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Chemical Impact of Idol Immersion Activities on Water Quality of Urban Lakes in Bhopal, India

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Abstract- **The present study examines** the **physico-chemical effects of idol immersion activities on the water quality of urban lakes in Bhopal, India, with particular reference to the Upper and Lower Lakes. Idol immersion during religious festivals represents a recurring anthropogenic input that introduces both biodegradable and non-biodegradable materials into lake systems, thereby influencing their chemical characteristics. Water samples were collected from selected immersion sites during pre-immersion, immersion, and post-immersion periods and analyzed for key parameters including turbidity, total hardness, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), and oil and grease using standard analytical methods.**

Result- **The results indicated a marked deterioration in water quality during and after immersion events, reflected by increased turbidity, hardness, BOD, COD, and oil and grease levels. Dissolved oxygen showed a temporary increase during immersion due to physical mixing, followed by signs of increased oxygen demand in the post-immersion phase. The findings demonstrate that idol immersion acts as an episodic chemical stressor contributing to organic and chemical loading, sediment disturbance, and progressive eutrophication of urban lakes. The study emphasizes the need for continuous monitoring and adoption of environmentally sustainable idol immersion practices.**

Keyword- **Physico-chemical effects, Idol immersion, Anthropogenic input, Total hardness, Biochemical oxygen demand (BOD), Chemical oxygen demand (COD).**

I. INTRODUCTION

Urban lakes in India are increasingly threatened by anthropogenic activities such as unregulated sewage inflow, catchment modification, and cultural practices, leading to progressive deterioration of water [1,2]. Religious activities, particularly idol immersion during festivals like Ganesh Chaturthi, have been identified as episodic sources of nutrient and sediment loading, which intensify eutrophication processes in urban lakes [3,4] Recent limnological studies emphasize that materials used in idol construction, including plaster of Paris, synthetic paints, and thermocol, contribute not only to short-term turbidity increases but also to long-term sediment contamination and internal nutrient cycling [5,6] Contemporary research (2022–2024) further indicates that repeated immersion events reduce ecological resilience by disrupting sediment–water equilibrium and enhancing microbial activity, particularly in shallow urban lakes [7,8].

II. STUDY AREA

The present study was conducted in the Upper and Lower Lakes of Bhopal, Madhya Pradesh, India, which are among the most prominent urban freshwater bodies in central India. These lakes have long been recognized for their ecological, historical, and socio-economic significance, while simultaneously being exposed to increasing anthropogenic pressures [3, 9].

The Upper Lake (Bhojtal), constructed in the 11th century by Raja Bhoj, is located between latitudes 23°12′–23°16′ N and longitudes 77°18′–77°23′ E. With a catchment area of approximately 361 km² and a water spread area of about 31 km², it serves as a major source of potable water for the city of Bhopal. Previous studies have documented relatively better water quality in the Upper Lake compared to the Lower Lake, although signs of nutrient enrichment and anthropogenic stress have been increasingly reported [3,5]. The Lower Lake, created in 1794 AD, is situated downstream of the Upper Lake and functions as an integral component of the lake system. It has a comparatively smaller catchment area (9.60 km²) and a water spread area of approximately 1.29 km². Due to its location within densely populated urban surroundings, the Lower Lake receives substantial inflows of untreated sewage, domestic wastewater, and solid waste, leading to severe eutrophication and oxygen depletion [9,10]. Both lakes are easily accessible and are extensively used for idol immersion during major religious festivals, particularly Ganesh Chaturthi and Navratri. Earlier investigations have highlighted idol immersion as a localized but intense disturbance, introducing large quantities of biodegradable and non-biodegradable materials such as plaster of Paris, synthetic paints, metals, and organic offerings into the lake water [11,4]. These activities are spatially concentrated at selected shoreline locations, resulting in site-specific deterioration of water quality.

The cumulative impact of repeated idol immersion events, coupled with urban runoff and sewage inflow, has been shown to accelerate sediment accumulation, nutrient enrichment, and loss of aesthetic value in both lakes [12,13]. Recent limnological assessments emphasize that such culturally driven disturbances, when superimposed on existing urban stressors, significantly reduce the ecological resilience of urban lake ecosystems [1,14]. Therefore, the Upper and Lower Lakes of Bhopal provide an ideal and representative study area for evaluating the environmental impact of idol immersion activities on urban freshwater ecosystems and for understanding their long-term implications under increasing anthropogenic pressure.

III. Material And Method

Study Design and Sampling Framework:

The present study was designed to evaluate the physico-chemical effects of idol immersion activities on lake water quality through a phase-wise sampling strategy, a method widely used in assessing episodic anthropogenic disturbances in aquatic systems [12,7]. Sampling was carried out during three distinct phases to capture both immediate and residual impacts of idol immersion:

- *Pre-immersion phase* – one week prior to immersion activities
- *Immersion phase* – during active idol immersion
- *Post-immersion phase* – approximately fifteen days after completion of immersion

This temporal framework allows assessment of short-term chemical fluctuations as well as delayed effects resulting from organic matter decomposition and sediment interaction [8].

Sample Collection and Preservation:

Surface water samples were collected using standard grab sampling techniques in clean, acid-washed polyethylene bottles following established water quality protocols [15,16]. Prior to collection, sampling containers were rinsed thoroughly with site water to avoid contamination.

Dissolved oxygen samples were fixed immediately at the sampling locations using appropriate reagents to prevent alteration during transport, in accordance with the Winkler method [17]. All samples were transported to the laboratory under controlled conditions and analyzed within recommended holding times to ensure data integrity.

Physico-Chemical Parameters and Analytical Methods:

Water samples were analyzed for selected physico-chemical parameters that serve as sensitive indicators of chemical pollution, organic enrichment, and ecosystem stress associated with idol immersion activities.

- Turbidity was measured using a UV–Visible spectrophotometer and expressed in Formazin Attenuation Units (FAU), reflecting suspended particulate matter and sediment resuspension [18].
- Total Hardness, expressed as mg L^{-1} $CaCO_3$, was determined by EDTA titrimetric methods, indicating changes in ionic composition due to dissolution of calcium- and magnesium-rich materials [15].
- Dissolved Oxygen (DO) was estimated using the Winkler method with azide modification, providing an assessment of oxygen availability for aquatic organisms and biochemical processes [17].
- Biochemical Oxygen Demand (BOD) was determined after incubating samples at 20 °C for five days, representing the concentration of biodegradable organic matter present in the water [16,19].
- Chemical Oxygen Demand (COD) was measured using the potassium dichromate open reflux method, indicating total oxidizable organic and inorganic substances, including non-biodegradable inputs from idol materials and paints [20].
- Oil and Grease content was analyzed using solvent extraction techniques and served as an indicator of anthropogenic chemical inputs from synthetic coatings, decorative substances, and ritual materials [21].

All analytical procedures followed standardized methods, ensuring reproducibility and comparability with earlier and contemporary limnological studies [15,16]

Quality Control and Analytical Precision:

To ensure accuracy and reliability of results, all analyses were performed in duplicate and reagent blanks were run alongside samples where applicable. Analytical-grade reagents and calibrated instruments were used throughout the study. Strict adherence to standard protocols minimized experimental error and enhanced data precision [15].

Data Interpretation Approach:

The generated data were interpreted by comparing variations among pre-immersion, immersion, and post-immersion phases. Observed changes were evaluated in relation to chemical loading, organic enrichment, and sediment disturbance caused by idol immersion activities, as recommended in contemporary water quality assessment frameworks [14,6]

IV. Result And Discussion

The increase in turbidity observed during and after idol immersion reflects sediment resuspension and direct input of particulate matter, a phenomenon commonly reported in Indian urban lakes subjected to cultural disturbances [12,22].

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Elevated turbidity reduces light penetration and promotes nutrient release from sediments, thereby accelerating eutrophication [14].

Dissolved oxygen concentrations showed short-term enhancement during immersion due to physical mixing, followed by stabilization or decline in post-immersion periods. Similar delayed oxygen stress has been documented in tropical urban lakes, where microbial degradation of organic inputs increases oxygen demand [23,7].

Significant increases in BOD and COD during post-immersion periods indicate enhanced organic and chemical loading. Comparable trends have been observed in studies focusing on religious and urban pollution impacts, which report reduced self-purification capacity and increased microbial respiration following such events [2,6] and grease accumulation further reflects anthropogenic inputs and has been linked to surface film formation and chronic ecological stress in lentic systems [24].

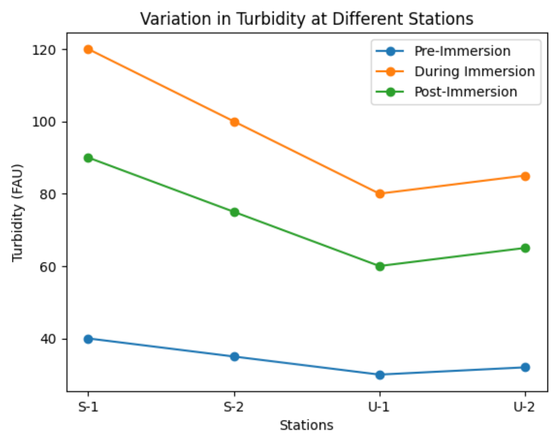

Figure. 1 : Variation in Turbidity at different stations. S-1 : Kalimandir, S-2 : Khatlapura, U-1 : Prempura, U-2 : Sheetal Das ki Bagiya

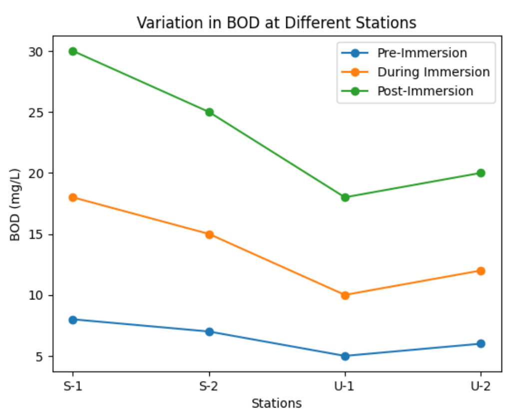

Figure. 2 : Variation in BOD at different stations. S-1 : Kalimandacir, S-2 : Khatlapura, U-1: Prempura, U-2 : Sheetal Das ki Bagiya

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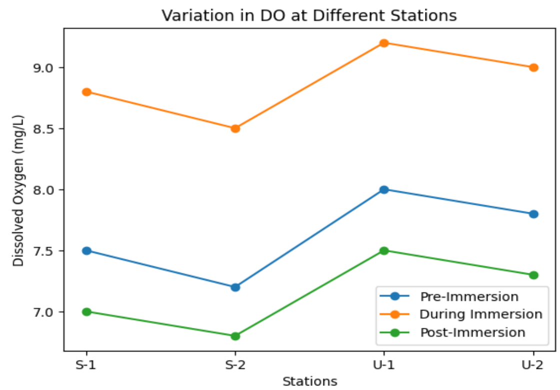

Figure. 3 : Variation in DO at different stations. S-1 : Kalimandir, S-2 : Khatlapura, U-1 : Prempura, U-2 : Sheetal Das ki Bagiya

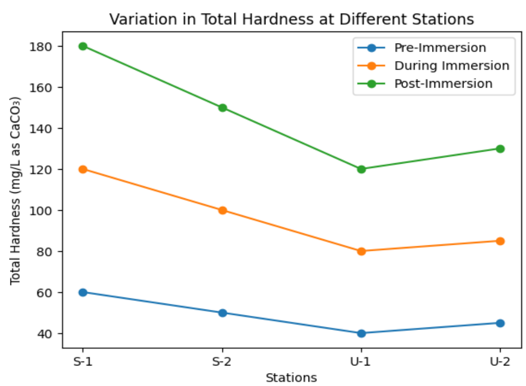

Figure. 4 : Variation in Total Hardness at different station. S-1 : Kalimandir, S-2 : Khatlapura, U-1 : Prempura, U-2 : Sheetal Das ki Bagiya

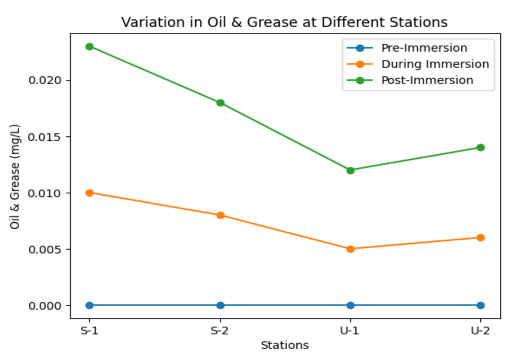

Figure. 5 : Variation in Oil & Gress at different stations. S-1 : Kalimandir, S-2 : Khatlapura, U-1 : Prempura, U-2 : Sheetal Das ki Bagiya

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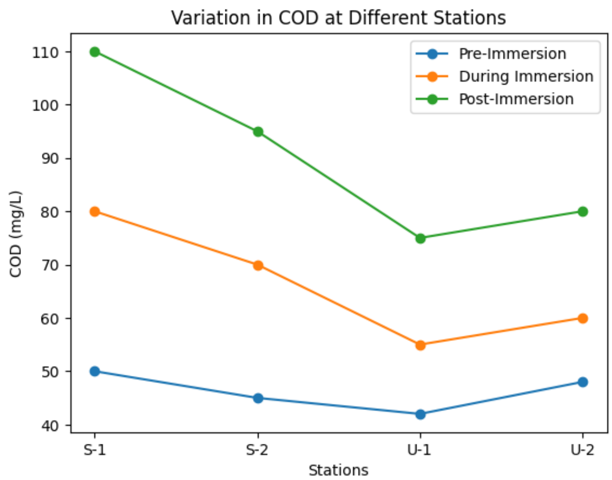

Figure. 6: Variation in COD at different stations. S-1: Kalimandir, S-2: Khatlapura, U-1: Prempura, U-2: Sheetal Das ki Bagiya

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