Impact of Anthropogenic Activities on Mavala Lake's Water Quality In Adilabad, Telangana, India

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Abstract: This study evaluates the physicochemical parameters of Mavala Lake, located in Adilabad District, Telangana State, to assess water quality variations and pollution indicators from February to July 2023. Water samples were collected from two sites: Site-A, positioned centrally, and Site-B, near the shoreline, to capture spatial variations in water quality. Mavala Lake exhibited higher temperatures and pH levels, suggesting a more stressed aquatic environment. Elevated EC, turbidity, and nutrient levels, particularly in phosphate and nitrate, were observed, reflecting increased pollution and potential eutrophication. The reduced DO levels and elevated BOD and COD values, pointed to significant organic and inorganic pollution. These findings highlight the lake's vulnerability to pollution and underscore the need for improved management practices. The results emphasize the importance of continuous monitoring and targeted interventions to address pollution sources and improve the lake's environmental conditions, thereby supporting sustainable water management and conservation efforts.

Keywords: Mavala pond, Adilabad, Physicochemical parameters, Biochemical oxygen demand, Chemical oxygen demand, Dissolved oxygen

Mavala Lake, located in Adilabad District, Telangana State, has emerged as a critical subject of environmental concern due to increasing pollution and its impacts on water quality. Over recent years, the lake has faced growing pressures from agricultural runoff, industrial discharge, and urban development, which contribute to significant changes in its physicochemical properties. The importance of monitoring such changes has been emphasized by recent studies, highlighting the need to understand the extent of human influence on freshwater ecosystems (Kumar et al 2009). Anthropogenic activities can lead to nutrient enrichment, which fosters algal blooms and deteriorates water quality, thus compromising the health of aquatic life and disrupting ecological balance (Manivasakam et al 2003, Shukla et al 2019). Understanding these impacts is essential for developing effective management practices and ensuring the sustainability of the lake's ecosystem. Physicochemical parameters such as temperature, pH, electrical conductivity (EC), and turbidity are crucial for assessing water quality and ecological health. Variations in these parameters can provide insights into the level of pollution and the degree of environmental stress affecting the lake. The elevated EC and turbidity levels often indicate increased runoff and the presence of suspended particles, which can adversely affect water quality and aquatic habitats (Lamma et al 2018). Temperature and pH fluctuations also play a significant role in determining the lake's health, as they influence the solubility of nutrients and the overall biological activity within the water body (Arulnagai et al 2021). Effective monitoring of these parameters helps in understanding the dynamics of pollution and its effects on aquatic life.

This study aims to provide a detailed evaluation of Mavala Lake's physicochemical parameters over a six-month period, with a focus on identifying trends and potential indicators of pollution. By systematically analyzing data from various sampling sites, the research seeks to offer a comprehensive assessment of the lake's water quality. Such an analysis is critical for detecting pollution sources and assessing the effectiveness of current management strategies (Bihari et al 2010). Previous research has demonstrated that continuous monitoring and data collection are vital for mitigating the adverse effects of pollution and ensuring the protection of aquatic ecosystems (Srithar et al 2006). This study will contribute valuable insights into the environmental status of Mavala Lake and support efforts to enhance water quality and ecosystem health.

MATERIAL AND METHODS

Sampling sites: The present investigation was conducted in Mavala Pond, located in Adilabad District, Telangana State, with water samples collected over a six-month period from February 2023 to July 2023. Two specific sites within the pond were selected for sampling to ensure a comprehensive analysis of the water quality. Site-A, situated at coordinates 19°37'52"N and 78°30'38"E, represents the central region of the pond, while Site-B, located at 19°37'52"N and 78°30'43"E, is positioned closer to the pond's shoreline. These sites were chosen to capture the potential spatial

variability in physicochemical parameters within the pond, allowing for a detailed assessment of water quality trends and their possible environmental implications over the study period. Site-A is characterized by deeper waters and is likely to reflect the general water quality of the lake's main body, influenced by both natural processes and human activities. Site-B is situated closer to the shoreline, where the water is shallower and more directly impacted by runoff and nearshore activities. The selection of these two sites allows for the assessment of potential differences in water quality between the central and peripheral areas of Mavala Lake, providing valuable insights into the spatial distribution of pollutants and other physicochemical parameters within the lake.

Sampling and sample collection methods: The sampling and sample collection methods for this study were designed to ensure the accurate representation of water quality in Mavala Lake. Water samples were collected monthly from February 2023 to July 2023, covering both pre-monsoon and monsoon seasons. Samples were taken from two predetermined sites within the lake-Site-A (central area) and Site-B (shoreline area)-to capture potential spatial variations in water quality. The collection process followed standard procedures as outlined by APHA (2017). At each site, water samples were collected at a depth of approximately 30 cm below the surface using pre-cleaned polyethylene bottles. To ensure consistency, samples were collected between 8:00 and 10:00 AM, minimizing the influence of diurnal variations in water quality. The collected samples were immediately stored in iceboxes and transported to the laboratory for analysis. Parameters such as temperature, pH, and dissolved oxygen were measured on-site using portable instruments, while other parameters were analyzed in the laboratory.

Physicochemical parameters: To assess the physicochemical parameters, a series of chemical and physical measurements were conducted in accordance with established standard methods. Key parameters such as electrical conductivity (EC), total hardness (TH), dissolved oxygen (DO), and major anions like chloride (Cl−), nitrate (NO3−), and phosphate (PO_4^{3-}) were evaluated using protocols detailed by the APHA (2005) and Khadka et al (2021). In-field measurements of pH, EC, and turbidity were carried out with a multi-parameter instrument to ensure precise readings. Biological Oxygen Demand (BOD) was determined by incubating the samples in the dark at 20°C for five days and then calculating the BOD by subtracting the final DO concentration from the initial DO concentration, as recommended by Olompande et al (2011). Chemical Oxygen Demand (COD) was measured using potassium dichromate as an oxidizing agent, following the method described by Bagalwa et al (2006). Collected water samples were promptly transported to the laboratory in a cooler with ice to preserve their integrity. If immediate analysis was not feasible, samples were stored at 4°C in a refrigerator to prevent any changes in their chemical properties.

Statistical analysis: Statistical analysis of the collected data was conducted using MS Excel.

RESULTS AND DISCUSSION

Physicochemical parameters: Mean physicochemical parameters of two sites of Mavala Lake water in different months are presented in Table1.

Temperature: The temperature of Mavala Lake water showed significant variation from February to July 2023, ranging from 24.0°C in February to a peak of 37.0°C in May, slightly surpassing the standard permissible limit. This indicates the influence of seasonal changes, with the highest temperatures in March and May (30.0°C and 37.0°C, respectively). The cooling effect observed in July (30.0°C) can be attributed to the onset of monsoon rains, which typically lead to a decrease in ambient temperatures. These fluctuations suggest that Mavala Lake experiences considerable thermal variations, which may impact aquatic life, as temperature changes can affect the solubility of oxygen and other critical factors for ecosystem health (Vijay Kumar et al 2024).

pH: The pH levels of Mavala Lake water varied slightly over the months, ranging from 7.9 in March to 9.5 in July, indicating a trend towards alkalinity. The highest pH value recorded in July (9.5) is above the recommended upper limit of 8.5 for freshwater bodies, suggesting a potential risk of alkalinity-related issues, such as reduced biodiversity and altered chemical processes in the water. The consistency in pH values throughout the months implies a relatively stable

chemical environment, albeit one that may be becoming increasingly alkaline over time. The rising pH levels could be due to factors like increased photosynthetic activity by algae, .Arulnangai et al (2021) also observed algal blooms in similar lakes led to higher pH due to carbon dioxide uptake.

Electrical Conductivity (EC): The electrical conductivity (EC) in Mavala Lake displayed a steady upward trend from February to July 2023, ranging from 169.9 µS/cm in February to 195.0 µS/cm in July. These values within the acceptable range of 20-500 µS/cm, suggest increasing levels of dissolved salts and ions in the water. The rise in EC is particularly notable in April and May, with values reaching 187.3 and 198.8 µS/cm, respectively, indicating a higher concentration of ionic substances, possibly due to evaporation during the warmer months or agricultural runoff. The standard deviations remain moderate, suggesting consistent EC levels across the sampling period. However, the overall increase in conductivity could signal potential water quality issues, such as the intrusion of pollutants or salinity from surrounding areas. Monitoring these levels is crucial, as high EC can affect the water's suitability for drinking, irrigation, and aquatic life (Vijaya Kumar et al 2024).

Turbidity: The turbidity levels in Mavala Lake water exhibited moderate fluctuations across the months, with values ranging from 26.9 NTU in February to a low of 17.9 NTU in July. These values reflect the presence of suspended particles in the water, such as silt, algae, and organic matter. The highest turbidity recorded in February (26.9 NTU) suggests a higher concentration of particulates, possibly due to soil erosion or runoff from nearby areas. The decrease in turbidity towards the monsoon season, particularly in July, is indicative of the settling of particles as a result of reduced surface runoff or dilution by rainwater. There was slight fluctuating turbidity level throughout the months. The turbidity

values are not excessively high, but still necessitate regular monitoring, as increased turbidity can reduce light penetration, affecting photosynthesis and the overall health of aquatic ecosystems (Asha et al 2007)

Total hardness (TH): The total hardness (TH) of Mavala Lake water varied notably over the six months, with values ranging from 119.1 mg/L in July to peak of 176.6 mg/L in April. These levels, while within the permissible limit of 300 mg/L, indicate fluctuations in the concentration of calcium and magnesium ions, which contribute to water hardness. The highest TH in April suggests an increased mineral content, possibly due to evaporation and concentration of dissolved salts during the hotter months. The lower values in June and July may result from the dilution effects of incoming rainwater during the monsoon season. e TH levels are not critically high, continuous monitoring is essential to prevent potential scaling in water systems and to ensure the water remains suitable for domestic and agricultural use (Krishnamurthy and Selva Kumar 2010).

Total Alkalinity (TA): Total alkalinity (TA) in Mavala Lake showed significant fluctuations throughout the observation period, with values ranging from 111.0 mg/L in June to 209.1 mg/L in April. These values, which exceed the standard limit of 250 mg/L at times, suggest a varying ability of the water to neutralize acids, which is crucial for maintaining pH stability. The peak in April could be attributed to increased carbonate and bicarbonate ions due to evaporation and the concentration of these ions in the water. Conversely, the drop in TA in May and June suggests dilution effects, likely from monsoon rainfall. The variability in TA, as reflected by the standard deviations, indicates the lake's changing chemical composition, which could impact aquatic life by affecting the availability of nutrients and the overall buffering capacity of the water. Regular monitoring is advised to ensure the lake's

Table 1. Physicochemical parameters of Mavala Lake water**.**

Physicochemical parameters (Standard values)	Physicochemical parameters in different months					
	February	March	April	May	June	July
Temperature (<37)	24.0 ± 1.6	30.0 ± 2.8	33.5 ± 2.0	37.0 ± 1.7	35.5 ± 3.2	30.0 ± 2.3
pH (6.5-8.5)	8.9 ± 0.7	7.9 ± 0.3	8.1 ± 0.9	8.4 ± 0.7	8.6 ± 0.4	9.5 ± 0.3
EC (uS/cm) (20-500)	169.9 ± 12.8	171.2 ± 9.8	187.3 ± 14.1	198.8 ± 15.2	192.2 ± 14.1	195.0 ± 9.2
Turbidity (NTU)	26.9 ± 4.2	20.6 ± 6.5	24.9 ± 2.2	23.4 ± 4.1	21.9 ± 3.2	17.9 ± 4.5
TH (mg/L) (300)	141.6 ± 11.4	163.6 ± 9.2	176.6 ± 8.2	147.4 ± 9.0	128.6 ± 12.1	119.1 ± 10.3
TA (mg/L) (250)	196.4 ± 12.7	171.1 ± 10.1	209.1 ± 7.0	122.0 ± 11.6	111.0 ± 10.3	206.6 ± 6.5
Chloride (mg/L) (250)	73.4 ± 9.9	78.6 ± 8.1	81.7 ± 4.4	83.1 ± 10.1	74.0 ± 5.0	76.7 ± 11.6
Nitrate (mg/L) (<45)	1.21 ± 0.04	1.54 ± 0.22	0.44 ± 0.01	0.54 ± 0.003	0.52 ± 0.001	0.53 ± 0.01
Phosphate (mg/L) (<4)	0.98 ± 0.04	1.65 ± 0.06	2.97 ± 0.09	3.52 ± 0.10	1.76 ± 0.08	1.21 ± 0.03
DO (mg/L) (6)	6.7 ± 1.2	2.0 ± 0.3	3.7 ± 0.5	4.8 ± 1.2	5.6 ± 1.1	6.2 ± 0.5
BOD (mg/L) (0-50)	12.8 ± 3.1	10.2 ± 2.2	15.2 ± 2.9	13.6 ± 2.0	15.4 ± 3.1	14.7 ± 2.0
COD (mg/L) (10-20)	35.8 ± 4.8	23.8 ± 4.3	41.6 ± 2.1	35.5 ± 5.4	29.2 ± 7.0	22.7 ± 3.1

Values are presented in mean ± SD.

alkalinity remains within safe limits for its ecological and human uses (Kulkarni et al 2008, Mathur et al 2010).

Chloride: The chloride levels in Mavala Lake water ranged from 73.4 mg/L in February to 83.1 mg/L in May, with the highest concentration observed during the pre-monsoon months. These values, below the permissible limit of 250 mg/L, indicate the presence of chloride ions, which can originate from both natural sources, such as the weathering of rocks, and anthropogenic activities, such as agricultural runoff or wastewater discharge. The increase in chloride levels in May may be due to the concentration of salts during the dry season when water levels are lower. The subsequent decrease in June and July suggests dilution by rainwater. The standard deviations indicate a moderate level of variability, with the most significant changes occurring between March and May. Although the chloride levels are within acceptable limits, should be monitored regularly to prevent potential issues related to salinity, which can affect the taste of water and its suitability for irrigation (Rohankar et al 2009).

Nitrate: Nitrate levels in Mavala Lake remained relatively low and stable throughout the six-month period, with values ranging from 0.44 mg/L in April to 1.54 mg/L in March. These levels are well within the permissible limit of 45 mg/L, indicating minimal nitrate pollution, which is often associated with agricultural runoff or sewage discharge. The slight increase in nitrate levels in March could be attributed to seasonal agricultural activities, where fertilizers are more likely to be applied. The current nitrate levels do not pose a significant risk to water quality, ongoing monitoring is essential to ensure that they remain low, as elevated nitrate concentrations can lead to eutrophication, resulting in excessive algae growth and oxygen depletion, which can harm aquatic life (Singh et al 2013).

Phosphate: Phosphate levels in Mavala Lake showed considerable variation from February to July 2023, ranging from 0.98 mg/L in February to a peak of 3.52 mg/L in May. These fluctuations indicate a dynamic nutrient environment within the lake, with the highest phosphate levels recorded during the pre-monsoon months. The elevated levels in April and May could be due to increased agricultural runoff or the release of phosphate-rich effluents into the lake. Although the values remain within the acceptable limit of 4 mg/L, the observed peaks suggest potential risks of eutrophication, where high phosphate levels can lead to excessive algal blooms, reducing oxygen availability and harming aquatic life. The standard deviations reflect moderate variability, with the most significant changes occurring between March and May. Regular monitoring and management of phosphate sources are crucial to maintaining the lake's water quality and preventing long-term ecological damage (Sivalingam et al 2013).

Dissolved Oxygen (DO): Dissolved oxygen (DO) levels in Mavala Lake exhibited fluctuations, ranging from a low of 2.0 mg/L in March to a high of 6.7 mg/L in February. These values reflect the lake's capacity to support aquatic life, with higher levels typically indicating better water quality. The drop in DO during March and April, significantly below the standard limit of 6 mg/L, suggests periods of oxygen stress, likely due to increased organic matter decomposition or algal blooms, which consume oxygen. The study indicate significant variability, particularly during the warmer months, when higher temperatures can reduce the solubility of oxygen in water. The gradual increase in DO levels towards July suggests some recovery, possibly due to cooler temperatures and increased mixing from rainfall. Maintaining adequate DO levels is essential for the health of aquatic ecosystems, and ongoing monitoring is necessary to prevent periods of hypoxia, which can lead to fish kills and biodiversity loss (Bagade and Belagali 2010).

Biochemical Oxygen Demand (BOD): The biochemical oxygen demand (BOD) of Mavala Lake water fluctuated between 10.2 mg/L in March and 15.4 mg/L in June, with the highest observed during the warmer months. These levels, while within the acceptable range of 0-50 mg/L, indicate varying degrees of organic pollution, where higher BOD values suggest an increased presence of biodegradable organic matter in the water. The peak in June could be attributed to the accumulation of organic materials, such as plant debris or wastewater discharge, which depletes oxygen levels as microorganisms break down these substances. There was moderate variability in BOD levels, with significant changes occurring between March and April. The current BOD levels are not critically high but should be monitored closely, as elevated BOD can lead to oxygen depletion, affecting aquatic life and overall water quality. Preventive measures, such as controlling pollutant sources, are recommended to maintain balanced BOD levels (Bihari Singh et al 2010).

Chemical Oxygen Demand (COD): Chemical oxygen demand (COD) showed considerable variation over the months, with the highest level recorded in April (41.6 mg/L) and the lowest in July (22.7 mg/L). These values exceed the standard limit of 20 mg/L, indicating the presence of significant amounts of organic and inorganic pollutants in the lake. The peak in April suggests an increased load of oxidizable pollutants, possibly due to agricultural runoff or industrial discharge. The subsequent decrease in June and July could be attributed to the dilution effect of rainwater during the monsoon season. There was notable variability, particularly during the pre-monsoon months, when pollutant concentrations tend to be higher. High COD levels are a cause

for concern, as they reflect the lake's reduced ability to support aquatic life and its increased susceptibility to pollution. Regular monitoring and effective pollution control measures are essential to mitigate the impact of these pollutants on the lake's ecosystem (Dwivedi and Pathak 2009).

CONCLUSION

The study of Mavala Lake's physicochemical parameters from February to July 2023 reveals significant environmental challenges, particularly when compared with others Lake. Mavala Lake exhibited higher temperatures, elevated pH, increased electrical conductivity, and turbidity levels, all indicative of a more polluted and stressed aquatic environment. The elevated phosphate concentrations and lower dissolved oxygen levels, especially during the pre-monsoon period, suggest a heightened risk of eutrophication and oxygen depletion, which could severely impact aquatic life. These findings highlight the urgent need for effective pollution control and water management strategies to mitigate the impact of agricultural runoff, industrial discharge, and other anthropogenic activities on Mavala Lake. Regular monitoring and intervention are essential to preserve the lake's ecological balance and prevent further environmental degradation.

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