October	548	548	549	548
7	November	542	552	538	544
8	December	712	710	712	711
9	January - 2022	716	718	714	716
10	February	718	718	716	717
11	March	772	774	776	774
12	April	744	742	742	742



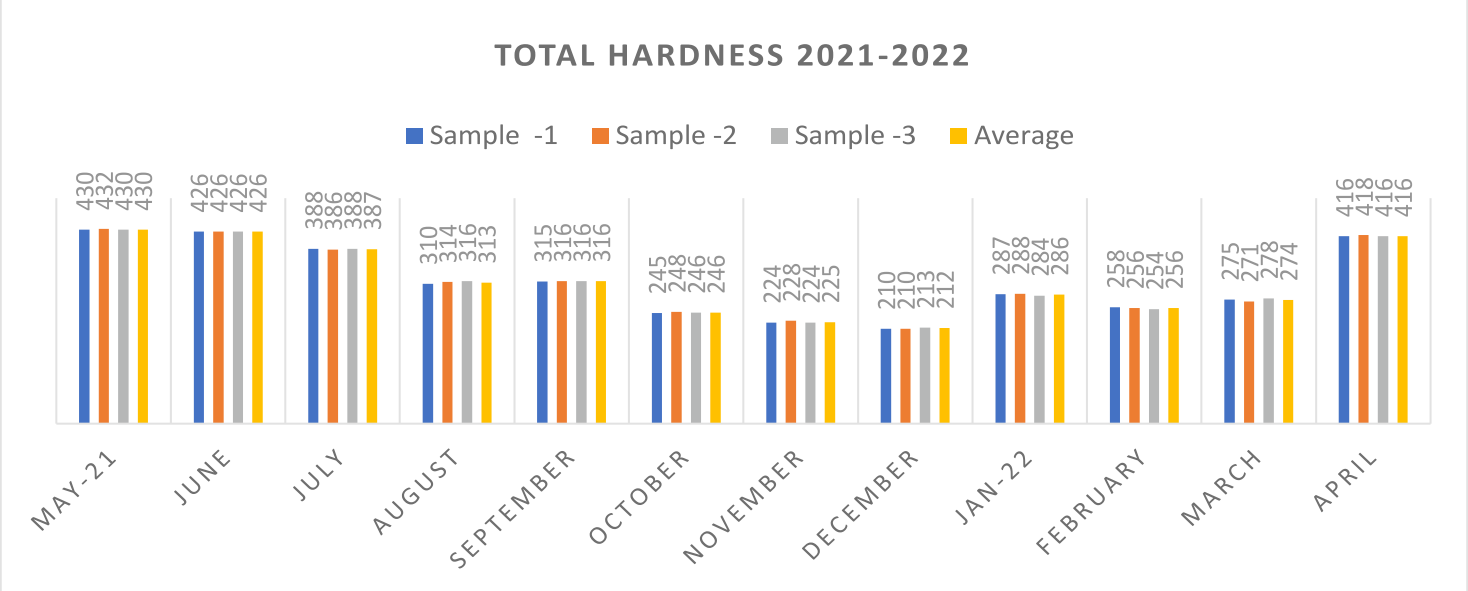
Graph 5.

Total Hardness

Total hardness ranged from 210 ppm in December to 430 ppm in May (Table 6). The highest average hardness of 430 ppm was observed in May, correlating with increased mineral content during warmer months. Seasonal fluctuations in water hardness are commonly reported in freshwater systems [22-24].

Table 6. Monthly Variations in Total hardness (ppm) at Bibinagar Lake (2021-22)

S.NO.	Month	Sample -1	Sample -2	Sample -3	Average
1	May-2021	430	432	430	430
2	June	426	426	426	426
3	July	388	386	388	387
4	August	310	314	316	313
5	September	315	316	316	316
6	October	245	248	246	246
7	November	224	228	224	225
8	December	210	210	213	212
9	January - 2022	287	288	284	286
10	February	258	256	254	256
11	March	275	271	278	274
12	April	416	418	416	416



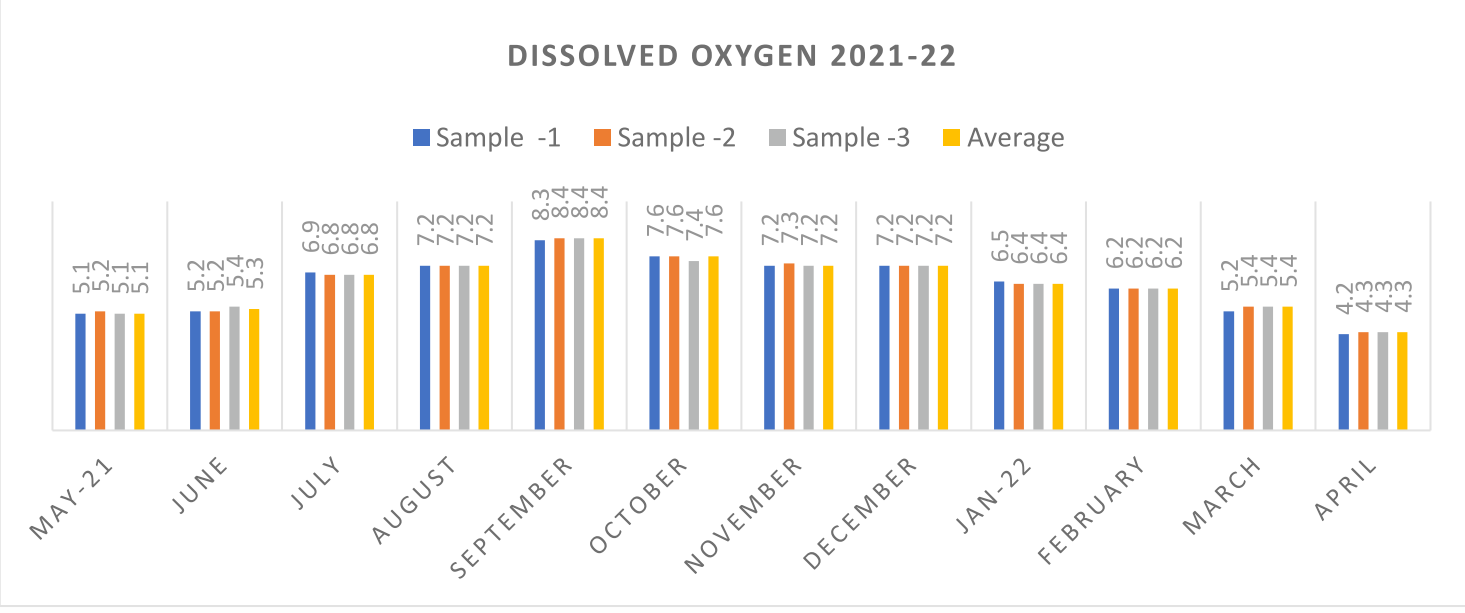
Graph 6.

Dissolved Oxygen (DO)

DO levels ranged from 4.3 mg/L in April to 8.4 mg/L in September (Table 7 and Graph 7). The highest average DO of 8.4 mg/L in September suggests favourable conditions for oxygenation, potentially due to cooler temperatures and enhanced photosynthetic activity during this period [25-26].

Table 7. Monthly Variations in Dissolved Oxygen (DO) at Bibinagar Lake (2021-22)

S.NO.	Month	Sample -1	Sample -2	Sample -3	Average
1	May-2021	5.1	5.2	5.1	5.1
2	June	5.2	5.2	5.4	5.3
3	July	6.9	6.8	6.8	6.8
4	August	7.2	7.2	7.2	7.2
5	September	8.3	8.4	8.4	8.4
6	October	7.6	7.6	7.4	7.6
7	November	7.2	7.3	7.2	7.2
8	December	7.2	7.2	7.2	7.2
9	January - 2022	6.5	6.4	6.4	6.4
10	February	6.2	6.2	6.2	6.2
11	March	5.2	5.4	5.4	5.4
12	April	4.2	4.3	4.3	4.3



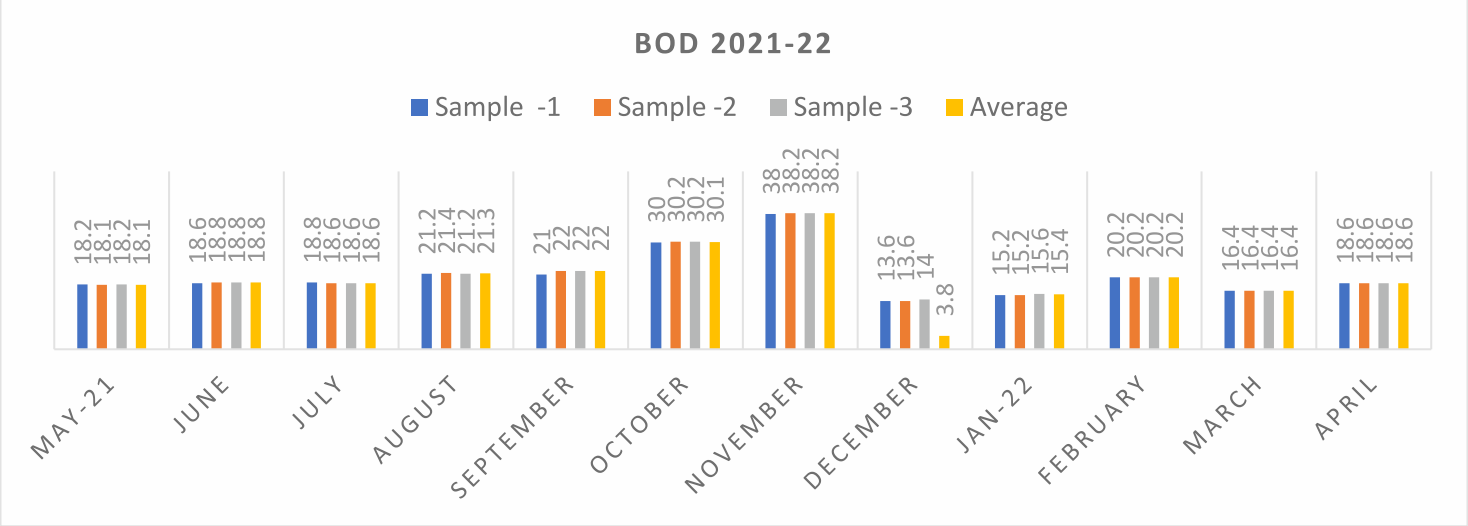
Graph 7.

Biochemical Oxygen Demand (BOD)

BOD values ranged from 13.8 mg/L in December to 38.2 mg/L in November (Table 8 and Graph 8). The elevated BOD in November indicates higher levels of organic pollution, which may result from increased runoff and waste discharge [27-29].

Table 8. Monthly Variations in Bio-Chemical Oxygen Demand (BOD) at Bibinagar Lake (2021-22)

S.NO.	Month	Sample -1	Sample -2	Sample -3	Average
1	May-2021	18.2	18.1	18.2	18.1
2	June	18.6	18.8	18.8	18.8
3	July	18.8	18.6	18.6	18.6
4	August	21.2	21.4	21.2	21.3
5	September	21	22	22	22
6	October	30	30.2	30.2	30.1
7	November	38	38.2	38.2	38.2
8	December	13.6	13.6	14	3.8
9	January - 2022	15.2	15.2	15.6	15.4
10	February	20.2	20.2	20.2	20.2
11	March	16.4	16.4	16.4	16.4
12	April	18.6	18.6	18.6	18.6



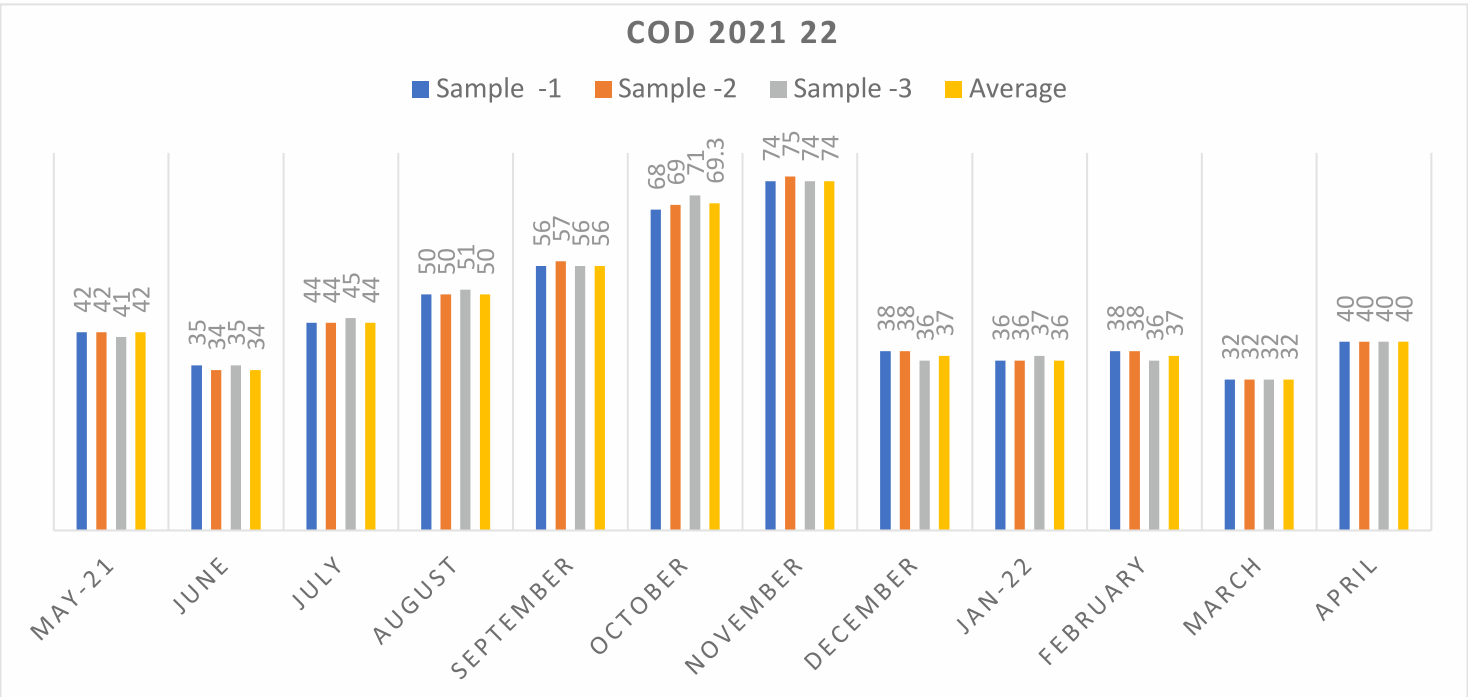
Graph 8.

Chemical Oxygen Demand (COD)

COD values ranged from 32 mg/L in March to 74 mg/L in November (Table 9 Graph 9). The highest average COD of 74 mg/L in November reflects increased levels of oxidizable organic material, similar to patterns observed in other studies [29-30].

Table 9. Monthly Variations in Chemical Oxygen Demand (COD) at Bibinagar Lake (2021-22)

S.NO.	Month	Sample -1	Sample -2	Sample -3	Average
1	May-2021	42	42	41	42
2	June	35	34	35	34
3	July	44	44	45	44
4	August	50	50	51	50
5	September	56	57	56	56
6	October	68	69	71	69.3
7	November	74	75	74	74
8	December	38	38	36	37
9	January - 2022	36	36	37	36
10	February	38	38	36	37
11	March	32	32	32	32
12	April	40	40	40	40



Graph 9.

The data indicate that Bibinagar Lake experiences substantial seasonal variations in water quality parameters. Temperature, turbidity, and TDS showed significant fluctuations influenced by seasonal weather patterns and water inflow. High turbidity and TDS during the monsoon months are attributed to increased runoff and sedimentation. Elevated BOD and COD levels in November suggest increased organic pollution, potentially due to agricultural runoff or waste discharge.

The variations in pH and electrical conductance reflect seasonal changes in water chemistry, with higher conductance during the summer indicating increased ion concentrations. Lower DO levels in April suggest reduced oxygen availability, likely due to lower temperatures and higher organic loads.

These findings are consistent with previous studies on seasonal variations in lake water quality [31-32]. The observed trends underscore the importance of continuous monitoring and management to address pollution and maintain the ecological health of the lake.

Conclusion

Bibinagar Lake exhibits considerable seasonal variability in water quality parameters. Understanding these variations is crucial for effective lake management and pollution control. Continued monitoring is recommended to ensure the lake's ecological health and to inform strategies for mitigating adverse impacts from both natural and anthropological caused sources.

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Author's contribution

All the authors designed the study, collected and analysed data, and drafted the read and the develop final manuscript for publication.

Availability of data and material

All data generated and analysed during this study are included in this published article.

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Declarations

Conflict of interest

The authors declare that they have no conflict of interest.

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