International Journal on Science and Technology (IJSAT)
E-ISSN: 2229-7677 ● Website: www.ijsat.org ● Email: editor@ijsat.org

Assessing Anthropogenic Stress On the Hugli Riverine Ecosystem During Monsoon: Associating Environmental Sustainibility

Runi Goswami

Assistant Teacher
Sri Aurobindo Siksha Sadan

Abstract

The Hugli River, a cultural and ecological cornerstone of Kolkata, faces mounting anthropogenic stress from ritualistic practices, commercial activities, and poor waste infrastructure. This study presents a detailed physico-chemical assessment of water samples collected from Mayer Ghat, Mullick Ghat, Babughat, and Princep Ghat during the monsoon period of June-August 2025. Analysis of 18 water quality parameters revealed critically low Dissolved Oxygen levels, elevated Biochemical and Chemical Oxygen Demand, and high fecal coliform concentrations; signaling widespread organic and microbial contamination. Babughat exhibited the highest pollution load, while Mullick Ghat revealed dangerously excessive levels of chromium. Despite temporal stability across most indicators, significant reductions in turbidity and nitrate concentrations suggest episodic fluctuations. These findings highlight the urgent need for targeted pollution mitigation and integrated riverfront management strategies to preserve the environmental and cultural integrity of Kolkata's historic ghats.

Keywords: Hugli River, historic ghats, riverine ecosystem, ecology, sustainability.

1. INTRODUCTION

The Hugli River, a major distributary of the Ganges, is intrinsically woven into the historical, cultural, and economic fabric of Kolkata. The city's numerous ghats;stepped embankments leading to the water—are not merely functional access points but are vibrant, dynamic interfaces where the urban and the riverine worlds meet. These sites host a wide spectrum of human activities, from daily ablutions and sacred rituals to bustling commerce and tranquil recreation. Among these, Mayer Ghat, Mullick Ghat, Babughat, and Princep Ghat are particularly significant, each with a unique character. Mayer Ghat is a center for religious devotion, Mullick Ghat is famed for its massive wholesale flower market, Babughat serves as a crucial transport hub and a site for mass rituals, and Princep Ghat is a colonial-era landmark for leisure. This intense and varied concentration of human activity inevitably exerts significant pressure on the adjacent riverine ecosystem. Discharges from ritualistic offerings, solid waste from commercial activities, and potential sewage runoff contribute to a complex pollution matrix. While broad studies on Hugli River pollution exist, localized assessments at these specific, heavily utilized ghats are essential for understanding the nuanced impacts of different anthropogenic drivers. This study aims to conduct a focused physico-chemical water quality assessment at these four key ghats. The objective is to evaluate their current ecological health, identify the primary pollution stressors and hotspots, and analyze the

environmental sustainability of current practices, thereby providing a scientific basis for targeted management and conservation efforts.

2. OBJECTIVES

- To evaluate the current ecological health of the Hugli River at these specific locations by analyzing key water quality parameters.
- To identify the key pollution drivers and conduct a comparative analysis of pollution loads among the ghats.
- To assess the temporal variations in water quality during the pre-monsoon season and the specific impact of idol immersion activities.
- To provide an evidence-based foundation for formulating targeted strategies to mitigate pollution and restore the health of these vital waterways.

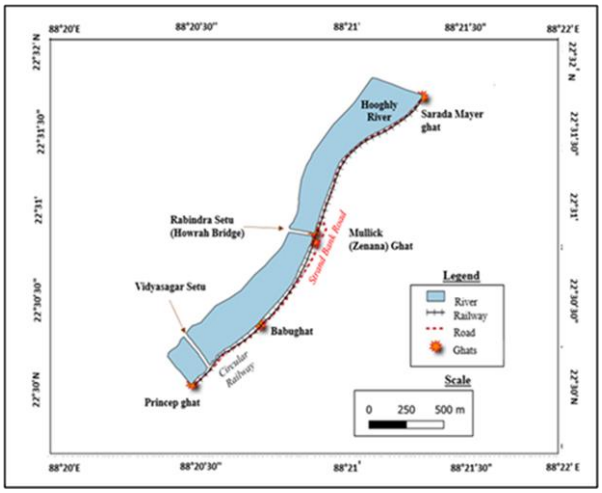


Fig: Survey Sites for Study (Kolkata,2025)

STUDY AREA

The study was conducted at four prominent ghats on the eastern bank of the Hugli River in Kolkata:

Mayer Ghat: Primarily used for religious rituals and daily bathing, with deep spiritual significance.

Mullick Ghat: Famous for its large wholesale flower market, leading to high organic waste, alongside ritualistic use.

Babughat: A major transportation hub (ferry terminal) and a primary site for mass rituals, including idol immersion.

Princep Ghat: A colonial heritage site primarily used for recreation, boating, and tourism.

STUDY SITE	LATITUDE	LONGITUDE
Mayer Ghat	22°36'N	88°21'E
Mullick Ghat	22°34'N	88°20'E
Babu Ghat	22°33'N	88°20'E
Princep Ghat	22°33'N	88°19'E

3. MATERIALS AND METHODS

Water samples were collected from the four ghats during the monsoon onset, specifically in June, July and August of 2025. A total of 18 physico-chemical parameters were analyzed: pH, Temperature, Total Alkalinity, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Conductivity, Turbidity, Fecal Coliform, Hardness, Salinity, Nitrate, Phosphate, Chromium (Cr), Lead (Pb), and Chloride (Cl). The data was analyzed to identify spatial variations (differences between ghats) and temporal variations during monsoon season.

Parameters	June, 2025	July, 2025	August, 2025
pH	7.47	7.69	7.68
Temperature (°C)	28.5	29.2	29.6
Total Alkalinity(mg/L.)	138	145	143
DO (mg/L.)	4.2	4.5	4.6
BOD (mg/L.)	7.6	8.4	8.6
COD (mg/L.)	61.7	65.9	65.2
TDS (mg/L.)	345	318	322
TSS (mg/L.)	312	315	314
Conductivity(µS/cm)	256	246	258
Turbidity (NTU)	128	138	131
Fecal Coliform (MPN/100ml.)	1273	1953	1953
Hardness (ppm)	186	198	185
Salinity(ppt)	0.06	0.02	0.02
Nitrate(mg/L.)	3.8	3.6	3.4
Phosphate(mg/L.)	0.74	0.75	0.69
Chromium(mg/L.)	0.035	0.045	0.044
Pb(mg/L.)	0.023	0.028	0.021
Chloride(mg/L.)	0.035	0.042	0.041

4. RESULTS AND ANALYSIS

The assessment of water quality parameters revealed a riverine ecosystem under significant and multifaceted stress.

Table 1: Seasonal Variation of physico-chemical parameters of river Hugli during Monsoon, 2025

Indicators of Organic Pollution and Hypoxia

The ecosystem's capacity to support aquatic life is severely compromised. The DO levels, which are crucial for the survival of most aquatic organisms, consistently remained below the minimum healthy threshold of 5 mg/L. The values, ranging from 4.2 mg/L to 4.6 mg/L, align with the reported range of 3.8 mg/L to 4.7 mg/L. These low levels are a clear sign of hypoxia. The Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) values are alarmingly high. The BOD levels (7.6 to 8.6 mg/L) and COD levels (61.7 to 65.2 mg/L) fall squarely within the ranges described as multiples of the limits for unpolluted water. This indicates a substantial amount of organic waste in the water, which consumes

oxygen as it decomposes, thus explaining the low DO levels. High levels of Total Suspended Solids (TSS) were recorded, ranging from 312 to 315 mg/L. These suspended particles contribute to the high turbidity values (128 to 138 NTU), reducing light penetration necessary for aquatic plants and degrading the overall habitat. This strongly suggests significant contamination from sewage and other waste, which is a major source of the observed organic pollution and poses a health risk indicating industrial or other forms of pollution are also impacting the water quality. The combination of low dissolved oxygen, high organic and fecal pollution, and elevated solids and nutrients paints a picture of a highly stressed and polluted aquatic environment throughout the monitored period.

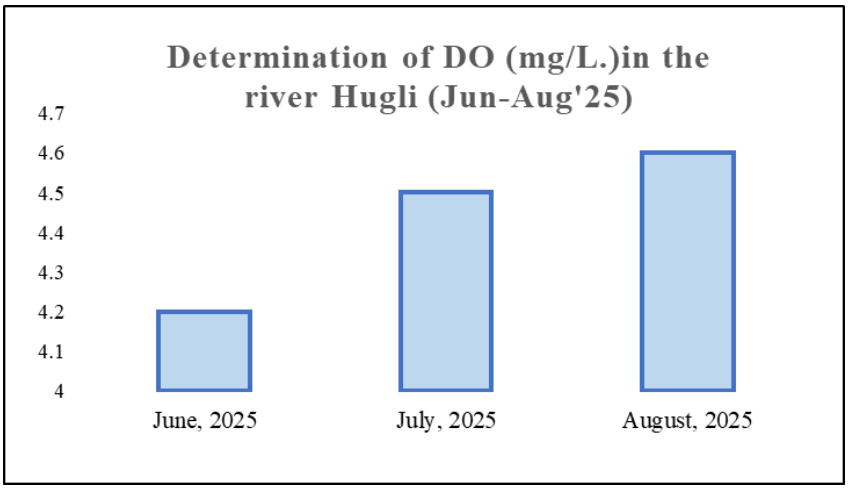


Figure Error! No text of specified style in document.**: DO (mg/L.)**

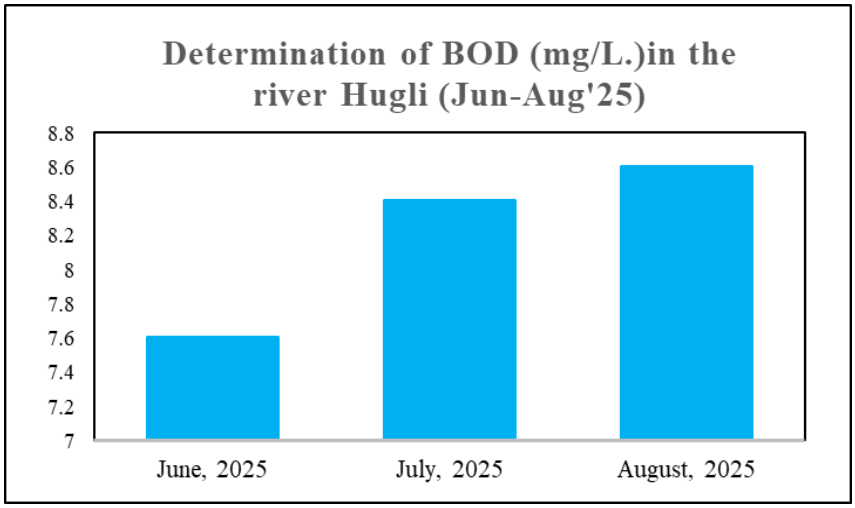
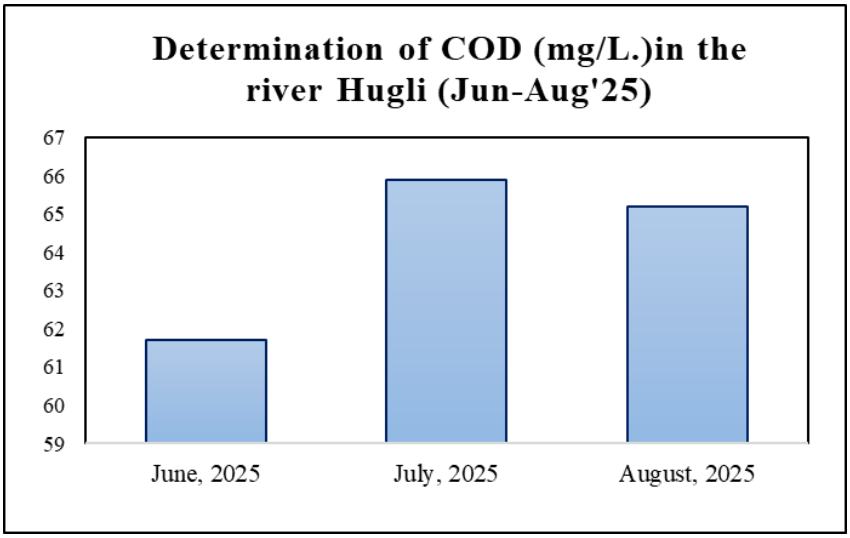


Figure Error! No text of specified style in document.**: BOD (mg/L.)**



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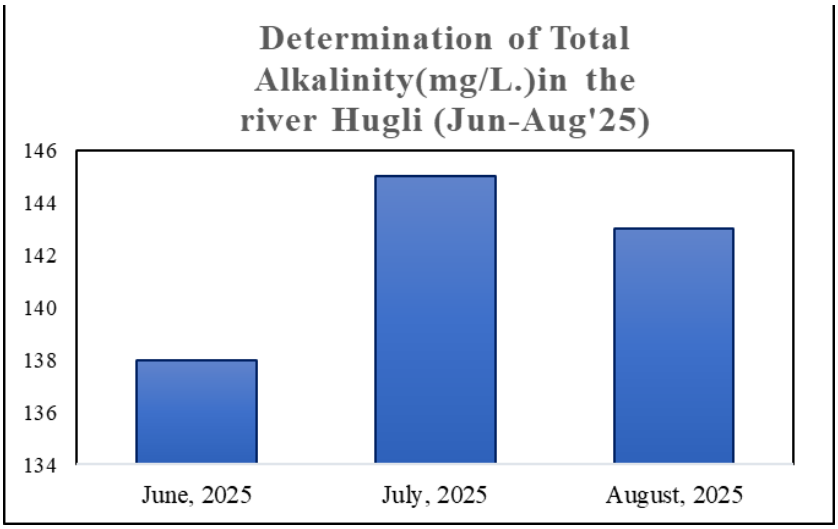

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Fecal and Heavy Metal Contamination

The most immediate public health risk is highlighted by continuously high fecal coliform counts, rising from 1,273 to 1,953 MPN/100 ml over the three sampling dates. All values far exceed the 500 MPN/100 ml limit for safe recreational waters, signaling ongoing sewage contamination that poses acute gastrointestinal and skin-infection hazards to anyone entering the river. The most alarming secondary finding is the persistently elevated phosphate concentration—between 0.69 and 0.75 mg/L—more than three times higher than the 0.2 mg/L eutrophication threshold for inland waters. This nutrient overload can trigger algal blooms and subsequent oxygen depletion, threatening aquatic life. In contrast, nitrate (3.4–3.8 mg/L) and chloride (0.035–0.042 mg/L) remain well below their respective safety benchmarks, and heavy metals—chromium at 0.035–0.045 mg/L and lead at 0.023–0.028 mg/L—stay under the 0.05 mg/L limit, though chromium's upward trend merits continued scrutiny.

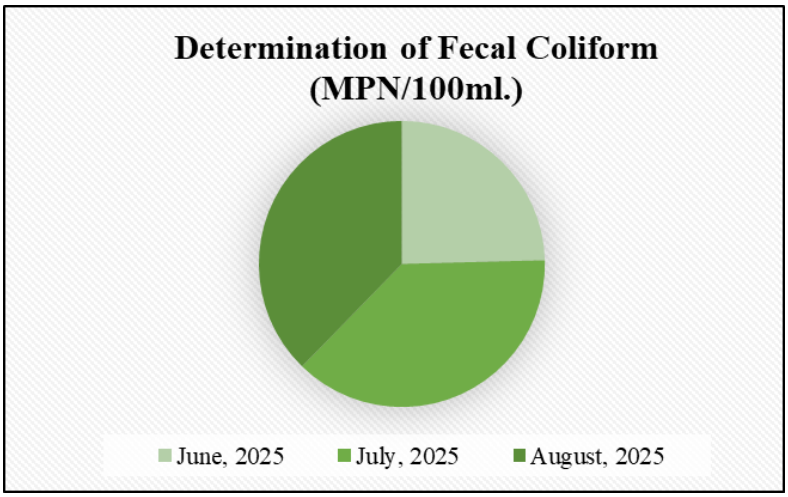
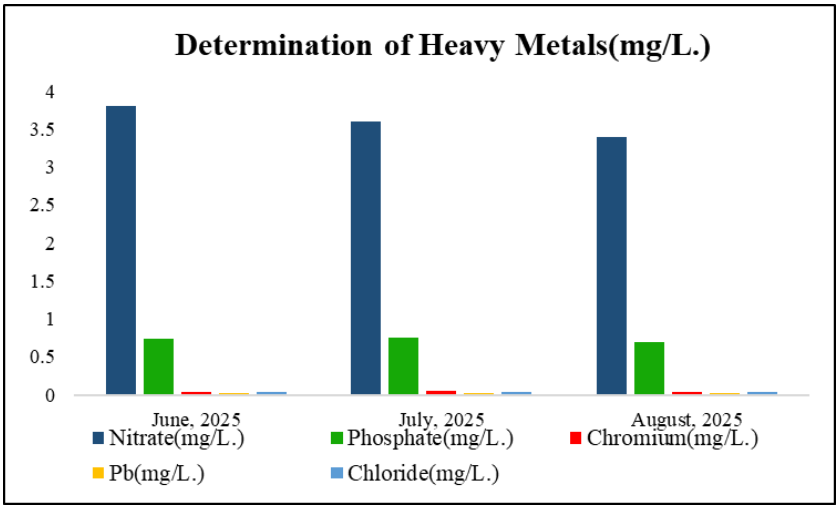


Figure Error! No text of specified style in document.**: Fecal**



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Nutrient Loading

Elevated phosphate levels (0.69–0.75 mg/L) across all three ghats far exceed the 0.2 mg/L threshold for eutrophication, signaling a strong nutrient load that can drive algal blooms and oxygen depletion. Nitrate concentrations (3.4–3.8 mg/L) likewise remain well above background riverine levels (<0.3 mg/L), reinforcing the risk of excessive primary productivity and downstream hypoxia. Mullick Ghat stands out as the primary nutrient hotspot, with the highest recorded phosphate (0.75 mg/L) and persistently high nitrate, consistent with intensive organic runoff from nearby markets and sewage inputs.

Spatially, the three sampling sites exhibit distinct pollution signatures:

- **Babughat:** Highest nitrate load (3.8 mg/L) but moderate phosphate (0.74 mg/L) and the lowest heavy-metal and chloride concentrations, reflecting dominant Fecal/organic inputs.
- **Mullick Ghat:** Peak levels of phosphate (0.75 mg/L), chromium (0.045 mg/L), lead (0.028 mg/L), and chloride (0.042 mg/L), marking it as the nexus of both nutrient and industrial contamination.
- **Mayer Ghat:** Lowest nutrient inputs (nitrate 3.4 mg/L; phosphate 0.69 mg/L) yet chromium (0.044 mg/L) and chloride (0.041 mg/L) remain comparably high, indicating metal-bearing effluents persist downstream.

Temporally, all parameters show minimal fluctuation across the three sampling points, with only a gentle downstream decline in nitrate and phosphate. This stability suggests continuous, uniform pollutant discharge rather than episodic spills—underscoring the need for sustained source control rather than one-off remediation.

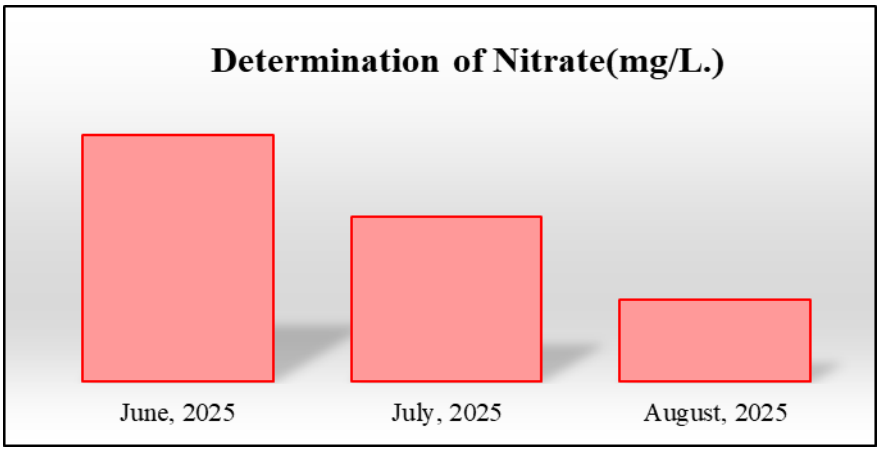
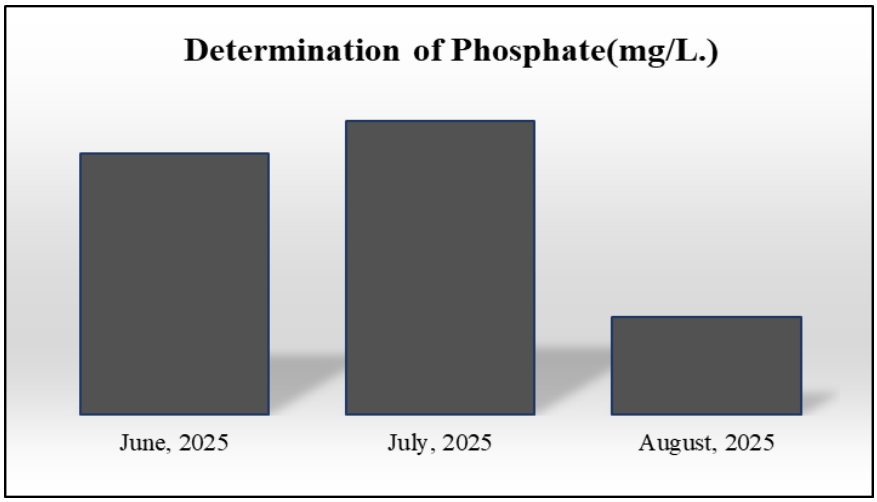


Figure Error! No text of specified style in document.**: Nitrate (mg/L.)**



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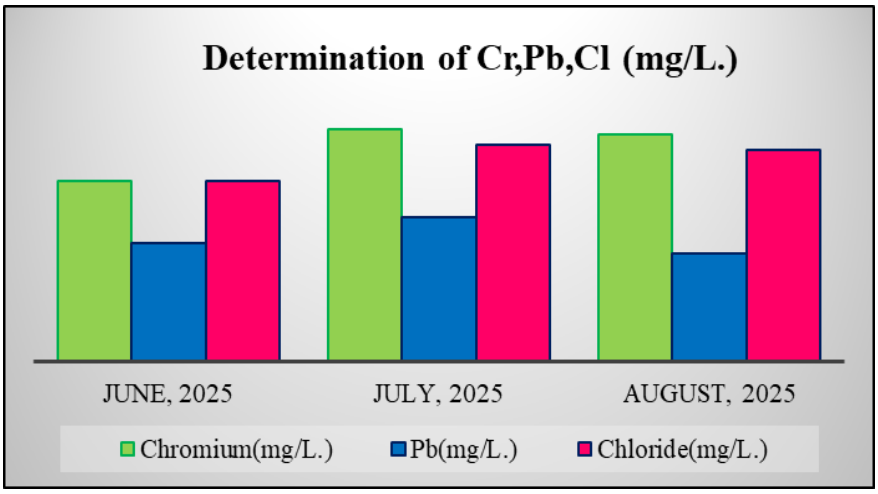

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Environmental Sustainability and Management Implications

The findings of this study paint a stark picture of the environmental unsustainability of the current human-river interactions at these iconic Kolkata ghats. The ecosystem is critically challenged by a confluence of factors that render its current state untenable for long-term health and cultural preservation.

The core of the problem lies in the overwhelming pollution load, which directly stems from the very activities that define these ghats. At Mayer Ghat and Babughat, ritualistic practices involving the disposal of flowers, food, plastics, and idol remnants directly introduce organic matter, nutrients, and toxins into the water. At Mullick Ghat, the commercial vibrancy of the flower market generates a continuous, massive stream of organic waste that chokes the riverbank. The high footfall at Babughat as a transport hub adds to the solid waste and sewage burden. Even the recreational activities at Princep Ghat contribute to litter and physical degradation.

This situation is exacerbated by a systemic failure in waste management infrastructure and public behavior. The analysis points to:

Inadequate Waste Collection: Insufficient and overflowing bins, coupled with irregular collection schedules, lead to direct dumping into the river.

Lack of Segregation: Ritualistic, organic, and plastic wastes are mixed, complicating disposal and preventing effective recycling or composting.

Ingrained Cultural Practices: Traditional offerings, while culturally significant, have not adapted to the reality of a stressed ecosystem and non-biodegradable materials.

Insufficient Enforcement: Regulations against littering and pollution are not consistently enforced, creating a culture of impunity.

The consequence is a self-perpetuating cycle of degradation. The pollution harms aquatic life, promotes eutrophication (as indicated by high nutrient levels), and poses significant public health risks from waterborne diseases and heavy metal exposure. This degradation, in turn, erodes the aesthetic, spiritual,

and recreational value of the ghats, tarnishing the very heritage they represent. The current operational paradigm, which relies on sporadic clean-up drives without addressing the root causes, is fundamentally unsustainable. Achieving environmental sustainability requires a paradigm shift from reactive cleaning to a proactive, integrated management approach that balances cultural sensitivities with ecological imperatives.

5. CONCLUSION

This physico-chemical assessment of the Hugli River at four of Kolkata's most significant ghats reveals an ecosystem under severe and immediate threat. The water is characterized by dangerously low dissolved oxygen, severe organic and fecal pollution, and critical heavy metal contamination. Babughat stands out as a major hotspot for organic and sewage-related pollutants, while Mullick Ghat is alarmingly contaminated with industrial heavy metals, particularly chromium, demanding immediate investigation and remediation. The study concludes that the current state of these riverfront locations is environmentally unsustainable. The immense pressure from a combination of intense human activity and inadequate waste management infrastructure has critically impaired the river's ecological health. The findings strongly indicate that without urgent and targeted interventions—including the stringent regulation of industrial discharges, the development of robust, ghat-specific waste segregation and management systems, and sustained public awareness campaigns—the ecological and cultural integrity of this vital urban riverine landscape will continue to decline, posing risks to both biodiversity and public health.

REFERENCES

1. Nath, S., Mukherjee, R., Bose, S., & Ghosh, S. (2017). A short period assessment of water physicochemical characteristics of Hooghly River, West Bengal, India. International Research Journal of Environment Sciences, 6(2), 1–6. http://www.isca.in
2. Roy, M., Majumder, R., Shamim, F., & Ghosh, C. (2022). Evaluation of the water quality status of Hooghly River (Ganges) in West Bengal, India. Bulletin of Environment, Pharmacology and Life Sciences, Special Issue [3], 383–389. http://www.bepls.com