Seasonal Study on the Assessment of Physico-Chemical Parameters of Narasapura Lake, Karnataka

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ABSTRACT

The present study was conducted to evaluate the seasonal variation of selected physico-chemical parameters in Narasapura Lake, Kolar, Karnataka, from January to December 2024. Key parameters analysed included pH, total alkalinity, total dissolved solids (TDS), magnesium, calcium, total hardness, iron, chloride, biochemical oxygen demand (BOD), and chemical oxygen demand (COD). The results revealed noticeable seasonal fluctuations in all parameters, primarily influenced by monsoon dynamics. The pH remained within the acceptable range (6.5–8.5) throughout the study period. Alkalinity and TDS showed higher values during pre-monsoon months and declined significantly during monsoon. Magnesium levels remained relatively stable. Calcium, total hardness, Iron and chloride exhibited higher concentrations during dry months and lower values during the monsoon season. BOD and COD values were higher during the initial months, indicating organic and chemical load, but showed a declining trend towards the end of the year, suggesting improvement in water quality. The variations in water quality were mainly attributed to natural factors such as rainfall, evaporation, and water inflow. However, results showed most parameters were within acceptable limits, with no significant pollution observed.

Keywords: pH, Alkalinity, TDS, Magnesium, Calcium, Hardness, Iron, Chloride, BOD, COD.

INTRODUCTION

Lakes are non-marine, standing water bodies that are functionally linked to their surrounding landscapes (watersheds) through hydrological and atmospheric inputs. As relatively well-defined and self-contained ecosystems, they provide a clear framework for understanding the interactions among physical, biogeochemical, and biological processes. The distinct boundaries between water and land, as well as between water and air, facilitate strong coupling among ecosystem components, making lakes highly suitable for ecological study and informed management. Despite covering only 3% of the Earth's land surface, lakes store approximately 87% of the world's liquid freshwater (Yao *et al*., 2023), providing invaluable ecosystem services to more than 131 million people (Jenny *et al*., 2020). The ever-increasing population, rapid urbanization, and modernization have intensified problems related to sewage disposal and the contamination of surface water bodies such as lakes. In addition to anthropogenic factors, natural processes like weathering of rocks, soil leaching, and mining activities also contribute to water pollution. These factors collectively lead to nutrient enrichment in lakes, a process known as eutrophication. Furthermore, changes in land use patterns and longer growing seasons promote increased use of fertilizers, which often leach into nearby watercourses, rivers, and lakes. This nutrient influx accelerates eutrophication, ultimately resulting in the degradation of water quality and loss of aquatic biodiversity. It is essential to test water quality before it is used for drinking, domestic, agricultural, or industrial purposes. Water may contain various types of impurities, including floating, dissolved, suspended, as well as microbiological and bacteriological contaminants. Therefore, comprehensive analysis using different physico-chemical parameters is necessary. Physical tests are conducted to assess characteristics such as temperature, pH, turbidity, and total dissolved solids (TDS). In addition, chemical tests are performed to determine parameters like biochemical oxygen demand (BOD), chemical oxygen demand (COD), dissolved oxygen (DO), alkalinity, hardness, and other relevant properties (Kumar, *et al*., 2023). These assessments help ensure the safety and suitability of water for its intended use (Sanath and Ramakrishna 2025). Conventional water quality assessments mainly emphasize physico-chemical parameters

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such as turbidity, pH, and conductivity. While these indicators are important, they are insufficient to fully represent the complexity of water quality. Various environmental factors also play a crucial role, including topographical features like slope and aspect, and geological characteristics such as lithology and soil type. These factors influence water quality both directly and indirectly by affecting processes like runoff, erosion, and the movement of nutrients and pollutants, ultimately shaping the overall condition of aquatic systems (Choudhury, *et al*., 2022; Gupta, *et al.*, 2022). Several research works have been carried out on the water quality of different lakes in India (Mishra Amarnath, 2020; Prachi Vasistha, 2020; Chaudhary, 2021; Singh, 2022). Studies on the physico-chemical characteristics of ponds and lakes provide valuable insights into water quality status and emphasize the need for effective management strategies to maintain ecological balance. Freshwater has become a scarce resource due to overexploitation, pollution, population growth, rapid urbanization, industrialization, and agricultural runoff (Gupta and Shukla, 2006). In karnataka lakes, several researchers have attempted to assess the water quality periodically. Panikkar et al., (2022) have studied hydrogeochemistry and water quality index (WQI), in different small and medium reservoirs of Karnataka, Purandara *et al*., (2012) in surface water quality evaluation and modelling of Ghataprabha River, Ravikumar *et al,* (2013) in Sankey tank and Mallathahalli Lake, Bangalore urban district, and Kumar and Prabhu, (2019) in Kushawathi watershed area Chikkaballapur District. However, no comprehensive water quality survey has been conducted in the study area to date. Hence, the present study has been undertaken to assess the water quality of Narasapura Lake, Karnataka, with particular reference to its physico-chemical parameters.

MATERIALS AND METHODS

Study area and fish collection

Narasapura Lake, situated in the Kolar district of Karnataka, is an important freshwater body covering an area of approximately 327.35 acres (131 hectares). Geographically, the lake is located at 13°07′59.7″N latitude and 77°59′59.0″E longitude, about 15 km from Kolar city and nearly 55 km from Bengaluru, making it a significant water resource in the region. The lake exhibits an irregular, roughly circular morphology, with considerable variation in depth across different parts, influenced by seasonal changes, sediment deposition, and water inflow patterns. Hydrologically, Narasapura Lake is connected to the Koramangala–Challaghatta (KC) Valley Project, through which treated wastewater is supplied. This inflow plays a crucial role in maintaining the water level of the lake, especially during dry periods, but may also influence its physico-chemical characteristics. The lake supports a rich aquatic ecosystem and is particularly known for its high fish productivity. Its relatively shallow nature, combined with nutrient availability, creates favorable conditions for fish growth and breeding, making it a prominent site for local fishing activities. In addition to its ecological importance, the lake also contributes to the livelihoods of nearby communities and plays a role in groundwater recharge and microclimatic regulation. However, increasing anthropogenic pressures and changes in water quality necessitate continuous monitoring and effective management to sustain its ecological health and productivity.

Surface water sampling

The surface water samples were collected from three different locations namely; Inlet of the Lake, Lake bund area and lake backwater area of Narasapura Lake From January 2024 - December 2024.The water samples were collected on a monthly basis in sterilized polythene bottles for a period of 12 months, starting from January 2024 and ending in December 2024. The collected samples were subjected to comprehensive physicochemical analysis. General parameters such as water temperature, pH, electrical conductivity, and total dissolved solids were measured at the sampling site immediately after obtaining the samples. For the remaining parameters, the water samples were transferred to the laboratory and stored in a refrigerator at 4 °C for further analysis. All the physicochemical analyses were performed in accordance with the American Public Health Association (APHA, 2017; Gopal, *et al*., 1984).

RESULTS AND DISCUSSIONS

The water analysis was carried out to understand the level of some chemical parameters like pH, Alkalinity, TDS, Magnesium, Calcium, Hardness, Iron, Chloride, BOD and COD in Narasapura lake water from January 2024 to December 2024 are tabulated in the table 2 and illustrated in the figures 2 - 11.

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Table 1. Showing Indian standard permissible values

Sl.no	Parameters	Methods	Permissible
1	pH Value	IS 3025(Part-11) 1983	6,5 to 8.5
2	Total Alkalinity (mg/L)	IS3025(Part -23)1986	600
3	Total Dissolved Solids (mg/L)	IS 3025(Part-16) 1984	2000
4	Magnesium as Mg (mg/L)	IS3025(Part-46) 2003	100
5	Calcium as Ca (mg/L)	IS3025(Part -40) 2004	200
6	Total Hardness as CaCO3 (mg/L)	IS3025(Part -21) 2009	600
7	Iron (as Fe) (mg/L)	IS3025(Part—53) 2003	NR
8	Chlorides (as Cl) (mg/L)	IS3025(Part—32) 1988	1000
9	BOD 3 days at 27° C (mg/L)	IS 3025 (Part.44)	100
10	COD (mg/L)	IS 3025 (Part.58)	250

Table 2. Showing values of water parameters collected from different sampling sites of Narasapura lake.

Parameter	Sampling sites	Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24	Nov-24	Dec-24
pH	Inlet Lake Water	8	8	7.98	7.6	7.35	7.38	7.3	7.15	7.18	7.95	7.82	7.48
	Lake Back Water	8.02	8.05	8	7.95	7.05	7.08	7	7.05	7.08	8	7.9	7.55
	Lake Bund Middle	7.65	7.7	7.72	7.6	7.35	7.25	7.1	7.12	7.18	7.98	7.88	7.4
Alkalinity (mg/L)	Inlet Lake Water	260	260	255	220	195	190	85	85	90	250	180	175
	Lake Back Water	250	255	250	145	140	75	75	80	85	275	140	135
	Lake Bund Middle	245	250	245	230	190	85	80	85	90	260	255	235
TDS (mg/L)	Inlet Lake Water	550	560	550	500	430	400	250	260	270	520	500	480
	Lake Back Water	530	540	530	510	20	250	260	270	280	530	470	450
	Lake Bund Middle	470	470	470	470	400	370	250	260	270	520	490	470
Magnesium (mg/L)	nlet Lake Water	34	34	35	34	28	25	20	22	20	46	28	30
	Lake Back Water	35	35	36	35	22	20	18	19	18	44	42	38
	Lake Bund Middle	32	33	33	32	24	23	18	19	18	42	40	34
Calcium (mg/L)	nlet Lake Water	55	57	54	52	42	36	26	28	29	58	56	52
	Lake Back Water	48	49	50	48	31	30	25	27	28	45	42	40
	Lake Bund Middle	50	51	50	48	43	41	26	28	30	47	42	40
Hardness (mg/L)	Inlet Lake Water	260	260	255	220	210	200	135	150	145	260	250	230
	Lake Back Water	270	270	265	270	150	145	140	150	145	285	270	240
	Lake Bund Middle	250	255	250	220	205	195	130	145	145	260	250	225
Iron (mg/L)	Inlet Lake Water	0.17	0.16	0.16	0.15	0.12	0.11	0.1	0.12	0.11	0.16	0.15	0.12
	Lake Back Water	0.16	0.17	0.18	0.19	0.11	0.1	0.07	0.09	0.1	0.19	0.16	0.12
	Lake Bund Middle	0.16	0.14	0.15	0.14	0.13	0.12	0.1	0.11	0.12	0.18	0.16	0.12
Chloride (mg/L)	nlet Lake Water	60	62	64	66	70	72	60	65	70	150	145	130
	Lake Back Water	62	64	66	68	72	75	58	63	68	155	150	135
	Lake Bund Middle	58	60	62	65	90	180	70	65	72	150	145	130
BOD (mg/L)	nlet Lake Water	72	76	71	66	38	43	24	20	20	12	5	4
	Lake Back Water	78	80	82	76	69	77	52	55	62	5	5	5
	Lake Bund Middle	67	61	64	61	55	60	20	20	19	6	4	3
COD(mg/L)	Inlet Lake Water	150	170	160	158	95	90	82	80	72	55	60	55
	Lake Back Water	120	122	130	128	125	126	140	143	145	70	62	55
	Lake Bund Middle	218	212	218	210	178	150	68	80	68	75	78	72

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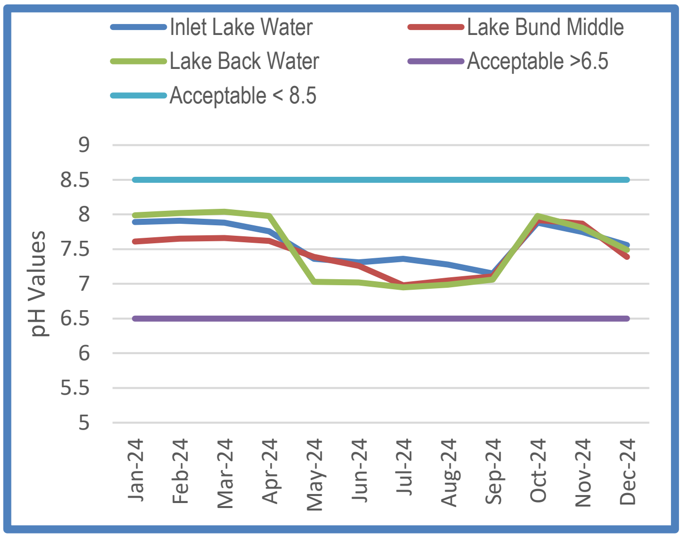


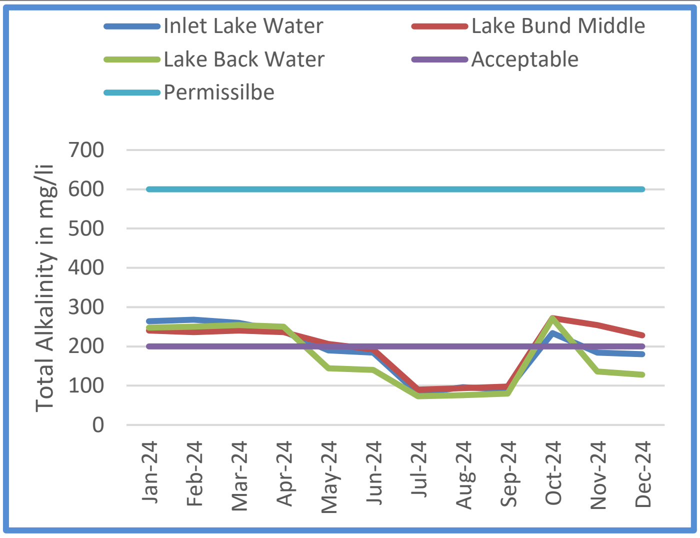
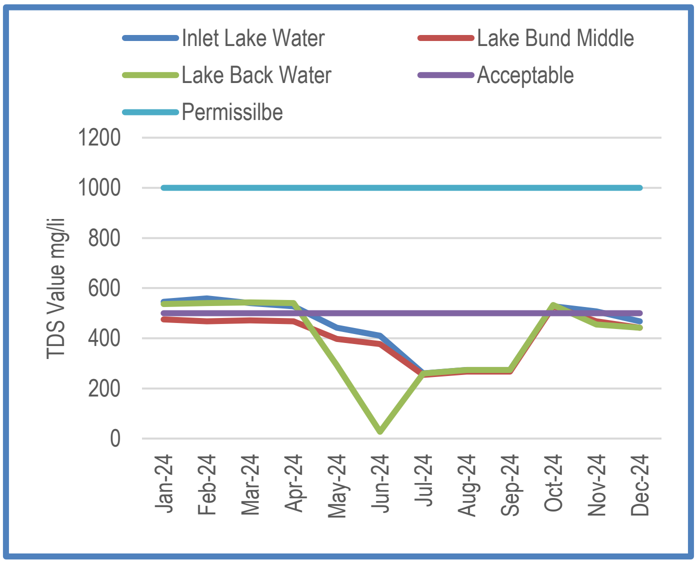


Fig.2. pH Content in the water samples

Fig.3. Total Alkalinity Content in the water



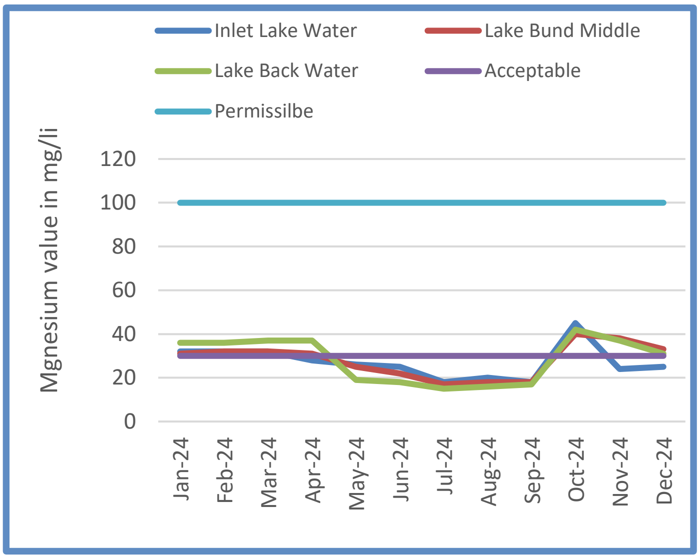
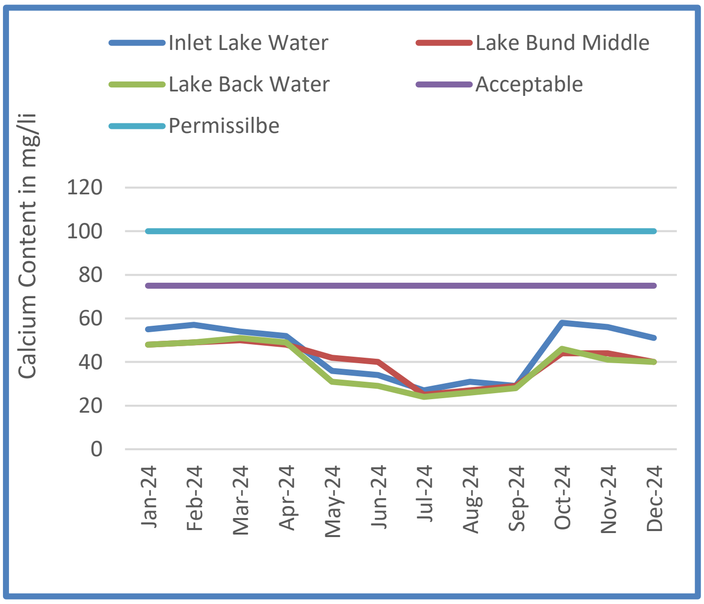


Fig.4. TDS Level in the water samples

Fig.5. Magnesium Content in the water



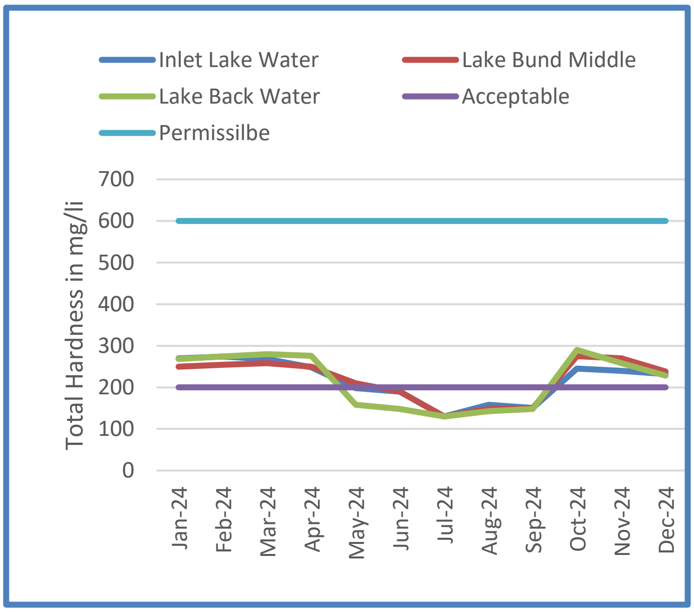


Fig.6. Calcium Level in the water

Fig.7. Hardness of water samples

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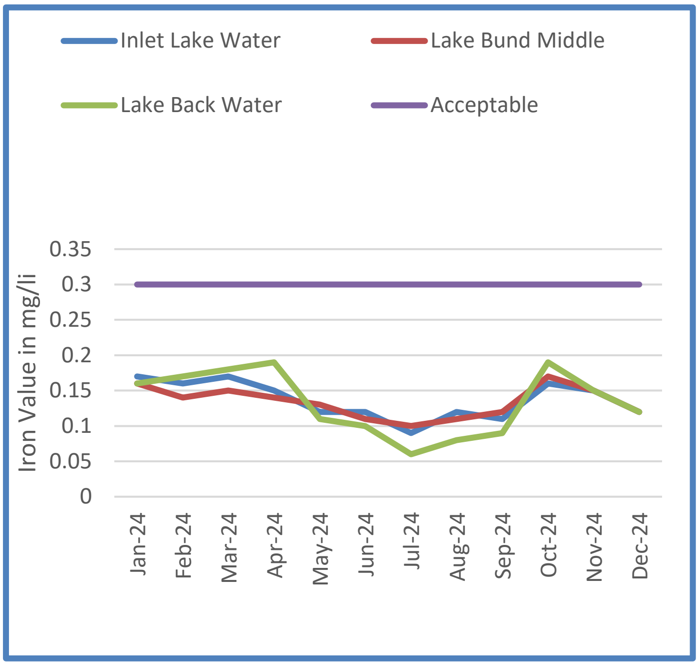

Fig.8. Iron Content in the water samples

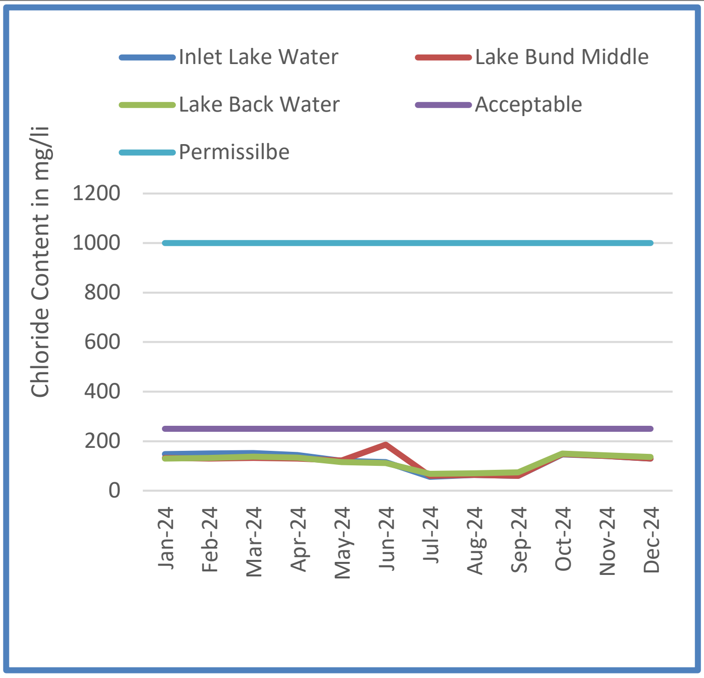

Fig.9. Chloride Content in the water

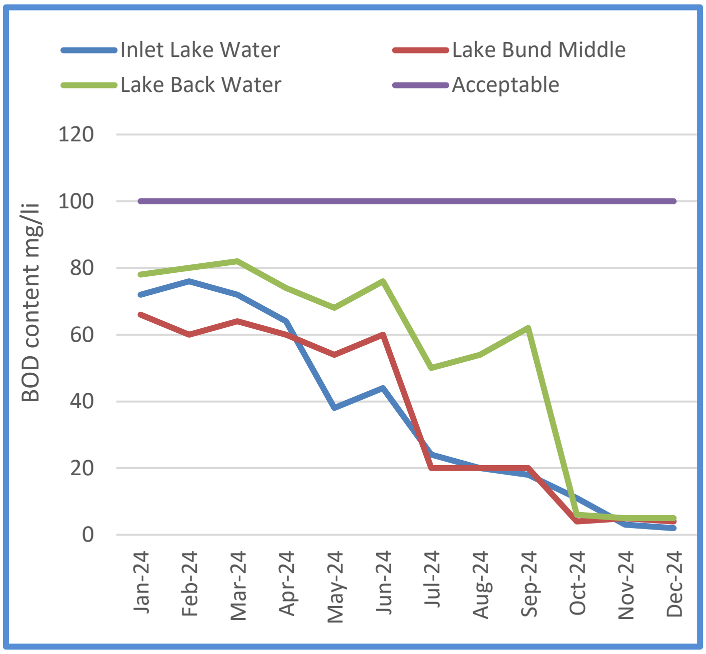

Fig.10. BOD Level in the water

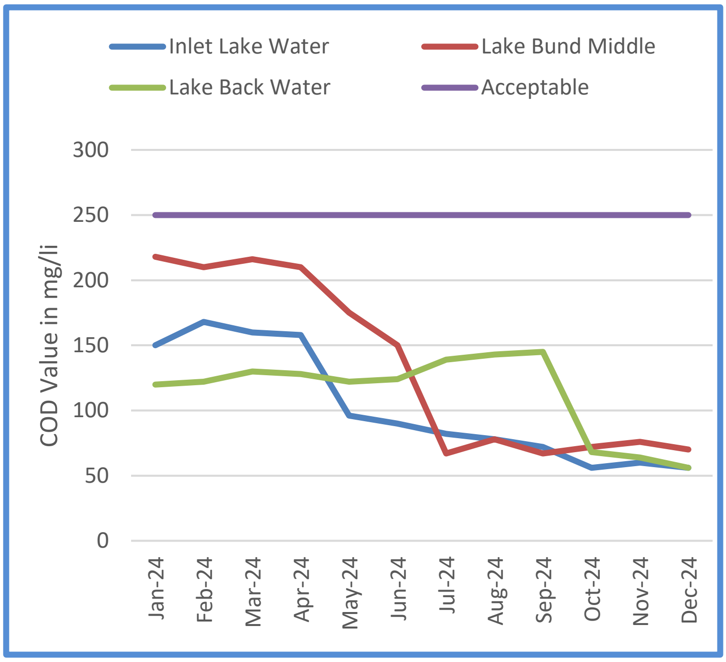

Fig.11. COD Level in the water

The results of the present study showed (Figures 2 to 11 and Table 2) monthly variation of selected physico-chemical parameters—pH, total alkalinity, total dissolved solids (TDS), and magnesium—in Narasapura Lake at three sampling locations: inlet water, lake bund middle, and backwater region over the study period.

The pH of lake water remained slightly alkaline throughout the study period, ranging from 7.00 to 8.05, and was well within the BIS acceptable range of 6.5–8.5. The highest pH values were recorded during January–March and October, while comparatively lower values were observed during the monsoon months (May–September), likely due to dilution from rainfall and increased runoff. Among the three sampling sites, Lake Back Water generally exhibited slightly higher pH values than the Inlet Lake Water and Lake Bund Middle. The observed pH indicates a stable aquatic environment suitable for sustaining freshwater biota and supporting normal ecological processes. A significant decline occurs during the monsoon period (June to August), with

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the lowest values recorded in July, especially in the backwater region. This decrease is likely due to dilution from rainwater and reduced concentration of bicarbonates (Mohajan 2018).

The total alkalinity of the lake water exhibited considerable seasonal variation, ranging from 75 to 275 mg/L across the three sampling sites. Higher alkalinity values were recorded during January–April and again in October, whereas the lowest values occurred during the monsoon period (June–September), particularly at the Lake Back Water site, indicating dilution caused by rainfall and surface runoff (Park, et al., 2015). The Inlet Lake Water showed alkalinity values between 85 and 260 mg/L, Lake Back Water between 75 and 275 mg/L, and Lake Bund Middle between 80 and 260 mg/L. Although alkalinity exceeded the desirable BIS limit of 200 mg/L during some months, all recorded values remained well below the permissible limit of 600 mg/L, indicating moderate alkalinity typical of freshwater ecosystems. Such alkalinity levels provide adequate buffering capacity against sudden pH fluctuations and support the ecological stability and productivity of the lake (Mohajan 2018).

The Total Dissolved Solids (TDS) concentration exhibited marked seasonal variation, ranging from 20 to 560 mg/L across the three sampling sites. The Inlet Lake Water recorded TDS values between 250 and 560 mg/L, while the Lake Back Water ranged from 20 to 540 mg/L, and the Lake Bund Middle varied between 250 and 520 mg/L. Higher TDS values were observed during January–April and October–December, indicating increased dissolved mineral content, whereas comparatively lower values occurred during the monsoon period (May–September) due to dilution by rainfall and freshwater inflow (Callow et al., 2020). With the exception of a single anomalously low value (20 mg/L) recorded at the Lake Back Water site in May, all observations were close to or below the BIS acceptable limit of 500 mg/L and well within the permissible limit of 1000 mg/L. The TDS levels indicate moderately mineralized freshwater, suitable for domestic and ecological purposes, although the unusually low May value should be verified against the original dataset before interpretation.

The magnesium concentration ranged from 18 to 46 mg/L, showing higher values during January–April and October, and lower values during the monsoon season (May–September) due to rainfall-induced dilution. The Inlet Lake Water recorded 20–46 mg/L, Lake Back Water 18–44 mg/L, and Lake Bund Middle 18–42 mg/L. Although magnesium exceeded the desirable BIS limit (30 mg/L) during some months, all values remained well below the permissible limit (100 mg/L), indicating acceptable water quality and moderate hardness characteristic of freshwater ecosystems (Gaikwad and Sasane 2013).

The calcium concentration ranged from 25 to 58 mg/L across the three sampling sites, with higher values observed during January–April and October–December, and lower values during the monsoon period (May–September) due to dilution by rainfall. The Inlet Lake Water recorded calcium concentrations of 26–58 mg/L, Lake Back Water 25–50 mg/L, and Lake Bund Middle 26–51 mg/L. All recorded values remained well below the BIS acceptable limit of 75 mg/L, indicating good water quality and calcium levels suitable for freshwater ecosystems and domestic use and the results are in conformity with the results of (Chandra, and Tomar 2012).

The total hardness of the lake water ranged from 130 to 285 mg/L, exhibiting higher values during January–April and October–December, and lower values during the monsoon season (May–September) due to dilution by rainfall. The Inlet Lake Water recorded hardness values of 135–260 mg/L, Lake Back Water 140–285 mg/L, and Lake Bund Middle 130–260 mg/L. Although hardness exceeded the BIS desirable limit of 200 mg/L during several months, all values remained well below the permissible limit of 600 mg/L, indicating moderately hard freshwater suitable for aquatic life and domestic use.similar results were shown by Chandra, and Tomar (2012).

The iron (Fe) concentration remained low throughout the study, ranging from 0.07 to 0.19 mg/L across the three sampling sites. The Inlet Lake Water recorded 0.10–0.17 mg/L, Lake Back Water 0.07–0.19 mg/L, and Lake Bund Middle 0.10–0.18 mg/L. Slightly higher concentrations were observed during January–April and October, while lower values occurred during the monsoon season (May–September) due to dilution by rainfall (Islam, et al., 2012). All measured values were well below the BIS acceptable limit of 0.30 mg/L, indicating the absence of significant iron contamination and good water quality suitable for aquatic life and domestic use.

The chloride concentration ranged from 58 to 180 mg/L across the three sampling sites, with higher values recorded during October–December and comparatively lower values during January–September. The Inlet Lake Water recorded chloride concentrations of 60–150 mg/L, Lake Back Water 58–155 mg/L, and Lake Bund Middle 58–180 mg/L, with a peak value observed at the Lake Bund Middle site in June. Our results are in agreement with Norela, (2013). All measured values remained well below the BIS acceptable limit of 250 mg/L, indicating the absence of significant chloride pollution and confirming that the lake water is suitable for freshwater ecosystems and domestic use.

The Biochemical Oxygen Demand (BOD) values ranged from 3 to 82 mg/L, showing pronounced seasonal variation across the three sampling sites. The Inlet Lake Water recorded 4–76 mg/L, Lake Back Water 5–82 mg/L, and Lake Bund Middle 3–67 mg/L. Higher BOD values were observed during January–June, indicating increased organic matter decomposition and microbial activity, whereas substantially lower values occurred during July–December, reflecting improved water quality and reduced organic pollution. The Lake Back Water exhibited the highest BOD levels, suggesting a comparatively greater organic load than the other sampling sites (APH 2005; Premlata and Vikal. 2009; Zaher and Hammam 2014).

The Chemical Oxygen Demand (COD) values ranged from 55 to 218 mg/L, exhibiting marked seasonal variation across the three sampling sites. The Inlet Lake Water recorded COD values of 55–170 mg/L, Lake Back Water 55–145 mg/L, and Lake Bund Middle 68–218 mg/L. Higher COD concentrations were observed during January–June, indicating increased levels of oxidizable organic matter, while comparatively lower values occurred during July–December, reflecting improved water quality. The Lake Bund Middle consistently exhibited the highest COD values, suggesting a relatively greater organic pollution load than the other sampling sites. The observed COD levels indicate moderate organic contamination with distinct seasonal fluctuations influenced by hydrological conditions (Dubber and Gray 2010; Geerdink et al., 2017).

The experiment results showed there was no abnormal values observed in any of the parameters or in any season, most of the parameter’s values are within the acceptable limit and few are within the permissible limit. However, the fluctuation in the all the parameters showed due to inflow of water, prolong stagnation and none domestic interference. Previous studies have similarly reported lakes (Chandra et al., 2012; Musa et al., 2020; Bikila, et al., 2020; Akinbile & Yusuff, 2021; Pratibha et al., 2021; Simeon et al., 2022).

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