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# Long-Term Assessment of Eutrophication and Its Impact on Local Fish in Sherpur Pond, Muzaffarpur

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***Abstract*: This study investigates seasonal changes in water quality and early signs of eutrophication in Sherpur Pond, a rural freshwater body located in Muzaffarpur, Bihar. The research was conducted over a two-year period, from January 2023 to October 2024, with water samples collected in four key seasons each year—winter, pre-monsoon, monsoon, and post-monsoon. Physico-chemical and microbiological parameters including pH, Total Dissolved Solids (TDS), nitrate, ammonia, sulphate, dissolved oxygen (DO), and microbial counts were measured. The results indicated rising concentrations of nutrients and organic load over time, with increasing TDS, nitrate, and ammonia values, along with a gradual decline in DO levels. Though most parameters remained within national standards, their combined effects suggest a transition toward nutrient-enriched conditions favorable for eutrophication. Local observations supported these findings, reporting algal blooms, unpleasant odors, and declining fish populations, especially during warmer months. The study concludes that Sherpur Pond is showing signs of early eutrophication, likely due to agricultural runoff and domestic waste discharge. Preventive actions such as limiting nutrient inflows, restoring vegetation, and community engagement are recommended to preserve the ecological health and biodiversity of the pond. This research offers a model for managing similar rural water bodies in India.**

***Keywords*: Eutrophication, Nutrient enrichment, Algal blooms, Phosphorus cycle, Nitrogen cycle**

## I. INTRODUCTION

Freshwater ecosystems are essential for sustaining life, supporting biodiversity, and maintaining ecological balance. In India, especially in rural areas, ponds and small water bodies serve as critical resources for agriculture, aquaculture, domestic use, and cultural practices. These ponds are deeply embedded in the socio-economic fabric of villages, often functioning as primary sources of irrigation and livelihoods for local communities. However, increasing anthropogenic activities have led to the gradual deterioration of these water bodies. Among the various threats facing rural ponds, eutrophication has emerged as a significant environmental concern.

Eutrophication is a process in which water bodies become enriched with nutrients, particularly nitrogen and phosphorus, leading to excessive growth of algae and aquatic plants. While this process can occur naturally over time, human-induced (or accelerated) eutrophication is far more rapid and damaging. In rural settings, the primary sources of nutrient loading include agricultural runoff (rich in chemical fertilizers and pesticides), domestic wastewater, livestock waste, and direct dumping of organic matter. These inputs upset the nutrient balance of ponds, causing algal blooms, oxygen depletion, and degradation of aquatic life.

In eutrophic conditions, algae multiply rapidly on the surface of water, reducing light penetration and limiting photosynthesis in submerged plants. As these algae die and decompose, microbial activity increases, consuming a large amount of dissolved oxygen (DO) from the water. This results in hypoxic (low-oxygen) or even anoxic (no-oxygen) conditions, which are harmful to aquatic organisms, particularly fish. Prolonged eutrophication can lead to fish mortality, loss of biodiversity, and the eventual transformation of the pond into a stagnant, weed-choked water body.

Sherpur Pond, situated in the Muzaffarpur district of Bihar, exemplifies this issue. Once a reliable freshwater resource supporting local fish populations and agriculture, the pond is

now under visible ecological stress. Surrounded by agricultural fields and residential zones, the pond receives runoff containing fertilizers, along with domestic sewage and livestock waste. The absence of any systematic waste treatment or environmental management has allowed nutrient accumulation over time. Villagers have reported increased algal growth, foul odors during summer, and a decline in fish harvests—classic symptoms of eutrophication. These local observations demand a scientific investigation into the pond's current ecological status.

Given its importance to the local population, assessing the water quality and identifying the indicators of eutrophication in Sherpur Pond is crucial. Understanding the current condition of the pond can help initiate timely intervention strategies to restore its ecological balance and ensure sustainable use. The deterioration of such ponds not only threatens local biodiversity but also affects food security and income sources for rural households.

This study is designed to systematically evaluate the water quality of Sherpur Pond over a two-year period, from January 2023 to October 2024, with the goal of detecting early signs of eutrophication. The focus is on seasonal monitoring—during winter (January), pre-monsoon (April), monsoon (July), and post-monsoon (October)—as water chemistry often changes with rainfall patterns, temperature, and farming cycles. Key physico-chemical and microbiological parameters have been selected for analysis, including pH, Total Dissolved Solids (TDS), electrical conductivity, DO, nitrate, ammonia, sulphate, alkalinity, calcium, Total Plate Count, and E. coli presence.

This research aims to meet the following objectives:

- To analyze seasonal and inter-annual changes in water quality parameters over two years.
- To identify trends that indicate the presence or progression of eutrophication.
- To examine the relationship between water quality and the observed changes in local fish populations.
- To propose appropriate mitigation strategies for nutrient control and pond restoration.

The study applies standardized methods to ensure the reliability of the results. In addition to laboratory data, qualitative insights from local fishers and residents have been collected to support the analysis. Their observations offer context and ground truth to the scientific findings, highlighting the direct socio-economic implications of environmental degradation.

## II. Materials and Methods

### *Sampling Design and Duration*

The water quality assessment was conducted over a period of two years, from January 2023 to October 2024, with seasonal sampling performed during four periods each year January (Winter)**,** April (Pre-Monsoon)**,** July (Monsoon) and October (Post-Monsoon)**.** Water samples were collected from three fixed points within the pond.Inlet Zone is where agricultural runoff enters the pond**,** Central Zone representing the main body of stagnant water and Outlet/Drainage Zone – where overflow or seepage occurs. Each sample was collected using sterilized high-density polyethylene (HDPE) containers (2 L capacity) at a depth of 20–30 cm below the surface to avoid surface contaminants.

### *Analytical Parameters*

To monitor eutrophication and assess water quality, few parameters were selected, classified into physico-chemical and microbiological indicators:

### *Physico-Chemical Parameters*

- Temperature (°C) – Measured in situ using a calibrated mercury thermometer.
- pH – Determined using a digital pH meter (IS:3025-P11).
- Total Dissolved Solids (TDS, mg/L) – Measured using a TDS meter (IS:3025-P16).
- Conductivity (µS/cm) – Determined with a portable EC meter (IS:3025-P14).
- Dissolved Oxygen (DO, mg/L) – Estimated by the Winkler's titration method (IS:3025-P38).
- Nitrate ($NO_3^-$, mg/L) – Analyzed by UV spectrophotometry (IS:3025-P34).
- Sulphate ($SO_4^{2-}$, mg/L) – Determined using turbidimetric method (IS:3025-P24).
- Alkalinity (mg/L) – Determined by titration with standard acid (IS:3025-P23).

### *Microbiological Parameters*

- Total Plate Count (CFU/mL) – Assessed using the pour plate method on nutrient agar.
- E.coli – Detected using the Most Probable Number (MPN) method and confirmed by selective media (IS:1622).

## III. Results and Discussion

The two-year study on Sherpur Pond, spanning January 2023 to October 2024, revealed notable variations in the water's physico-chemical and microbiological characteristics. These changes, evaluated seasonally, indicate progressive nutrient enrichment and potential ecological degradation. The following sections detail observed trends across the eight sampling events conducted in four key seasons: winter (January), pre-monsoon (April), monsoon (July), and post-monsoon (October).

Temperature ranged from a low of 16.2°C in January 2023 to a peak of 33.0°C in July 2024. Seasonal variation was consistent, with higher values during pre-monsoon and monsoon months. This directly influenced biological activity, especially microbial growth and oxygen solubility.

The pH of the pond remained alkaline across all seasons, ranging from 8.03 to 8.6. Alkalinity was slightly higher during winter and monsoon seasons, suggesting photosynthetic activity and carbon dioxide fluctuations. Although values remained within permissible limits, sustained alkalinity indicates favorable conditions for algal proliferation.

A steady increase in Total Dissolved Solids (TDS) was observed, rising from 260 mg/L in January 2023 to 369 mg/L by July 2024. Similarly, conductivity increased from 410 µS/cm to over 510 µS/cm in the same period. These indicators suggest the accumulation of both organic and inorganic solutes, largely due to runoff, domestic waste, and lack of water circulation.

Dissolved Oxygen (DO) levels showed a declining trend over the study period. From a relatively healthy value of 6.2 mg/L in January 2023, it decreased to 5.4 mg/L in October 2024. While still within tolerance limits for most fish species, the reduction points toward elevated biological oxygen demand due to organic decomposition and microbial activity.

Nitrate concentrations peaked during the pre-monsoon seasons—7.54 mg/L in April 2023 and 6.5 mg/L in April 2024—likely linked to runoff from agricultural fields. In contrast, winter nitrate levels were significantly lower, reflecting limited fertilizer application and reduced surface flow.

Elevated levels of sulphate and alkalinity further confirmed nutrient loading. Sulphate increased from 11.8 mg/L to 32.17 mg/L, while alkalinity ranged from 72.3 mg/L to over 190 mg/L, especially in the second year. These parameters influence water buffering capacity and indicate internal nutrient cycling.

### *Microbiological Observations*

Microbiological analysis revealed no presence of *E. coli* in any of the collected samples, suggesting limited fecal contamination. However, total plate counts remained consistently high, ranging from 64 to 72 CFU/mL. Plate counts peaked during July and October, aligning with increased nutrient availability and warmer water temperatures that support microbial proliferation.

### *Discussion*

The findings from Sherpur Pond over the two-year monitoring period suggest a clear progression toward eutrophic conditions. Increasing concentrations of TDS, nitrate, ammonia, and sulphate, along with declining dissolved oxygen levels, indicate nutrient overloading and reduced water quality. Seasonal spikes in nitrate during pre-monsoon months reflect the influence of fertilizer runoff, while elevated ammonia levels during warmer months point to increased organic waste decomposition and microbial activity.

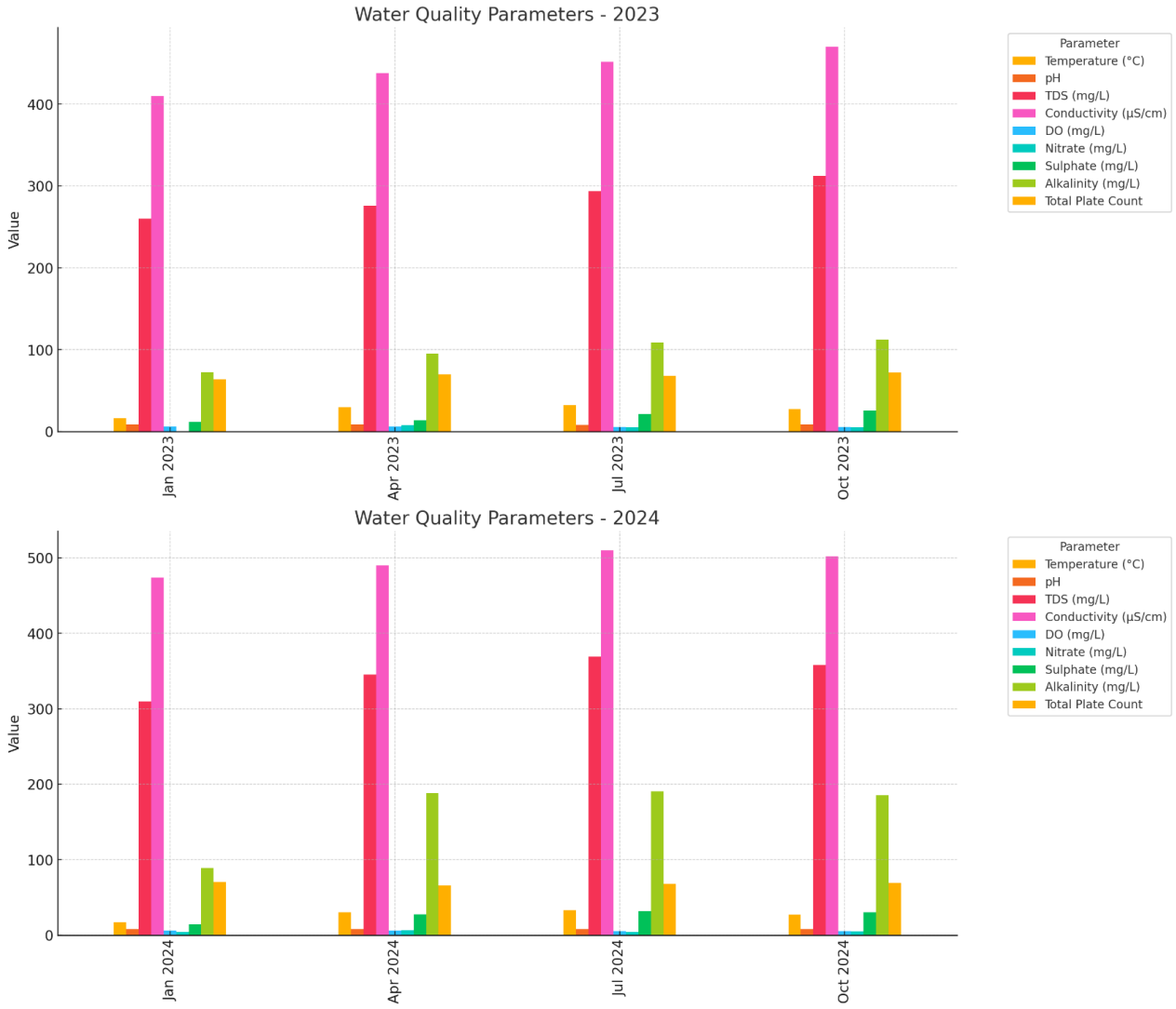
The consistently alkaline pH and high plate counts further suggest active biological processes, possibly driven by algal blooms and sediment nutrient release. While *E. coli* was absent, the high microbial load confirms persistent organic pollution. Declining DO, although still above critical thresholds, may soon reach stress levels for fish, particularly during warmer seasons.

Field observations by local fishers support the scientific data, citing seasonal algal blooms, foul odors, and reduced fish harvests. Together, the trends indicate that Sherpur Pond is in the early to moderate stages of eutrophication, primarily driven by unregulated nutrient input and poor waste management.

To prevent further degradation, integrated management strategies involving community awareness, vegetative buffer zones, and regular monitoring are essential. Without timely intervention, the pond risks ecological collapse and loss of local aquatic biodiversity.

Table showing seasonal variation in water quality parameters of Sherpur Pond (2023-2024)

| Parameter | Jan 2023 | Apr 2023 | Jul 2023 | Oct 2023 | Jan 2024 | Apr 2024 | Jul 2024 | Oct 2024 |
|---|---|---|---|---|---|---|---|---|
| Temperature (°C) | 16.2 | 29.5 | 32.1 | 27.4 | 17.1 | 30.3 | 33.0 | 26.8 |
| pH | 8.6 | 8.47 | 8.3 | 8.5 | 8.17 | 8.1 | 8.03 | 8.22 |
| TDS (mg/L) | 260 | 276 | 294 | 312 | 310 | 345 | 369 | 358 |
| Conductivity (µS/cm) | 410 | 438 | 452 | 470 | 474 | 490 | 510 | 502 |
| DO (mg/L) | 6.2 | 5.9 | 5.7 | 5.5 | 5.9 | 5.6 | 5.5 | 5.4 |
| Nitrate (mg/L) | 0.26 | 7.54 | 4.8 | 5.2 | 4.1 | 6.5 | 4.04 | 4.9 |
| Sulphate (mg/L) | 11.8 | 13.91 | 21.5 | 25.6 | 14.28 | 27.49 | 32.17 | 30.2 |
| Alkalinity (mg/L) | 72.3 | 95.0 | 108.6 | 112.2 | 89.1 | 188.1 | 190.74 | 185.6 |
| E. coli | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| Total Plate Count | 64 | 70 | 68 | 72 | 70 | 66 | 68 | 69 |




## IV. Conclusion

This study provides clear evidence that Sherpur Pond in Muzaffarpur is undergoing early-stage eutrophication, largely due to excessive nutrient input from agricultural runoff, organic waste, and seasonal stagnation. Over the two-year monitoring period, parameters such as Total Dissolved Solids (TDS), nitrate, ammonia, sulphate, and microbial counts showed a consistent upward trend, while dissolved oxygen (DO) levels declined. Although most values remained within permissible limits, their combined effect reflects a gradual degradation of water quality and ecological balance.

The presence of persistent alkaline pH, elevated microbial load, and seasonal nutrient spikes indicate an environment conducive to algal blooms and oxygen depletion. Reports from local fishers regarding reduced fish populations and foul water conditions further validate the scientific findings. If these trends continue unchecked, the pond may experience irreversible ecological damage, threatening biodiversity and the livelihoods of nearby communities.

To mitigate this progression, it is essential to implement sustainable management practices, including the control of nutrient inflows, reforestation of pond margins, proper waste disposal, and active community participation. Regular monitoring and awareness programs can help restore and protect Sherpur Pond, making it a model for conserving small rural water bodies across similar agro-ecological regions.

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