International Journal of Advance and Applied Research
www.ijaar.co.in
ISSN – 2347-7075 Impact Factor – 8.141
Peer Reviewed Bi-Monthly
Vol. 12 No. 6 July – August 2025

Assessment Of Physicochemical And Microbial Environment Of The Adi Ganga Stream

Rudra Sarker Das[1] & Kaizar Hossain[2]

[1]*A full-time student at TTU K-12, Texas Tech University, Texas Tech Plaza, 1901 University Ave, Lubbock, TX 79401, USA*

[2]*Department of Environmental Science, Asutosh College, University of Calcutta, Kolkata 700026 West Bengal, India*

Corresponding Author - Rudra Sarker Das

DOI - 10.5281/zenodo.17175902

Abstract:

This study investigated the physicochemical and microbial properties of surface water collected from the Adi Ganga stream in Kolkata, India. Its analysis revealed several particularly concerning results. While the pH value was standard and pointed to balanced acidity, other parameters implied significant pollution. Abnormal and alarming values were found for conductivity, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Dissolved Oxygen (DO), and Biological Oxygen Demand (BOD), all of which were well outside the limits for water as recommended by the Central Pollution Control Board (CPCB) of the Government of India. The microbial colonies also had a high concentration, indicating bacterial contamination containing threatening amounts of pathogenic bacteria. The Chemical Oxygen Demand (COD), however, was unusually low, which may indicate a high concentration of non-oxidizable substances or an experimental error. The overall findings indicate that the Adi Ganga stream is heavily polluted, with a hypoxic environment and potentially dangerous bacteria.

Keywords: Adi Ganga, River Stream, Kolkata and Water Pollution

Introduction:

The Adi Ganga stream, a distributary that flows from the river Hooghly to the Bay of Bengal via the river Piyali (Bhattacharya, et al 2023), is one of Kolkata's most historically and culturally significant waterways. Viewed as the original path of the famous Ganges River by local tradition, it is said that by its banks the ascetic Jangal Gir was told by the Hindu deity Kali to build the holy site of Kalighat, which has for centuries thereafter served as a prominent pilgrimage site in eastern India. The stream is also mentioned in medieval Bengali Mangal Kavyas, where it features as a sacred brook, and its banks were later noted by Portuguese traders and travelers (Kapoor 2006). During the colonial era, the East India Company incorporated the Kalighat region and adjoining stretches of the Adi Ganga into the city of Kolkata, a move that enhanced its economic and strategic importance. The river's relevance resurfaced again in modern times, when it became a settlement site for thousands of refugees during the Bangladesh Liberation War of 1971 (Bhattacharya et al., 2023).

In its early history, the Adi Ganga derived its importance from its connections

to the pilgrimage routes to Kalighat. Nonetheless, by the 16th century, Portuguese traders began to use it as a major stream to transport goods and cargo. Even before their conquest of Bengal, the Adi Ganga would additionally come under British importance when in 1775, Major Tolly appealed to the administration to construct a canal known as Tolly's Nullah between Hooghly and the salt lakes in the region. This canalization transformed the river into an important artery of colonial commerce as depicted in **Figure 1**, contributing to the Bengal economy that supplied nearly 44% of British India's revenue (Kapoor, 2006). However, with the rise of the railways in the 19th century, the Adi Ganga's commercial importance diminished. Urban expansion and poor drainage gradually converted it from a vibrant distributary into a polluted *nullah*, laden with sewage and industrial effluents. Today, while many locals still regard the waterway as sacred, the river itself suffers from acute ecological degradation and public health hazards.

Figure 1: *The Adi Ganga in the late 1800s (Samuel Bourne, India No. 1714)*

The deterioration of the Adi Ganga is not simply an ecological crisis but also a socio-anthropological one. The river often floods into adjoining settlements, spreading waterborne diseases such as diarrhea, hepatitis, and encephalitis (Mandal, 2018). Illegal settlements of impoverished migrants along its banks depend heavily on its contaminated waters for daily activities such as bathing, washing utensils, and sanitation, thereby perpetuating cycles of disease and death. Despite municipal attempts at periodic cleanup, untreated sewage, solid waste, and industrial discharge continues to overwhelm the river. The situation is further aggravated by the development of antibiotic- and metal-resistant bacteria within its waters, posing significant risks not only to local communities but also to adjacent aquifers and wider public health systems (Ghosh et al., 2021).

Over the past decade, a growing body of scientific literature has examined the physicochemical and microbial condition of the Adi Ganga. Hydrogeochemical studies have revealed low dissolved oxygen, high biological oxygen demand, turbidity, oil and grease accumulation, and heavy metal

contamination, confirming severe anthropogenic stress on the ecosystem (Ghosh et al., 2019; Bhattacharya et al., 2018). Microbial analysis has shown dangerously high concentrations of coliform and vibrio bacteria (Bhattacharya et al., 2018), while multi-metal and antibiotic resistance studies highlight the proliferation of highly resistant microbial strains capable of gene transfer (Ghosh et al., 2021). Anthropological surveys have linked this degradation to rapid urbanization, encroachment, and poor waste management, underscoring the intertwined human and ecological dimensions of the crisis (Mandal, 2018; Maitra et al., 2022).

Given this convergence of historical significance, cultural reverence, ecological degradation, and public health risk, the Adi Ganga emerges as a unique case study of a river system at the crossroads of heritage and hazard. Though previous studies have already performed analysis on the river, this study seeks to reinforce and continue that work by documenting physicochemical and microbial parameters of the Adi Ganga stream within the core of Kolkata as recorded in May of 2025, opening the door for further, temporally stratified analysis to better understand the extent of its degradation and identify potential pathways for restoration. Common scientific knowledge suggests that pollution in the river will undergo seasonal variation depending on the rainfall, amount of sunshine *etc.* throughout the year. This is an aspect that has hitherto not been explored so far in the literature. The results, if found to be highly sensitive to seasonal effects, might have profound implications on the recommendations of human activities in the river environs. Though the current investigation pertains to a single set of measurements taken in the month of May, it is envisioned that similar tests will be carried out in the future to accurately capture the seasonal effects on the river pollution. Furthermore, the current local site from which the sample was taken is gradually experiencing an increase in human activities. As a result, the investigation is very timely as it can provide relevant data for useful recommendations for nearby human settlements that are likely to increase in the near future.

Materials & Methods:

Study Area:

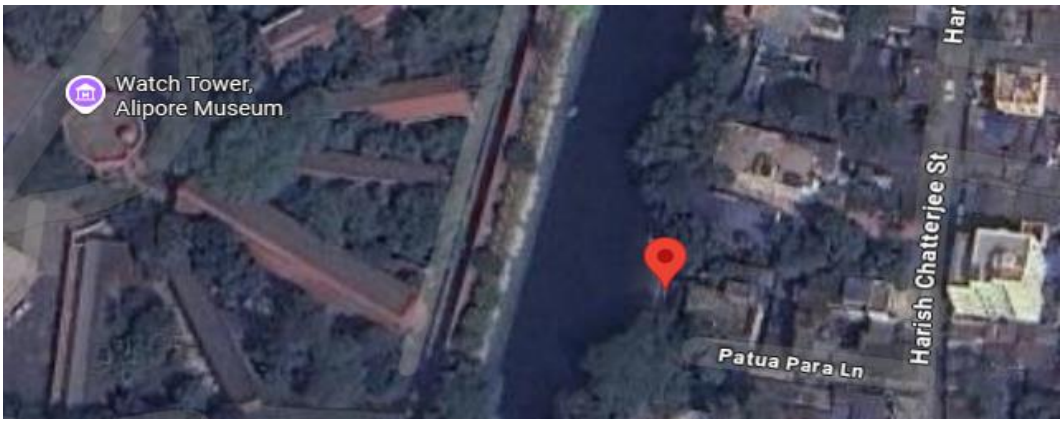

Figure 2: Latitude, Longitude of the sample collection site: 22°31'30.0"N 88°20'27.5"E

Figure 3: *Photo of sample collection at study area*

The water sample was collected in Kalighat, Kolkata, West Bengal, India as indicated in **Figures 2** and **3**. It was then brought to the Asutosh College laboratories measuring various parameters as per American Public Health Association (APHA) guidelines. These parameters include *pH, conductivity, total dissolved solids (TDS), total suspended solids (TSS), hardness, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD),* and *microbial colonies*.

- *pH* was measured using a calibrated pH meter that utilized an electrode in buffer solution.
- *Conductivity* was quantified with a conductometer that utilized standard KCl calibration.
- *TDS* and *TSS* were determined by their respective processes involving filtration, drying, and weighing.
- *Hardness* was measured via EDTA titration using an EBT indicator.
- *DO* & *BOD* utilized Winkler's method (initially for DO vs. 5-day incubation at 20 °C for BOD) for measurement.
- *COD* was analyzed by dichromate oxidation and titration using ferrous ammonium sulfate.
- The *amount of microbial colonies* were estimated via serial dilution, agar plate incubation, and colony counting.

Results and Discussion:

Table 1 illuminates the values of the measured properties of the water sample while **Figures 4** and **5** plot these values as contrasted to the guideline limits in bar diagrams.

Table 1: Measurements of Water Sample

Property Measured	Final Value
pH	7.0
Conductivity	4,032 µS/cm
Total Dissolved Solids	817.7 mg/L
Total Suspended Solids	124 mg/L
Hardness	117.25 $CaCO_3$ mg/L
Dissolved Oxygen	1.2 mg/L
Biological Oxygen Demand	64.75 mg/L
Chemical Oxygen Demand	1.6 mg O_2/L
Microbial Colonies	30,000 CFU/mL

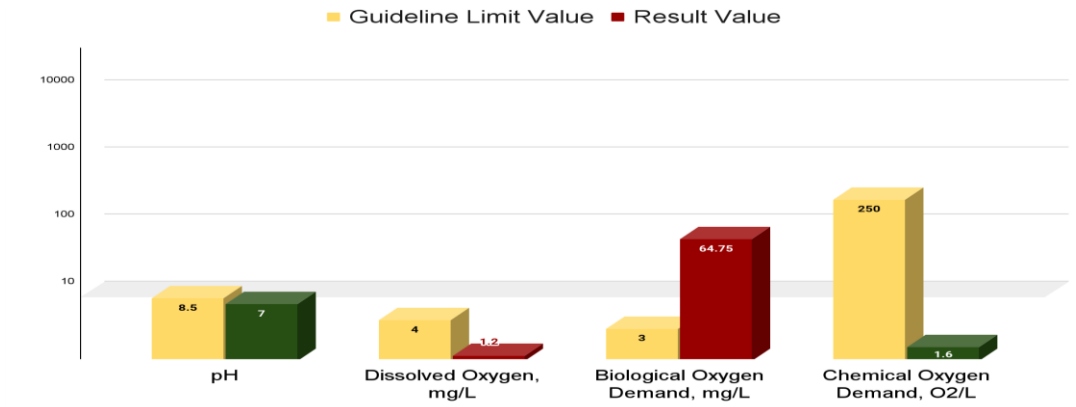

Figure 4: Measurements and corresponding guideline limit values. **Green color denotes compliance while red color denotes outside limits.**

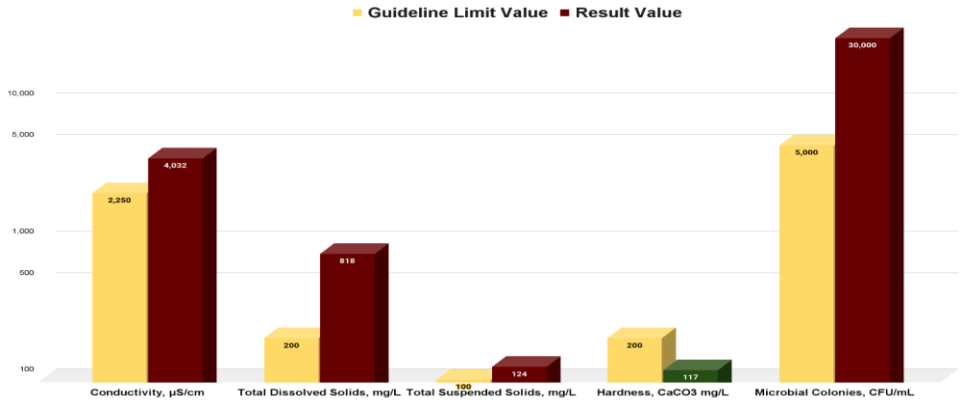

Figure 5: Measurements and corresponding guideline limit values. Green color denotes compliance while red color denotes outside limits.

The analysis of Adi Ganga water (Kalighat, Kolkata) reveals multiple parameters lying outside the permissible range set by the Central Pollution Control Board (CPCB). What follows below is a critical examination of each of the measured values against its acceptable range with possible implications on human health and environmental pollution.

- The conductivity is much higher than even industrial standards which have a maximum of 2250 µS/cm. This indicates a heavy degree of conductive materials have contaminated the water.
- The dissolved oxygen is lower than the limits for drinking or fishery water set at a minimum of 4 mg/L, which causes hypoxic conditions not suitable for most life.
- The BOD is much larger than the limit of 3 mg/L, indicating heavy organic pollution that has depleted the oxygen content, corroborating the low dissolved oxygen as indicating an aquatic environment that is unable to suit most life.
- The TDS is greater than the limit of 200 mg/L, reflecting an unsafe amount of dissolved substances in the water.

- The measured microbial colonies of 30,000 CFU/mL make it highly likely that the water sample exceeds the limits of coliform bacteria set at 5,000 mpn/100mL (Water Quality Criteria), indicating that the water is too contaminated by pathogens to be safe for human consumption.
- The TSS is also higher than the standard limit for inland water at 100 mg/L (The Environmental Rules), pointing to an unsafe amount of suspended solids within the water.
- However, the hardness still falls within the acceptable limits of 200 $CaCO_3$ mg/L, indicating the magnesium and calcium levels do not pose any danger.
- The pH is also standard and safe as it lies within the range of 6.5 to 8.5 (Drinking Water Specification), which means the water is not dangerously acidic or basic.
- The COD value is far below the limit of 250 O_2 mg/L (The Environmental Rules), and the fact that the value is even lower than the BOD would indicate a unique situation: certain chemicals, metals, or salts that have entered the water may not oxidize properly. However, it is also possible that there may have been an experimental error.

While pH and hardness remain within acceptable ranges, almost all other parameters like the conductivity, solids, oxygen demand, and microbial load greatly exceed CPCB standards. The results confirm severe pollution, consistent with earlier findings (Bhattacharya et al,, 2018; Ghosh et al., 2019), making the water unfit for human use or aquatic life without extensive treatment.

Conclusion:

The measurement and analysis conclude that the Adi Ganga River is highly polluted, having been turned into a dumping ground for sewage and similar waste. Many of its physicochemical parameters and much of its microbial environment have been disrupted. While certain parameters such as pH and possibly COD may be within acceptable limits, the others, including conductivity, TSS, TDS, DO, BOD and microbial colonies, violate pollution control limits. These results indicate the contamination of the river via toxic, conductive, and oxidizable materials and a nearly extinct aquatic ecosystem. Furthermore, the large amount of microbial colonies indicate a heavy concentration of pathogens in the stream, indicating that its water is dangerous for human consumption. Overall, in harmony with previous studies, the results suggest the Adi Ganga water is incredibly toxic, unable to sustain ecological systems, and unsafe for human use. Future measurements at different times of the year can illuminate the variation of the amount of pollution at the same site, thereby providing more data to either buttress or undermine the current claims.

Acknowledgements:

One of the authors, Rudra Sarker Das, is particularly thankful to Asutosh College, Calcutta University (India) for giving permission to utilize infrastructures

and the laboratory facility throughout his research work.

References:

1. Bhattacharya, S., Roy, S., Banerjee, S., & Lahiri-Dutt, K. (2023). Reifying "river": Unpacking pluriversal possibilities in rejuvenation surrounding the Adi Ganga of Kolkata. Frontiers in Water, 5, 1–13. https://doi.org/10.3389/frwa.2023.1070644
2. Bhattacharjee, A., & Bose, S. (2018). A comparative study of microbial status and dissolved heavy metals in River Ganga. Unpublished manuscript. https://www.academia.edu/36888667/A_comparative_study_of_Microbial_status_and_Dissolved_Heavy_Metals_in_River_Ganga
3. Bureau of Indian Standards. (2012). Drinking water — Specification (Second Revision). https://cpcb.nic.in/wqm/BIS_Drinking_Water_Specification.pdf
4. Central Pollution Control Board. (2019). Water quality criteria. Government of India. https://cpcb.nic.in/water-quality-criteria/
5. Ghosh, S., Bera, A., De, S., & Jana, J. (2019). Assessment of the effect of urban pollution on surface water–groundwater system of Adi Ganga, a historical outlet of river Ganga. Chemosphere, 237, 124–132. https://doi.org/10.1016/j.chemosphere.2019.124507
6. Ghosh, S., Bera, A., De, S., & Jana, J. (2021). Impact of microbial multi-metal and broad spectrum antibiotic tolerance in urban surface water (Adi Ganga, Kolkata) on adjacent groundwater: A future threat. Groundwater for Sustainable Development, 14, 100608. https://doi.org/10.1016/j.gsd.2021.100608
7. Kapoor, P. (2010). Animating the Adi Ganga (Master's thesis, Massachusetts Institute of Technology, Department of Architecture). https://core.ac.uk/download/pdf/4423795.pdf
8. Maitra, P., Guha, M., & Bhattacharya, M. (2022). Destruction of Tolly Nullah leading to increasing vulnerability of the surrounding population. International Journal of Social Science and Economic Research, 7(5), 1153–1172. https://doi.org/10.46609/IJSSER.2022.v07i05.001
9. Mandal, A. (2018). Use of river water by the encroachers and related problems: A case study of the Adi Ganga River, Kolkata, West Bengal, India. American International Journal of Research in Humanities, Arts and Social Sciences, 21(1), 105–110. https://www.researchgate.net/publication/328494900
10. Ministry of Environment and Forests, Government of India. (1986). The Environment (Protection) Rules. https://cpcb.nic.in/generalstandards.pdf