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RECENT WATER QUALITY ASSESSMENT OF BURIGANGA AND TURAG RIVER

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Abstract

The Buriganga and Turag rivers are two of the most vital rivers in Bangladesh. Over the past 10-15 years, both rivers have suffered significantly from wastewater pollution. The main threat to their water quality is the discharge of untreated wastes due to their proximity to densely populated areas. Inadequate wastewater management is the key factor behind this pollution. Monitoring various physicochemical parameters such as pH, TDS, TSS, EC, BOD, COD, and alkalinity is essential to assess water quality. This study aims to evaluate the water quality of these rivers by analyzing key parameters and comparing them with standard values. Equipment-based methods were used to determine parameters like pH, TDS, TSS, and EC, while others were measured manually. The TDS levels range from 482 mg/L to 330 mg/L for the Turag River and 381 mg/L to 259 mg/L for the Buriganga River. The BOD values are between 112 and 165 mg/L for the Turag River, and 75 to 174 mg/L for the Buriganga River, indicating unsuitability for aquatic life. Although electrical conductivity remains within acceptable limits, water alkalinity shows significant deviations from standard values.

Keywords: Turag river, waste management, Water parameters, Water quality, Physiochemical analysis

1. Introduction

Water pollution has become a critical issue, especially in urban areas where industrialization and population growth are rampant [1], [2]. In recent years, the water quality of rivers in Bangladesh has significantly deteriorated due to the unregulated discharge of pollutants from industries, households, and other anthropogenic sources [3], [4]. Rivers like the Buriganga and Turag have been heavily impacted by pollution, leading to alarming levels of contamination [3], [5]. Polluted river water poses serious threats to public health and aquatic ecosystems. The presence of harmful chemicals, heavy metals, and organic pollutants poses significant threats to both human health and aquatic ecosystems [6].

The recent decline in river water quality is particularly evident in the Buriganga and Turag rivers [7], [8]. Both rivers have been heavily impacted by the unchecked dumping of industrial effluents and municipal waste over the past decade [8]. This pollution has resulted in dangerously high levels of contaminants, making the water unsafe for consumption, agricultural use, and aquatic life [2], [5]. Polluted river water is hazardous because it contains toxic substances such as heavy metals (lead, mercury, chromium) and organic materials that deplete dissolved oxygen levels [4], [9]. This creates an environment conducive to harmful bacteria growth, leading to the spread of waterborne diseases like cholera, diarrhea, and skin infections. Furthermore, the contamination of fish and agricultural products threatens food security and poses long-term health risks [10].

In the past 10-15 years, the Buriganga and Turag rivers have become victims of this worsening pollution crisis. Once considered vital lifelines for the communities along their banks, these rivers are now heavily polluted due to the dumping of industrial waste and household sewage [3], [4], [8], [11]. Dhaka's rapid industrialization has led to the establishment of numerous factories along the riverbanks, particularly tanneries, textile mills, and chemical factories [9]. Many of these industries discharge their wastewater directly into the rivers without adequate treatment. For instance, the Buriganga River, with over 250 tanneries on its banks, faces severe levels of chromium and other toxic chemicals. Similarly, the Turag River, which runs adjacent to major industrial hubs like Konabari, sees fluctuating levels of toxicity depending on the season, with contamination peaking during the dry months when water flow decreases, concentrating the pollutants [8], [11], [12].

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The consequences of this pollution are wide-reaching. The heavy contamination has devastated fish populations, leading to a decline in the local fishing industry and affecting the livelihoods of communities that depend on the river. The water is no longer safe for irrigation, leading to reduced agricultural yields and potential health risks for consumers of contaminated crops [13], [14]. The people living near the Buriganga and Turag rivers are directly impacted, facing health problems such as respiratory issues, skin diseases, and even long-term diseases like cancer due to exposure to toxic pollutants [10], [11].

In this study, we focus on measuring key physicochemical parameters such as Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Total Dissolved Solids (TDS), and Total Suspended Solids (TSS). These parameters are essential for assessing the extent of pollution in the rivers. COD and BOD levels in both rivers have far exceeded the acceptable limits, indicating a high concentration of organic matter and reduced oxygen levels. The presence of heavy metals and toxic chemicals further complicates the situation, as these pollutants pose long-term ecological and health risks.

2. Materials and Methodology

Five water samples were collected from various locations along both the Buriganga and Turag rivers (Table 1). The samples were stored in pre-cleaned plastic bottles and kept at approximately 4°C in the laboratory for analysis. The pH of each sample was measured using a HANNA pH meter. The probe was inserted into a beaker containing the sample, and after allowing the meter to stabilize for 10-15 seconds, the pH reading was recorded along with the temperature. The electrical conductivity (EC) of the water was measured by dipping the conductivity meter probe into a well-stirred sample, and readings were taken after stabilization.

To measure dissolved oxygen (DO), a calibrated DO meter was used. The samples were prepared by ensuring no visible debris was present, and the probe was immersed in the water sample until stabilization, after which the DO value was recorded in mg/L or ppm. For the Biological Oxygen Demand (BOD) test, 300 mL BOD bottles were inoculated with specified volumes of the sample (0.25 mL, 0.5 mL, or 1 mL) and diluted with water to a total volume of 300 mL. Winkler reagent was added to ensure a complete reaction with the oxygen demand. The bottles were incubated in the dark at 20°C for five days. After the incubation period, the final DO concentration was measured using a DO meter, and BOD_5 was calculated using the formula:

BOD_5 = ((Initial DO - Final DO - Correction factor) /(sample volume) ×300.

Depletion in DO in 5 days, Y = DO of the sample (mg/L) – DO of blank. BOD at 20°C (mg/L) = Vol. of bottle X Y / vol. of sample taken.

For Chemical Oxygen Demand (COD) testing, 1 mL of the water sample was diluted to 100 mL with distilled water. A 2 mL portion of the diluted solution was taken and mixed with 3.5 mL of sulfuric acid and 2 mL of potassium dichromate solution. The mixture was digested at 150°C for two hours. After cooling, the absorbance of the solution was measured at 525 nm using a spectrophotometer, and COD was calculated using a pre-calibrated equation: COD = 4204.948 * X * dilution factor + 13.8657, where X represents the absorbance.

For acidity measurements, 100 mL of water was titrated using 1.6 N H_2SO_4, with phenolphthalein and Bromocresol green used as indicators. The endpoint was determined by the color change from green to grey. The acidity was calculated by multiplying the titration result by the appropriate digit multiplier. Similarly, for alkalinity, 20 mL of the water sample was titrated with 1.6 N NaOH, using phenolphthalein as the indicator. The endpoint was reached when the solution turned light pink for 30 seconds, and the alkalinity was calculated by multiplying the titration result by a digit multiplier (5).

3. Results and Discussion

The results of this study provide insight into the current water quality of the Buriganga and Turag rivers, highlighting key parameters such as pH, Total Dissolved Solids (TDS), Electrical Conductivity (EC), alkalinity, acidity, Biological Oxygen Demand (BOD), and Chemical Oxygen Demand (COD). The data collected from different locations along both rivers suggest that water quality has been severely impacted by industrial activities, urban runoff, and untreated waste.

The continuous discharge of untreated industrial and domestic waste into the rivers has been identified as a primary factor contributing to these pH levels.

Table 1: Sample Locations of the Rivers Turag and Buriganga

Sample name	Sampling Locations, Turag	Sample name	Sample Locations, Buriganga, Dhaka

T-1	Near Fulpukuria Thread & Accessories Ltd., Tongi, Gazipur	B-1	Pagla Ghat
T-2	Tongi Rail Bridge, Gazipur	B-2	Postogola Bridge
T-3	Ashulia Kacha Bazar	B-3	Sadarghat Launch Terminal
T-4	Ashulia Landing Station	B-4	Chandir Ghat
T-5	Diabari Ghat, Mirpur Road	B-5	Kholamora Ghat, Kamranghirchar

The pH variations along the Turag and Buriganga rivers are shown in Figure 1. A slight variation of pH levels of the water samples from both the Buriganga and Turag rivers was observed. For the Turag River, the pH ranged from 7.28 to 7.71, reflecting a slightly alkaline nature. In contrast, the Buriganga River exhibited pH values ranging from 6.92 to 7.35, indicating that the water is generally neutral to slightly acidic. Despite these differences, the variation in pH between the samples is relatively small and may not significantly impact the overall properties or behavior of the water[15].

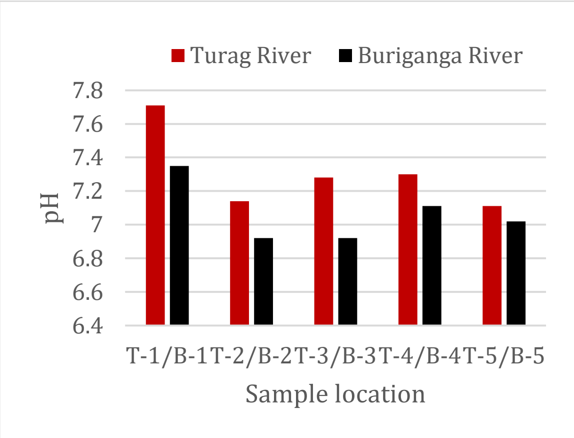

Figure 1: The pH levels for both the Turag and Buriganga rivers

Figure 2 represents the TDS value for both the Turag and Buriganga river. TDS values, an important indicator of water pollution, ranged from 482 mg/L to 330 mg/L for the Turag River and 381 mg/L to 259 mg/L for the Buriganga River, suggesting a significant presence of dissolved substances such as salts and minerals. These relatively high values are typical for urban rivers, reflecting the impact of human activities and industrial discharge. Elevated TDS levels can disrupt the osmoregulation of aquatic organisms, reducing the river's capacity to support biodiversity [7], [16]. TDS concentrations were generally higher during the dry season compared to the wet season, as water scarcity in the dry season leads to a greater accumulation of dissolved solids. The values observed in both rivers align with the expected range for rivers in heavily urbanized areas, further emphasizing the influence of industrial and domestic waste on water quality.

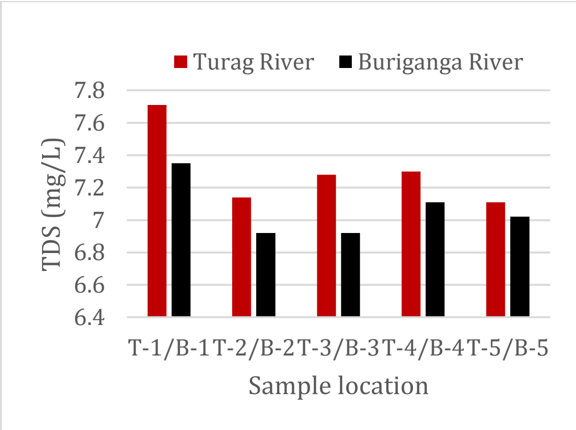

Figure 2: The TDS value for both the Turag and Buriganga rivers

Figure 3 represents the Electrical Conductivity (EC) value for both the Turag and Buriganga river. EC, which indicates the concentration of dissolved ions in water, was recorded at a maximum of 970 µS/cm for the Turag River and 760 µS/cm for the Buriganga River. While the typical EC range for freshwater is between 50 and 1500 µS/cm, with values above 2000 µS/cm considered brackish or saline [17], the levels observed in both rivers fall within the freshwater range but are notably high. These elevated values suggest a significant presence of ionized pollutants, likely due to industrial discharge [18]. Research has shown that high EC levels can contribute to aquatic toxicity, particularly in environments exposed to industrial pollution from metal processing, cement, water processing and chemical industries[18], [19].

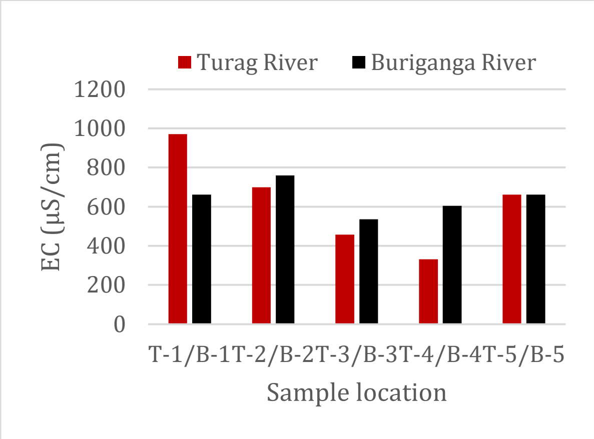

Figure 3: the Electrical Conductivity for both the Turag and Buriganga Rivers

Alkalinity, another important water quality parameter, showed significantly higher levels in both Turag and Buriganga rivers. Figure 4 shows the analyzed values. The Turag River had alkalinity values ranging from 256 mg/L to 552 mg/L, while the Buriganga River ranged from 213 mg/L to 306 mg/L with higher values recorded during the monsoon season when the river flows were higher. These elevated levels indicate a high concentration of bicarbonate, carbonate, and hydroxide ions, which can affect the buffering capacity of the water. High alkalinity can also interfere with the reproduction and growth of aquatic organisms [16], [20].

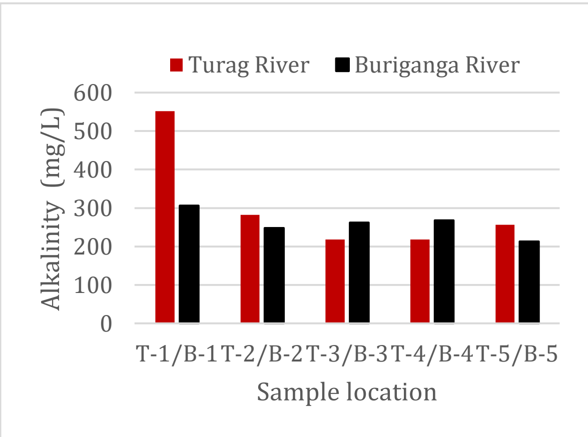

Figure 4: The alkalinity for both the Turag and Buriganga Rivers

Figure 5 shows the acidity for both the Turag and Buriganga Rivers. Acidity values for the Turag River ranged from 35 mg/L as $CaCO_3$ to 225 mg/L as $CaCO_3$, while the Buriganga River exhibited acidity values from 25 mg/L as $CaCO_3$ to 240 mg/L as $CaCO_3$. These findings are well above the World Health Organization's recommended limit of 20 mg/L for freshwater bodies [21], indicating the presence of acidic pollutants, likely due to industrial discharge, agricultural runoff, and untreated sewage.

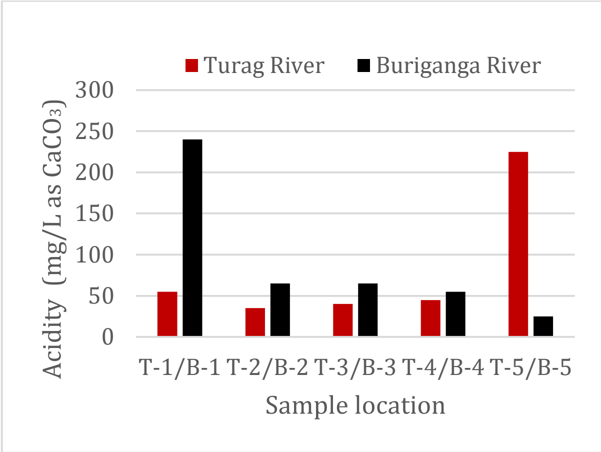

Figure 5: The acidity for both the Turag and Buriganga Rivers

Figure 6 indicates a comparison of BOD_5 values between the Turag River and Buriganga River. The BOD values, which reflect the amount of biodegradable organic material in water, ranged from 112 mg/L to 165 mg/L for the Turag River and 75 mg/L to 174 mg/L for the Buriganga River. These high BOD levels suggest that both rivers are heavily polluted with organic waste, leading to oxygen depletion, which is detrimental to aquatic life. The high BOD values indicate poor water quality and pose serious ecological risks [1], [22].

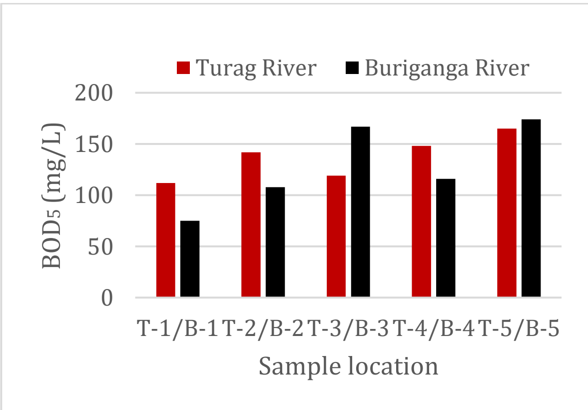

Figure 6: Comparison of BOD_5 values of the Turag and Buriganga Rivers

Similarly, the COD levels, which represent the total amount of oxygen required to oxidize both organic and inorganic compounds in water, were also found to be alarmingly high. Figure 7 shows the values for both Turag and Buriganga Rivers. For the Turag River, COD values ranged from 224 mg/L to 350 mg/L, and for the Buriganga River, the values ranged from 140 mg/L to 388 mg/L. These findings indicate the presence of a high concentration of oxidizable pollutants in the rivers, further supporting the evidence of extensive pollution. A previous study reported similar COD values, attributing them to industrial effluents from tanneries, textiles, and metal-processing units [17], [22].

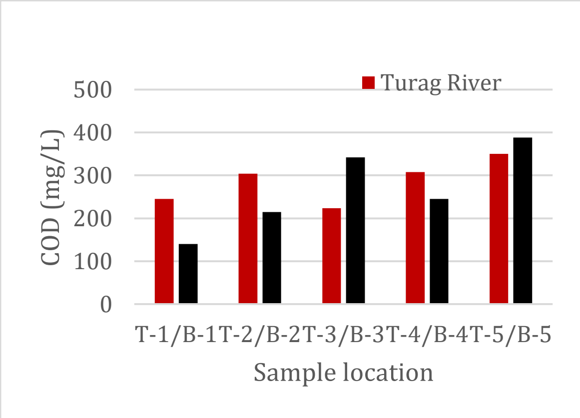

Figure 7: Comparison of COD values of the Turag and Buriganga Rivers

The water quality of the Buriganga and Turag rivers is severely compromised, as evidenced by the high levels of pollutants found across multiple parameters such as COD, BOD, and TDS. These emphasize the urgent need for improved wastewater management practices in the Dhaka region.

4. Conclusion

This study provides a comprehensive assessment of the current water quality of the Buriganga and Turag rivers, highlighting the severe degradation caused by the continuous discharge of untreated industrial, agricultural, and domestic waste. The water quality of both rivers is severely compromised, as evidenced by the high levels of pollutants found across multiple parameters, including elevated pH, TDS, EC, alkalinity, acidity, BOD, and COD. These findings reflect the significant presence of organic matter, dissolved solids, and harmful chemicals that have accumulated due to ineffective wastewater management. The consequences of this pollution are not only detrimental to aquatic ecosystems, as seen in the depletion of dissolved oxygen and disruption of aquatic biodiversity, but also pose serious health risks to local populations who rely on these rivers for water, food, and daily use. The failure to address these untreated effluent dumping has worsened the situation, and without immediate intervention through stricter pollution control measures, implementation of advanced wastewater treatment facilities, and consistent monitoring of industrial discharges, the water quality of these critical rivers will continue to deteriorate. The need for sustainable water management practices and public awareness is more urgent than ever to restore and preserve the ecological balance and safeguard public health in the region.

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Rainwater quality parameters such as Iron content, Turbidity, Biological Oxygen Demand, Chemical Oxygen Demand and Total Dissolved Solid tests were carried out in Bangladesh University of Engineering and Technology (BUET) environmental laboratories. Their support is highly acknowledged.

References

[1] A. Arif, "Water pollution and industries," Pure and Applied Biology, vol. 9, no. 4, Dec. 2020, doi: 10.19045/BSPAB.2020.90237.

[2] J. Ahmed, A. Thakur, and A. Goyal, "Industrial Wastewater and Its Toxic Effects," Biological Treatment of Industrial Wastewater, pp. 1–14, Nov. 2021, doi: 10.1039/9781839165399-00001.

[3] P. Aktar and M. Sabrina Moonajilin, "Assessment of Water Quality Status of Turag River Due to Industrial Effluent," International Journal of Engineering and Information Systems, vol. 2017, no. 6, pp. 105–118, 2017, Accessed: Oct. 25, 2024. [Online]. Available: www.ijeais.org

[4] M. S. Islam, R. Afroz, and M. B. Mia, "Investigation of surface water quality of the Buriganga river in Bangladesh: Laboratory and spatial analysis approaches," Dhaka University Journal of Biological Sciences, vol. 28, no. 2, pp. 147–158, Jun. 2019, doi: 10.3329/DUJBS.V28I2.46501.

[5] M. Akbor, M. Uddin, and M. Ahsan. "Investigation of water quality parameters at different points in the Buriganga river," Bangladesh. J. Environ. Sci. Nat Resour., vol. 10, no. 1, pp. 75–80. 2019.

[6] B. N. Roy, H. Roy, K. S. Rahman, F. Mahmud, M.M.K. Bhuiyan, M. Hasan, M.S. Mahbub, R.M. Jahedi, M.S. Islam, M.S., Principal component analysis incorporated water quality index modeling for Dhaka-based rivers, City Environ. Interac. vol. 23, pp. 100150, 2024. https://doi.org/10.1016/j.cacint.2024.100150

[7] B. Ghosh et al., "Drinking Water Sources along the Banks of Buriganga River of Bangladesh are Polluted and Possess Serious Health Risks: A Comprehensive In Vivo Analysis," J Environ Public Health, vol. 2023, no. 1, p. 3369163, Jan. 2023, doi: 10.1155/2023/3369163.

[8] M. Al-Amin Hoque, M. Galal Uddin, M. Moniruzzaman, M. Hasan, and M. Khan, "Seasonal Variation of Physicochemical Properties of Water in the Buriganga River, Bangladesh Designated Reference Institute for Chemical Measurements (DriCM)," World Appl

Sci J, vol. 34, no. 1, pp. 24–34, 2016, doi: 10.5829/idosi.wasj.2016.34.1.22871.

[9] N. Majed and M. A. S. Islam, “Contaminant Discharge From Outfalls and Subsequent Aquatic Ecological Risks in the River Systems in Dhaka City: Extent of Waste Load Contribution in Pollution,” Front Public Health, vol. 10, p. 880399, May 2022, doi: 10.3389/FPUBH.2022.880399/BIBTEX.

[10] Y. N. Jolly et al., “Evaluation of surface water quality near pollution sources in Buriganga River and deciphering their probable emergence, ecological, and health risk aspects,” Reg Stud Mar Sci, vol. 63, p. 102988, Oct. 2023, doi: 10.1016/J.RSMA.2023.102988.

[11] H. M. Zakir and N. Shikazono, “Assessment of metal pollution in lower Torag River in Bangladesh,” AIP Conf Proc, vol. 987, pp. 86–90, 2008, doi: 10.1063/1.2896987.

[12] M. Delwar Hossain, M. Rahman, J. Bikash Chandra, M. Shammi, and M. Khabir Uddin, “Present Status of Water Quality of The Bangshi River, Savar, Dhaka, Bangladesh,” Bangladesh J. Environ. Res., vol. 10, pp. 17–30, 2012.

[13] M. Xu, Z. Wang, X. Duan, and B. Pan, “Effects of pollution on macroinvertebrates and water quality bio-assessment,” Hydrobiologia, vol. 729, no. 1, pp. 247–259, May 2014, doi: 10.1007/S10750-013-1504-Y.

[14] D. S. Malik, A. K. Sharma, A. K. Sharma, R. Thakur, and M. Sharma, “A review on impact of water pollution on freshwater fish species and their aquatic environment,” Advances in Environmental Pollution Management: Wastewater Impacts and Treatment Technologies, pp. 10–28, Dec. 2020, doi: 10.26832/AESA-2020-AEPM-02.

[15] M. A. Nkansah, F. Opoku, J. H. Ephraim, D. D. Wemegah, and L. P. M. Tetteh, “Characterization of Beauty Salon Wastewater from Kwame Nkrumah University of Science and Technology, Kumasi, Ghana, and Its Surrounding Communities,” Environ Health Insights, vol. 10, 2016, doi: 10.4137/EHI.S40360.

[16] S. S. Ahammed, S. Tasfina, K. A. Rabbani, and M. A. Khaleque, “An investigation into the water quality of Buriganga-a river running through Dhaka”, Int. J. Sci. Technol. Res., vol. 5 no. 3, pp.36–41, 2016.

[17] “Results of different water quality parameters of Buriganga River... | Download Table.” Accessed: Oct. 25, 2024. [Online]. Available: https://www.researchgate.net/figure/Results-of-different-water-quality-parameters-of-Buriganga-River-Sampling-date-September_tbl2_298375226

[18] R. Hiesgen and J. Haiber, “Measurement Methods | Structural Properties: Atomic Force Microscopy,” Encyclopedia of Electrochemical Power Sources, pp. 696–717, Jan. 2009, doi: 10.1016/B978-044452745-5.00073-3.

[19] K. Emumejaye and R. A. Daniel -Umeri, “Electrical Conductivity of Water in Some Selected Areas of Delta State, Nigeria,” American Journal of Engineering Research (AJER), vol. 4, no. 8, pp. 104–107, 2015, Accessed: Oct. 25, 2024. [Online]. Available: www.ajer.org

[20] K. Hasan, M. Happy, K. Nesha, and R. Karim, “Pollution Status of Balu River due to Industrial Input at Dhaka, Bangladesh,” Open Journal of Water Pollut. Treat., vol. 2014, no. 1, pp. 34–42, Jun. 2014, doi: 10.15764/WPT.2014.01004.

[21] “Referal standard value of important water quality parameters | Download Scientific Diagram.” Accessed: Oct. 25, 2024. [Online]. Available: https://www.researchgate.net/figure/Referal-standard-value-of-important-water-quality-parameters_tbl2_336986304

[22] A. C. Bader, H. J. Hussein, and M. T. Jabar, “BOD: COD Ratio as Indicator for Wastewater and Industrial Water Pollution,” Int. J. Special Education. vol. 37, no.3, 2022.