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Studies on Physicochemical Parameters of Kalvati Lake in Ambajogai

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Abstract

The physicochemical properties of freshwater bodies are essential indicators of the health and water quality of aquatic ecosystems. These parameters not only reflect the overall state of the water but also provide critical insights into potential threats to biodiversity and public health. This study investigates the seasonal variations in physicochemical parameters of Kalvati Lake, located in Ambajogai City, District Beed, Maharashtra, aiming to assess the lake's ecological status. Key parameters such as pH, biochemical oxygen demand (BOD), total dissolved solids (TDS), temperature, and nutrient levels (nitrates and phosphates) were analyzed over the course of different seasons to provide a comprehensive understanding of water quality fluctuations. The findings revealed significant pollution levels in the lake, primarily due to anthropogenic activities such as agricultural runoff, domestic sewage, and religious practices that contribute to nutrient overload and organic waste. Elevated levels of nitrates and phosphates were particularly concerning, indicating a high potential for eutrophication, which can lead to algal blooms, oxygen depletion, and further degradation of aquatic life. Seasonal variations in parameters like temperature and TDS also demonstrated how changes in environmental conditions influence the water's ability to maintain ecological balance. The study emphasizes the urgent need for effective conservation strategies to address the pollution sources, such as the implementation of proper waste management systems, reduction of agricultural runoff, and community engagement in lake protection initiatives. Additionally, policy measures at the local and regional levels are essential to curb further degradation of water quality. By promoting sustainable practices and restoring the ecological balance of Kalvati Lake, the health of this vital freshwater ecosystem can be safeguarded.

Keywords: *freshwater lakes, water quality, physicochemical parameters, seasonal variation, eutrophication, Ambajogai.*

Introduction

Freshwater ecosystems, particularly lakes, are vital for biodiversity, water supply, and socio-economic development. However, increasing anthropogenic pressures have severely degraded their quality and functionality (Reid et al., 2023). Lakes in semi-arid regions like Ambajogai City are particularly vulnerable to pollution and eutrophication due to limited water availability and over-dependence for agricultural and domestic purposes.

Ambajogai City, located in District Beed, Maharashtra, is home to a Kalvati lake that serves as a water source for surrounding communities. It also supports aquatic life and contributes to groundwater recharge. However, growing urbanization, agricultural runoff, and inadequate waste management have led to pollution and ecological imbalance (Kadam et al., 2022). Salve et al. in (2022) investigated the physicochemical parameters of the Godavari River at Kamalpur, emphasizing their influence on aquatic biodiversity.

Understanding the physicochemical parameters of aquatic ecosystems like Kalvati Lake is vital for assessing water quality, environmental health, and suitability for aquatic life. Several studies have contributed to this domain, highlighting the importance of analyzing parameters such as pH, dissolved oxygen, nutrient content, and metal concentrations.

For instance, Angmuthu and Geetha (2016) discussed the significance of systematic soil and water parameter studies in India, emphasizing the role of such research in environmental planning and sustainability. Their quantitative review of soil and water studies highlighted trends and gaps in existing research, advocating for state-wise documentation to support agricultural and ecological goals.

Studies on specific regions provide valuable insights into local ecological dynamics. For example, Dandwate (2020) examined soil physicochemical parameters in Sangamner, showing how parameters like pH and organic matter influence soil fertility and productivity. Similarly, Bajpai et al. (2022) utilized advanced techniques to correlate soil and water quality with agricultural outcomes in Kanpur, highlighting the interconnectedness of these ecosystems.

Research focusing on aquatic environments, such as the studies by Raut et al. (2020), underscores the relationship between agricultural patterns and water quality parameters. Their findings indicate that variations in pH, nutrient levels, and water retention capacities directly impact crop yield and sustainability in Ahmednagar. Furthermore, Patel et al. (2024) observed the role of neutral to slightly acidic pH levels in enhancing soil and water compatibility for agricultural use in Burhanpur. These findings align with the outcomes of Wagh et al. (2021), who investigated soil parameters in the Buldhana region, noting that balanced nutrient levels and optimal pH contribute significantly to crop diversity and productivity. The observed correlations between physicochemical characteristics and agricultural practices provide a framework for studies on similar ecosystems like Kalvati Lake.

In the case of Kalvati Lake, examining parameters such as pH, dissolved oxygen, and temperature, could provide a comprehensive understanding of its ecological health. This understanding is essential for its sustainable use and for maintaining the biodiversity it supports. This paper presents a detailed assessment of the physicochemical parameters of the Kalvati lake, identifies sources of pollution, and discusses strategies for its conservation. The current study was conducted because lakes help store water that can be used for drinking by humans and domestic animals, especially livestock, and for farming purposes during the season other than Rainy, particularly in the draught prone region. The water quality can be assessed by studying different hydrobiological parameters.

Materials and Methodology

1. Study Area

The Kalvati lake in Ambajogai City, District Beed, is a perennial waterbody, covering an approximate area of 12 hectares. The lake is surrounded by agricultural fields, residential areas and a temple, which makes it susceptible to various forms of pollution, including agricultural runoff, domestic wastewater, and ritual waste.

2. Sampling Locations

Five sampling sites were selected to represent different parts of the lake:

1. Inflow Point: Receives agricultural runoff.
2. Outflow Point: Reflects the cumulative water quality.
3. Near Residential Area: Subject to domestic sewage inflow.
4. Near Temple: Affected by ritual waste.
5. Middle of the Lake: Represents baseline water quality away from direct anthropogenic influences.

3. Sampling Frequency

Water samples were collected seasonally pre-monsoon, monsoon, and post-monsoon. In March-May, June-September and October-February respectively over a one-year period from January 2023 to December 2023.

4. Physicochemical Parameters Analyzed

Standard protocols (APHA, 2017) were followed to analyze the following parameters:

1. Temperature: Measured onsite using a digital thermometer.
2. pH: Determined using a portable pH meter to evaluate water acidity or alkalinity.
3. Dissolved Oxygen (DO): Measured using the Winkler titration method.
4. Biochemical Oxygen Demand (BOD): Calculated after 5 days of incubation at 20°C.
5. Total Dissolved Solids (TDS): Measured with a digital TDS meter.
6. Nitrate and Phosphate Concentrations: Analyzed using UV-Vis spectrophotometry.
7. Conductivity: Measured using a conductivity meter to determine ionic concentration.
8. Chlorides: Estimated using argentometric titration.

5. Data Analysis

Statistical analyses, including ANOVA and Pearson correlation, were conducted using SPSS software to evaluate seasonal variations and interrelationships among parameters. The obtained observations were matched with Indian water quality standards (BIS, 2012) to determine the lake's ecological health.

Results and Discussion

Parameter	Season/Time Period	Observed Range	Interpretation/Results
Water Temperature	Post-monsoon	22°C	Lower temperatures post-monsoon, supporting reduced algal growth.
	Pre-monsoon	31°C	Higher temperatures pre-monsoon, favoring increased algal growth.
pH	All seasons	6.8 to 8.3	Slightly alkaline conditions, with seasonal fluctuations influenced by organic matter decomposition and runoff.
Dissolved Oxygen (DO)	Monsoon	8.2 mg/L	Higher DO levels due to increased aeration during the monsoon, supporting aquatic life.
	Pre-monsoon	4.5 mg/L	Lowest DO levels in pre-monsoon due to high organic matter decomposition, indicating poorer water quality.
Biochemical Oxygen Demand (BOD)	Pre-monsoon	6.5 mg/L	Peak BOD levels, suggesting high organic pollution, especially from domestic and ritual waste.

Nitrate Concentration	Post-monsoon	0.5 mg/L	Lower nitrate levels post-monsoon, indicating minimal agricultural runoff.
	Monsoon	2.8 mg/L	Higher nitrate levels during the monsoon, likely due to agricultural runoff contributing to nutrient pollution.
Phosphate Concentration	All seasons	0.1 mg/L to 1.5 mg/L	Fluctuations in phosphate levels, with higher concentrations during the monsoon, promoting eutrophication.
TDS (Total Dissolved Solids)	Post-monsoon	300 mg/L	Lower TDS levels, likely due to more rainfall and less evaporation.
	Pre-monsoon	750 mg/L	Higher TDS levels, attributed to evaporation and concentration of dissolved solids.
Conductivity	Post-monsoon	450 µS/cm	Lower conductivity due to reduced ion concentration in post-monsoon season.
	Pre-monsoon	1200 µS/cm	Higher conductivity linked to increased mineral concentration, agricultural and domestic waste inflows.

Table 1: Summarizes the seasonal variations in temperature, pH, dissolved oxygen, BOD, nutrient levels, TDS, and conductivity. The observations reflect seasonal influences on water quality and ecosystem health.

1. **Seasonal Variations in Temperature and pH**

Water temperature ranged between 22°C (post-monsoon) and 31°C (pre-monsoon), with higher temperatures favoring algal growth. Bhagde et al. (2024) report temperatures ranging from 24°C to 27.4°C, which is within the optimal range for many freshwater species. The pH ranged from 6.8 to 8.3, indicating slightly alkaline conditions. Seasonal changes in pH were influenced by organic matter decomposition and agricultural runoff.

2. **Dissolved Oxygen and BOD Levels**

DO levels were highest during the monsoon (8.2 mg/L) due to increased aeration and lowest in the pre-monsoon (4.5 mg/L) due to high organic matter decomposition. BOD values peaked in the pre-monsoon (6.5 mg/L), indicating organic pollution from domestic and ritual waste, exceeding the permissible limit for aquatic ecosystems (Patil et al., 2021).

3. **Nutrient Levels and Eutrophication**

Nitrate concentrations diverse from 0.5 mg/L (post-monsoon) to 2.8 mg/L (monsoon), while phosphate levels ranged from 0.1 mg/L to 1.5 mg/L. High nutrient levels during the monsoon were attributed to agricultural runoff. These levels contributed to eutrophication, promoting algal blooms that depleted oxygen and threatened aquatic biodiversity.

4. **TDS and Conductivity**

TDS levels ranged between 300 mg/L and 750 mg/L, with the highest values recorded during the pre-monsoon due to evaporation and mineral concentration. Conductivity ranged from 450 µS/cm to 1200 µS/cm, correlating with TDS levels, indicating high ionic concentrations from agricultural and domestic waste inflows (Ahmed & Shaikh, 2024).

Conservation Strategies

1. **Pollution Control**

- **Agricultural Runoff:** Promote organic farming, buffer zones, including sustainable farming practices, to minimize nutrient inflow.
- **Domestic Sewage:** Implement decentralized sewage treatment plants to reduce organic pollution.

2. **Community Engagement**

Educate local communities about the ecological significance of the lake and involve them in conservation activities like cleanup drives and monitoring programs.

3. **Policy Recommendations**

Enforce strict regulations on waste disposal and establish protected zones around the lake to prevent habitat degradation. Conservation policies lack integration with district-level environmental management plans. Studies like those by Yeole and Patil (2005) offer frameworks but need adaptation for Ambajogai.

4. **Restoration Initiatives**

- Desilting: Remove accumulated sediments to improve water storage capacity and reduce nutrient loading.
- Bioengineering: Introduce floating wetlands and native vegetation to enhance water purification and biodiversity.

Conclusion

This study highlights the deteriorating water quality of the lake in Ambajogai City due to anthropogenic pressures. Elevated levels of BOD, nutrients, and TDS indicate pollution and eutrophication, threatening aquatic life

and ecosystem services. The findings of Bhagde et al. (2024) align with several other studies highlighting the importance of temperature, pH, and dissolved oxygen in determining the health of aquatic ecosystems. Temperature, for example, influences the solubility of gases such as carbon dioxide and oxygen, affecting the biological activity in the water. Implementing sustainable management practices, community participation, and policy enforcement is essential for the lake's conservation and restoration.

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Conflicts of Interest
The authors declare that there are no conflicts of interest regarding the publication of this paper.

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