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Seasonal Variation of Physicochemical parameters and coefficient correlation of Karave Lake (Nerul), Navi Mumbai, Maharashtra, India

Kamble Sayali R.* and Jadhav Anita S.

Department of Zoology, ICLES' Motilal Jhunjhunwala College, Vashi, Navi Mumbai, Maharashtra 400703, India

**Corresponding Author*

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Abstract: The study determined the seasonal fluctuations in physicochemical characteristics of Karave Lake Nerul's water (Navi Mumbai) at five sampling stations from August 2018 to July 2019 for fourteen different parameters. The findings demonstrated considerable seasonal change in various physicochemical parameters, with the highest levels recorded in COD, Nitrates, Total Dissolved Solids, and Temperature during the pre-monsoon period. During the monsoon, maximum levels were recorded in BOD, Hardness, Turbidity, Electrical Conductivity, DO and free CO_2. During post-monsoon, maximum levels were recorded in pH, Salinity, Alkalinity, and Phosphates; however, most of the parameters were within normal ranges, indicating improved lake water quality. The statistical correlation between Karave Lake's physicochemical parameters was calculated.

Keywords: Karave lake water, Physicochemical parameters, Seasonal variations

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Introduction

All biological lives and their nourishment are dependent on water. Sustainable development will be impossible without fresh water (Sharma *et al.*, 2012; Gund and Kakde, 2014; Desai, 2015). Lakes are one of the most valuable resources ecosystems because they support and maintain a balanced adaptive community of organisms with a huge species richness and unique biotic integrity due to the functional organisation of all organisms. Lakes, a key aquatic environment with life-supporting systems, have been experiencing ecological degradation for the past two decades as a result of physical, chemical, biological, and unwanted anthropogenic activity (Khan *et al.*, 2012; Bhateria and Jain, 2016; Nirbhavane and Khobragade, 2017; Mahalakshmi and Sivachandrabose, 2021). Several researchers in India and overseas have worked on physico-chemical parameters of lakes in relation to various aspects (Vyas *et al.*, 2006; Patra *et al.*, 2010; Parameswara *et al.*, 2012; Khan *et al.*, 2012; Samrat *et al.*, 2012; Basharat *et al.*, 2013; Karthick *et al.*, 2015; Jadhav *et al.*, 2015; Mehta *et al.*, 2016; Gupta *et al.*, 2017; Sharma and Tiwari, 2018; Raj and Sevarkodiyone, 2018; Mendonsa and Vishnuprasad, 2019; Bhagde *et al.*, 2020). Because lakes and constructed reservoirs are utilized for water supply for agricultural, domestic, and industrial purposes, monitoring and assessing water quality at any location is a vital part of survival and sustainability (Khan *et al.*, 2012; Md.Nahian *et al.*, 2018). Navi-Mumbai is one of the fastest-growing cities in the world, and it is blessed with numerous lakes that serve as a major natural resource. Because it is densely populated, it has a significant impact on the health of the water body. A review of literature revealed that there is a scarcity of study on lake ecosystems in and around Navi Mumbai, India. Due to the ongoing beautification process of concrete deposition and minimal maintenance, the lake is polluted, resulting in a drastic shift in the water hue. Because of the higher level of eutrophication, the lake is found to be more organically polluted. As a result, it is difficult to draw scientific conclusions about their current state, and the time has come to reform and analyze the water quality of the Navi Mumbai Lake. Thus, in this study, seasonal physicochemical characterization of water was analyzed at Karave Lake in Nerul Navi Mumbai (latitude of 19.0263° N and longitude of 73.0119° E) (Figs. 1, 2, 3).

Materials and Methods

Water samples for analysis was collected for the period of one year from August 2018 to July 2019. Water sample was collected from 5 different sites (Fig. 4) in well rinsed plastic cans between 9-11am. Water samples (1000 ml each) data was compiled for post-monsoon (October-January), pre-monsoon (February-May) and the Monsoon (June-September) Fourteen important physico-chemical parameters were analyzed for water quality. Analyses were performed following APHA (2012).

Results and Discussion

The water samples were analyzed for physicochemical parameters such as pH, Temperature, Electrical conductivity, Salinity, Turbidity, Hardness, Dissolved Oxygen (DO), BOD, Free CO_2, COD, Alkalinity, Phosphate, Nitrate-Nitrogen, Total Dissolved Solid (TDS) (Table 1, Figs. 5a, 5b, 5c).

pH:

The pH of water is a critical physical parameter in determining water quality. High pH indicates a high carbon dioxide content. The pH of Karave Lake was found to be rather stable in all three seasons between 7-8 (Table 1, Fig. 5a), indicating that the water is alkaline (Khan *et al.*, 2012; Afrin *et al.*, 2015; Ahmed *et al.*, 2016; Md. Nahian *et al.*, 2018) Similar findings were reported by Joshi *et al.* (2009), Ubarhande (2018), and Jadhav and Prajapati (2011). As a result, pH does not act as a limiting factor in the distribution of aquatic populations in the Karve water body (Rahman *et al.*, 2021). The elevated pH level could be attributable to a variety of factors, including drainage disposal and seasonal variations.

Temperature:

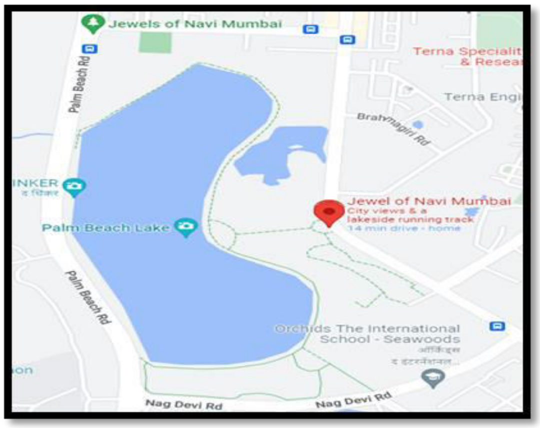
Temperatures during pre-monsoon and post-monsoon were almost identical, however, the water temperature dropped slightly to 26.58 C during the monsoon (Table 1, Fig. 5c). This is because water temperature is affected by ambient temperature. Comparable results were reported by Jayabhaye *et al.* (2005), Salve and Hiware (2006), Khan *et al.* (2012), Chatterjee and Ganesh (2020), Rahman *et al.* (2021) and Pimpalshende and Sitre (2021).

Electrical conductivity:

The electrical conductivity of water increases as the concentration of salts rises. Electrical conductivity in lakes is also a good indicator of pollution levels (Upadhyay *et al.*, 2012). In present study during pre-monsoon, electrical conductivity was 0.13 (μs/cm), during post-monsoon electrical conductivity was 0.14±0.02 μs/cm and during monsoon electrical conductivity was 1.74 (μs/cm) which was slightly high (Table 1, Fig. 5a). Kashyap (2016), Sneha Rashmi (2017), Md. Nahian *et al.* (2018) and Mendonsa and Vishnuprasad (2019) have reported similar findings. The EC in Karave Lake was below the permitted limits. It could be

1 2

Figs. 1, 2: Photograph of Karave Lake Nerul ,Navi Mumbai



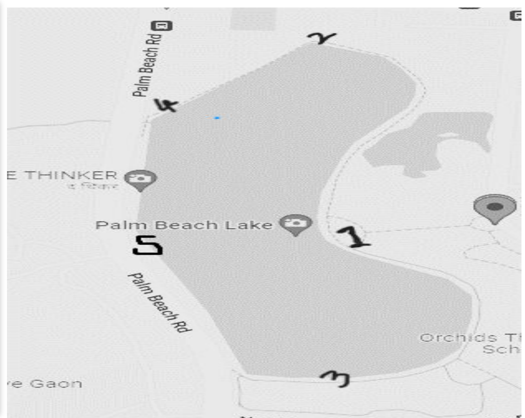


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Fig. 3: Fig. 3: Diagrammatic representation of lake Topography of Karave lake.

Fig. 4: Showing sampling stations at Karave lake.

Table1: Seasonal variation of Physiochemical parameter in Karave Lake Nerul – Navi Mumbai

Parameter	Pre-Monsoon	Monsoon	Post-Monsoon
pH	7.2	7.8	8.0
Temperature	27.97°±0.87	24.00°±0.25	27.94°±2.28
EC (μs/cm)	0.13±0.01	1.74±3.23	0.14±0.02
Salinity (mg/l)	2.61±0.43	3.21±1.17	4.26±1.59
Turbidity (NTU)	25.38±11.69	29± 19.74	7.88± 2.5
Hardness (g/l)	12.15±2.93	18.73±6.37	17.33±3.47
Dissolved Oxygen (mg/l)	4.46±0.85	6.06±0.55	4.5± 1.21
BOD (mg/l)	1.57±0.29	3.1± 1.17	2.97± 0.92
Free CO2 (mg/l)	11.27± 1.22	11.27±1.59	10.77±0.76
COD (mg/l)	39.38±7.47	32.5±12.91	31.88±11.25
Alkalinity (mg/l)	71.33±19.91	87.19±14.52	98.13±25.44
Phosphate (mg/l)	125.11±17.37	122.81±32.89	203.81±48.08
Nitrate-Nitrogen (mg/l)	35.05±2.89	31.31±4.26	34.5±2.42
TDS (mg/l)	5.35±0.73	4.31±1.3	5.25±0.81

Values are mean of five sampling stations ±Standard deviation due to a lack of carbonate mineral disintegration and waste water outflow.

Salinity:

The most essential factor is salinity, as changes in salinity can have an impact on aquatic life. During the investigation, it was noticed that salinity lowest during pre-monsoon and highest during post-monsoon (Table 1, Fig. 5a). Our findings are consistent with the observations of Shyamala and Hemavathy (2018). The high salinity of the lake is due to the high amount of inorganic salts dissolved in it.

Turbidity:

Water runoff from the land transports a large amount of sediment from the surrounding area. Turbidity is a decrease in water transparency caused by the presence of particle materials such as clay silts and other debris. During the investigations, the turbidity values recorded during the monsoon were 29±19.74, which was found to be greater, whereas the turbidity values recorded during post-monsoon were 7.88± 2.5 which was found to be the minimum (Table 1, Fig. 5c). Our findings are in concurrence with observations of previous authors (Manjare *et al.* 2010; Bhuiyan *et al.* 2011; Nirbhavane and Khobragade, 2017; Gupta *et al.* 2017; Sharma and Tiwari, 2018).

Hardness:

Hardness is mainly due to the presence of cations and anions, bicarbonates and carbonates. The hardness was found to be maximum during monsoon (18.73 mg/l) and minimum during pre-monsoon (12.12 mg/l) (Table1, Fig. 5a). Similar observations were reported by Jadhav and Prajapati (2011), Harney *et al.* (2012) and Sharma and Tiwari (2018).

Dissolved Oxygen (*DO*):

The concentration of dissolved oxygen in a lake is a good indicator of its overall health. The aquatic ecosystem struggles to thrive when the lake's dissolved oxygen levels fall below 5 mg/l (Desai, 2015, Nirbhavane and Khobragade, 2017). Concentrations below 2 mg/l may result in the extinction of the majority of aquatic biota (Shukla *et al.*, 2013; Meme *et al.*, 2014; Desai, 2015). The dissolved oxygen levels were below 5 mg/lit in pre-monsoon and post-monsoon, but it was 6.06 mg/l during monsoon (Table 1, Fig. 5a), which could be related to dilution of lake water and diffusion of air oxygen into water. Similar finding has been projected by Jadhav and Prajapati (2011), Gund and Kakde (2014) and Md. Nahian *et al.* (2018).The present investigation revealed a negative correlation between dissolved oxygen and water temperature.

Biochemical Oxygen Demand (*BOD*):

Any water body's biological oxygen demand can be utilized as an indicator of organic matter (Jain, 2016; Mendonsa and Vishnuprasad, 2019). Unpolluted water has a BOD of less than 1 mg/l, moderately polluted water has a BOD of 2–9 mg/l, and most polluted water has a BOD of more than 10 mg/l (Adakole, 2000). The average Biochemical Oxygen Demand level during pre-monsoon was 1.57 mg/l, indicating that there was less organic load, whereas the average BOD level during monsoon was 3.1 mg/l, and during the post-monsoon BOD level was 2.97 mg/l (Table 1, Fig. 5a). Our findings are consistent with those of Jadhav and Prajapati (2011), Islam *et al.*, (2014, 2015), Paramesher *et al.*, (2012) and Sharma and Tiwari 2018). Based on the findings of this study, the lakes can be classed as moderately contaminated.

Free Carbon Dioxide:

Free Carbon Dioxide is present in water body in the form of dissolved gas. Respiration and decomposition by aquatic life is the important source of carbon dioxide. It is the end product of organic carbon degradation. During this investigation, the free carbon dioxide value recorded was 11.27 mg/l during pre-monsoon, and monsoon and post-monsoon value was found to be 10.77 mg/l (Table 1, Fig. 5a). Minimum value in winter, might be due to high photosynthesis activity and maximum value in pre-monsoon may

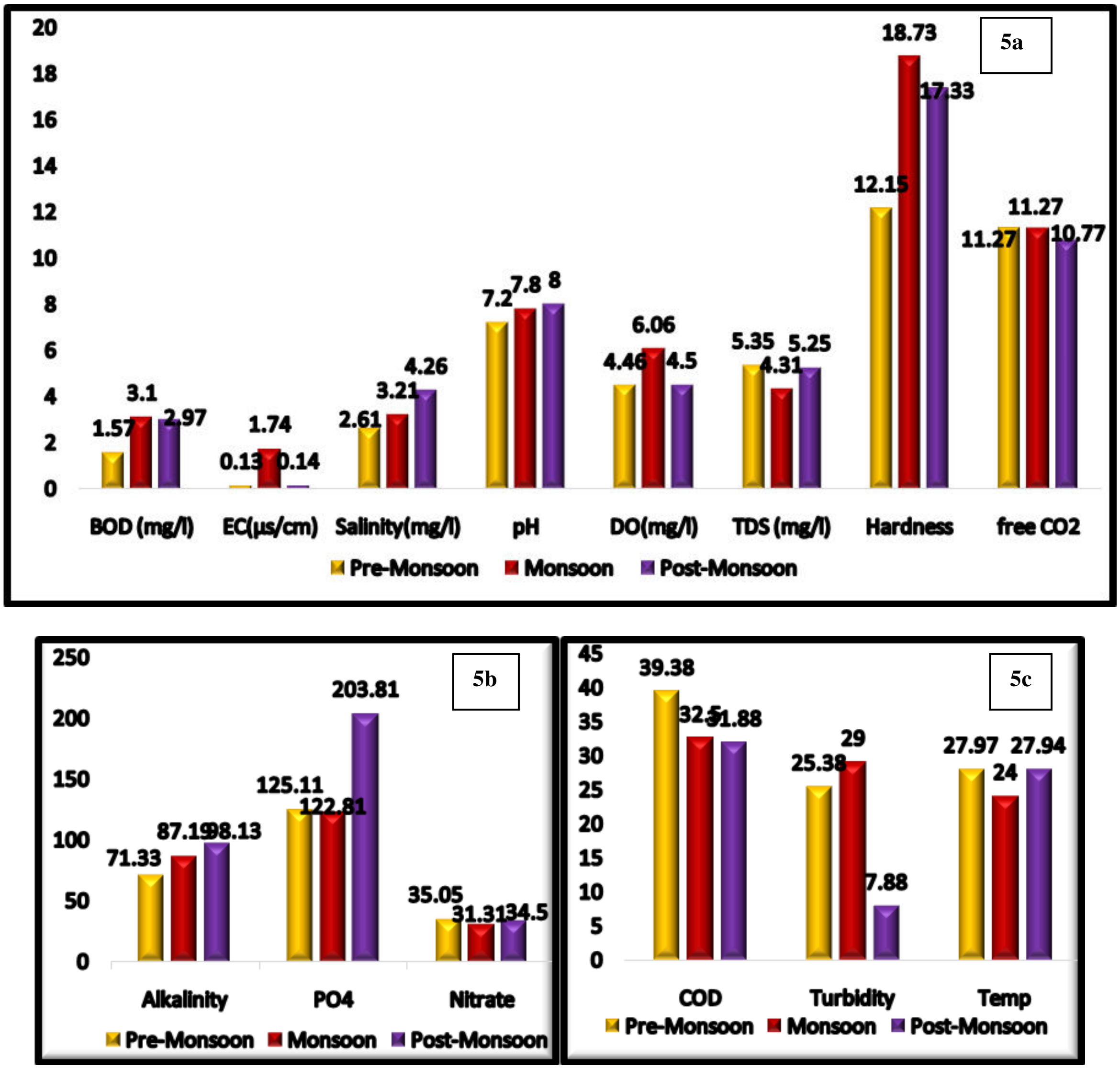

Fig. 5a, b, c: Histogram depicting the variations in physic-chemical parameters observed seasonally at Karave lake, Nerul–Navi Mumbai (Maharashtra) during August 2018 to July 2019.

be due to less photosynthetic activity because of low phytoplankton population. Rise in the free Carbon dioxide level during monsoon indicates its influx through rainwater in the form of carbonic (Raj and Sevarkodiyone, 2018). The observations of the present study are in conformity with the earlier findings reported by Ubarhande (2018).

Chemical oxygen demand (*COD*):

Chemical oxygen demand refers to the ratio of equivalent oxygen to organic content in a water sample that is easily oxidized by a powerful chemical oxidant (Patil *et al.*, 2011; Prajapati, 2013). The COD in water rises as the amount of organic matter in it rises. In this study, it was noticed that the COD level was 39.38 mg/l during pre-monsoon, 32.5 mg/l during the monsoon, and 31.88 mg/l during post-monsoon (Table 1, Fig. 5c), which could be attributable to an increase in nitrogen level. Our observation are in accordance with earlier studies reported by Zutshi *et al.* (2014) and Mehta *et al.* (2016). In the present study COD is greater than BOD which shows the presence of inorganic matter (Dadhich *et al.*, 2016).

Alkalinity:

Water alkalinity refers to its ability to neutralize acids. The activity of aquatic organisms, which ingest or release carbon dioxide, change the proportion of carbonates and bicarbonates present in the water (Mendonsa and Vishnuprasad, 2019). During this investigation it was observed that alkalinity during pre-monsoon was 71.33 mg/l, during post-monsoon it was 98.13 mg/l and during monsoon it was 87.19±14.52 (Table 1, Fig. 5b). These values are within the desirable level of alkalinity. Similar observations were reported by Das and Chand (2003), Manjare *et al.* (2010) and Jadhav and Prajapati (2011).

Phosphate:

The main source of phosphorous in natural water bodies may be by decomposition of dead organisms within the lake. During this investigation, the average phosphate level during pre-monsoon was found to be 125.11mg/l, during monsoon it was 122.21 mg/l , whereas during post-monsoon it was found to be 203.81 mg/l (Tabel 1, Fig. 5b). Our observation are in agreement with findings of Desai (2015) and Sneha Rashmi (2016). Phosphate levels in the post-monsoon can produce an excessive rise in algal development, while phosphate values in the monsoon may be attributed to absorption by planktons (Mendonsa and Vishnuprasad, 2019).

Nitrate:

The biological oxidation of nitrogenous organic materials produces nitrate in water. A high nitrate concentration suggests contamination. Nitrate levels more than 5 mg/l in natural waters usually indicate pollution (Sneha Rashmi, 2016). Nitrate pollution can lead to eutrophication of lakes and algae and aquatic plant use oxygen (Singh *et al.*, 2009; Patra, *et al.*, 2010). During the present investigation it was found that the Nitrate level during pre-monsoon and post-monsoon was almost 35.05 mg/l , whereas in monsoon the value was 31.31 mg/l (Table 1, Fig. 5b). Similar observation was reported by Mishra *et al.* (2014) and Ramesh and Selvanagam (2013).

Total Dissolved Solids:

TDS levels were determined to be nearly identical (5.35 g/l) before and after the monsoon during this study. TDS levels were measured as 4.31 g/l during the monsoon (Table 1, Fig. 5a). The high TDS value during the pre-monsoon season could be attributable to the high evaporation rate. Sahni and Yadav (2012), Yadav *et al.* (2013), Sneha Rashmi (2016), Gulia *et al.* (2017) and Md. Nahian *et al.* (2018) have reported similar findings which lend support to the present finding.

Correlation matrix:

Table 2 shows the correlation coefficients (r) of all studied parameters, with their significance level (P values). There was high positive significant correlation between pH with salinity (r=0.96), Hardness (r=0.75), BOD (r=0.83), Alkalinity (r=0.99), PO_4 (r=0.85) and Nitrate (r=0.96); Temperature with Highly positive significant TDS (r=0.97); EC with Hardness (r=0.67) and DO (r=0.95); salinity with BOD (r= 0.73), Alkalinity (r= 0.97), PO_4 (r= 0.92), Nitrate (r=0.98); Turbidity with Free CO_2 (r= 0.95); Hardness with DO (r=0.68), BOD (r= 0.98), Alkalinity (r= 0.81); BOD with Alkalinity (r= 0.88) and Free CO_2; Nitrate with (r= 0.97); Alkalinity with PO4 (r= 0.79), Nitrate (r=0.93) and PO_4 with Nitrate (r= 0.96).

Moreover, negative significant correlation was noticed such as pH with Turbidity (r= - 0.77), CO_2 (r= -0.87), COD (r=-0.9); Temperature with Hardness (r= -0.68), DO (r= 0.96); EC with TDS (r=-0.96); salinity with Turbidity (r= -0.86), CO_2 (r= -0.93) and COD (r= -0.82); Turbidity with Alkalinity (r= -0.7), PO_4 (r= -0.99), Nitrate (r= -0.91); Hardness with COD (r=-0.96), TDS (r= -0.73), DO (r= -0.98); Free CO_2 with Alkalinity (r= -0.81), PO_4 (r= -0.97) and COD with Alkalinity (r= -0.94) and Nitrate (r= -0.75).

Conclusion

In this study, physicochemical variables showed considerable seasonal change. There was a negative correlation between dissolved oxygen and water temperature. The lake's water quality can be enhanced and maintained by pitching and fencing the lake, which prevents anthropogenic activity. Within acceptable limits, physicochemical properties of lake water can support the ecosystem's stability and quality, promoting

Table 2: Pearson correlation matrix analysis of different physico chemical parameters of Karave Lake (Nerul) Navi Mumbai

	pH	Temp	EC	salinity	Turbidity	Hardness	DO	BOD	Free CO_2	COD	Alkalinity	PO_4	Nitrate	TDS
pH	1													
Temp	-0.02	1												
EC	0.01	-1	1											
Salinity	***0.96	0.14	0.15	1										
Turbidity	-0.77	-0.62	**0.63	-0.86	1									
Hardness	***0.75	-0.68	***0.67	**0.63	-0.16	1								
DO	0.02	-0.98	***0.95	-0.13	**0.62	***0.68	1							
BOD	***0.83	-0.58	*0.57	***0.73	- 0.28	***0.98	**0.58	1						
Free CO_2	-0.87	-0.48	*0.50	-0.93	***0.95	-0.31	0.48	-0.43	1					
COD	-0.9	0.45	0.44	-0.82	0.42	-0.96	-0.45	-0.99	*0.56	1				
Alkalinity	***0.99	-0.12	0.11	***0.97	-0.7	***0.81	0.13	***0.88	-0.81	-0.94	1			
PO_4	***0.85	0.51	0.52	***0.92	-0.99	0.29	-0.5	0.41	-0.97	0.54	***0.79	1		
Nitrate	***0.96	0.25	-0.26	***0.98	-0.91	*0.55	-0.24	**0.65	***0.97	0.75	***0.93	***0.96	1	
TDS	-0.09	***0.97	-0.96	0.07	-0.56	-0.73	-0.98	-0.63	-0.42	0..51	-0.19	0.45	0.18	1

Highly positive significant(r= 0.66 and above p<0.01***)

Moderately positive significant (r= =0.61-0.65 p<0.02**)

Fairly positive significant (r=0.53-0.60 p<0.05*)

Highlynegative significant r= 0.66and above p<0.01***)

Moderately negative significant (r= =0.61-0.65 p<0.02**)

Fairly negative significant (r=0.53-0.60 p<0.05 *) primary productivity. The high association between several of the variables evaluated backed up this conclusion. The seasonal fluctuations of surface river water quality data were evaluated using Pearson's correlation. Even though most of the metrics were within normal limits, this implies that the lake water is of better quality. Many human-made activities pollute the water supply, causing difficulties in aquatic ecosystems. Climate change caused by global warming has an impact on aquatic creatures in habitats, primarily owing to temperature variations. During the monsoon season, the lake's water quality deteriorated. Lake maintenance and constant vigilance are required to maintain the lake's water quality.

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