



Assessment of Physicochemical Dynamics and Aquaculture Suitability of Urban Lentic Ecosystems in Bhagalpur, India

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Abstract: Urban ponds are critical ecological assets that provide essential services but face increasing degradation due to anthropogenic pressure. This study evaluates the physicochemical health of Bhairwa pond in Bhagalpur over a 15-month cycle (2021–2022). Analysis of 14 key water quality parameters revealed a stable environment with an average water temperature of 26.5°C , slightly alkaline pH (7.29), and Dissolved Oxygen (DO) levels averaging 6.09 mg/l. Statistical correlations indicated a strong negative relationship between temperature and DO ($r = -0.85$). The results confirm that the pond maintains high biological fertility and is currently suitable for semi-intensive aquaculture. However, the recorded nutrient levels suggest a need for proactive management to prevent future eutrophication.

Keywords: Limnology, Primary Productivity, Urban Aquaculture, Water Quality Index, Bhagalpur, Nutrient Dynamics.

1. INTRODUCTION

Aquatic ecosystems, particularly small lentic habitats like ponds, are essential contributors to global biodiversity and provide critical ecosystem services such as carbon sequestration and local food security (Kumar et al., 2021). In India, ponds serve as traditional, cost-effective water sources for irrigation and economically vital fish culture. According to Banerjee (1968), the water quality and soil condition of fish ponds are the primary determinants of fish production.

However, rapid urbanization in cities like Bhagalpur has led to significant deterioration of water quality due to domestic sewage discharge and agricultural runoff (Saha et al., 2023). Recent studies highlight that rising global temperatures and erratic monsoon patterns are altering the thermal stratification and oxygen solubility of tropical shallow ponds (Prasad & Singh, 2022). Furthermore, maintaining specific nutrient thresholds is vital for preventing toxic cyanobacterial blooms while supporting beneficial phytoplankton growth (Verma et al., 2020). This research establishes a scientific baseline for sustainable pond management in Bhagalpur, assessing suitability for long-term aquaculture based on updated water quality guidelines (FAO, 2022; Bhatnagar et al., 2004).

2. Materials and Methods

2.1 Study Area

The research focused on Bhairwa pond, a perennial urban water body located in Bhagalpur city (Bihar). The pond is utilized for diverse purposes including cattle bathing and local fisheries.

2.2 Sampling and Analysis

Water samples were collected monthly (8:00 AM to 10:00 AM) between October 2021 and December 2022.

- Physicochemical Parameters: Temperature, transparency (Secchi disc), pH, and Dissolved Oxygen (Winkler's method) were analyzed following APHA (2018) standards.
- Nutrients: Nitrates and Phosphates were analyzed via spectrophotometric methods at 690 nm.



- Statistical Analysis: Interrelationships between variables were assessed using Pearson correlation coefficients (r) to identify drivers of biological productivity.

3. Results and Discussion

3.1 Physicochemical Dynamics

The annual data indicates a well-buffered aquatic environment. The mean values for critical parameters fall within the recommended ranges for tropical aquaculture.

Table 1: Physicochemical Profile & Aquaculture Suitability (Bhairwa Pond)

Sl. No.	Parameter	Annual Mean Value	Recommended Range	Status
1	Water Depth	4.605m	> 1.5 m	Optimal
2	Transparency	55.33 cm	30 – 60 cm	Optimal
3	Water Temp.	25.44 °C	20 – 30 °C	Optimal
4	pH	7.29	7.0 – 8.5	Ideal
5	TDS	84.33 ppm	< 400 ppm	Excellent
6	Dissolved Oxygen	6.09 mg/l	5.0 – 8.0 mg/l	Good
7	Free CO ₂	2.47 ppm	< 10 ppm	Safe
8	Total Hardness	55.98 mg/l	30 – 180 mg/l	Suitable
9	Total Alkalinity	85.98 mg/l	50 – 300 mg/l	Productive
10	Chloride	55.48 mg/l	< 250 mg/l	Low/Safe
11	BOD	4.42 mg/l	< 5.0 mg/l	Acceptable
12	COD	5.80 mg/l	< 20 mg/l	Low/Safe
13	Nitrate	2.71 ppm	0.1 – 4.0 ppm	Fertile
14	Phosphate	2.02 ppm	0.05 – 7.0 ppm	High

3.2 Discussion of Correlations

A strong negative correlation was observed between water temperature and DO, confirming that thermal stress during summer peaks (up to) reduces oxygen availability, a trend mirrored in recent tropical limnological studies (Das et al., 2024). The transparency mean (55.33 cm) is ideal for light penetration, facilitating primary productivity. Furthermore, the nutrient concentrations (Nitrate 2.71 ppm; Phosphate 2.02 ppm) indicate high fertility. As noted by Boyd (1998), such levels are conducive to healthy plankton blooms but require monitoring to avoid anaerobic conditions at the sediment-water interface.

4. Conclusion

The investigation confirms that Bhairwa pond in Bhagalpur is currently in a state of high biological fertility. All 14 parameters studied align with the optimum ranges for successful fish culture. To ensure the sustainability of this ecosystem, the study recommends the regulation of domestic waste discharge and the adoption of scientific aquaculture practices. This would not only enhance fish yield but also promote the ecological health of Bhagalpur's urban landscape.

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