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Assessment of Water Pollution in the Korotoa River: Implications for Ecosystems and Human Welfare in Bogura, Bangladesh

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Abstract - **This study presents a comprehensive evaluation of water quality in the Korotoa River, crucial to Bogura, Bangladesh, as it serves as a critical water supply for the city. Despite its significance, the river faces considerable pollution concerns from untreated pollutants emitted by urban and adjacent regions. The research attempts to analyze the level of water pollution and its repercussions on aquatic ecosystems and human usage. Through systematic water sample collection at numerous locations, the project examines physical and chemical features. Results, assessed against environmental criteria, indicate low dissolved oxygen levels and unsatisfactory water quality measures, particularly around confluence locations. The study exposes significant water pollution, necessitating immediate action to maintain aquatic life, ecosystems, and community well-being. Urgent pollution control actions are necessary to restore and preserve the Korotoa River's natural balance in Bogura, emphasizing the need for education, monitoring, and research. The research provides insights for authorities and stakeholders to reduce pollution, sustaining the river's critical role in the region's biodiversity, agriculture, and human activities.**
Keywords: **Korotoa River, Water Contamination, Aquatic Environment, Water Condition, Dissolved Oxygen Levels, Aquatic Ecosystems, Irrigation Suitability**

I. INTRODUCTION

The Korotoa River, a crucial aquatic lifeline flowing through the center of Bogura, Bangladesh, displays both the region's rich biodiversity and the significant issues coming from environmental deterioration [2]. This canal functions as a crucial source of sustenance for Bogura and adjacent communities, offering nutrition, livelihoods, and recreational activities. However, the river's health is under dire peril owing to massive pollution emanating from untreated pollutants emitted by urban areas and adjacent cities. The repercussions of this decline reach well beyond local concerns, injuring both the aquatic ecosystems it supports and the many human activities reliant on its waters. This research concentrates on the worrisome status of water quality in the Korotoa River, emphasizing problems such as inadequate Dissolved Oxygen (DO) levels and other metrics falling below defined standards at numerous locations along the river [8]. The study pursues two fundamental objectives: a comprehensive analysis of water pollution levels and an evaluation of probable ramifications on aquatic ecosystems and human activities, including irrigation. Bogura's strategic significance as a northern gateway town in Bangladesh lends relevance to investigating water quality in the context of the Korotoa River [1].

The river's unique habitat supports a vast spectrum of aquatic species, contributing substantially to the region's biodiversity. Moreover, its waters perform a crucial function in agricultural irrigation, sustaining livelihoods and guaranteeing food security in the region. Understanding and regulating water contamination in the Korotoa River are crucial not only for safeguarding aquatic ecosystems but also for guaranteeing the well-being and sustainability of local inhabitants. This work conveys significant importance by providing light on the dire issue of water pollution in the Korotoa River, advocating a timely and effective solution [5].

By analyzing data against established environmental standards and criteria, the study provides a clear and objective evaluation of the situation, surpassing simple reporting. It advocates for pollution management techniques and provides insights to assist authorities and stakeholders in restoring and preserving the natural equilibrium of the Korotoa River in the neighborhood of Bogura, Bangladesh. The initiative aims to maintain not just the river itself but also the greater environment and human communities depending on its valuable resources. The interdependence of ecosystems emphasizes the potential cascade of detrimental repercussions, requiring comprehensive understanding to develop targeted interventions and reverse the disquieting trend.

II. REVIEW OF LITERATURE

The examination of water quality and pollution in river ecosystems, particularly within the context of Bangladesh and comparable locations, has been a subject of considerable academic scrutiny, with numerous studies contributing valuable insights into the challenges posed by water pollution and its implications for both aquatic habitats and human societies.

In the unique context of Bangladesh, where river systems play a significant role, past research has addressed water quality problems, finding industrial effluents, agricultural discharge, and residential drainage as important sources to pollution in rivers like the Korotoa. These findings underscore the need of managing water contamination in densely populated locations where river ecosystems serve as critical resources for urban and rural residents. The Environmental protection Rules (ECR) of 1997 arise as a vital framework in the research of water quality and pollution, establishing essential principles for the protection and administration of inland surface waters in Bangladesh.

These guidelines define allowable limitations for numerous water quality indicators, providing a key reference point for monitoring the health of river systems and identifying locations where pollution exceeds permitted levels. Furthermore, the Environmental Protection Agency (EPA) water quality criteria, with their global application, present a complete set of guidelines for assessing water bodies globally, integrating factors for aquatic life support, irrigation, and human consumption. Researchers around have consistently utilized these indicators to evaluate water quality and pollution.

As we begin on our study of the Korotoa River, these past studies and regulatory frameworks provide as a platform upon which to construct our research. Drawing from this extant corpus of knowledge, our objective is to contextualize our findings within the broader framework of water quality and contamination investigations.

This literature review informs our study by guiding the selection of appropriate metrics, methodologies, and criteria to comprehensively evaluate the status of the Korotoa River, ultimately providing practical measures for its rehabilitation and preservation in the unique context of Bogura, Bangladesh.

III. RESEARCH APPROACH

To completely examine the water quality and contamination in the Korotoa River within the neighborhood of Bogura, Bangladesh, a systematic and scientifically rigorous technique was utilized. The following stages define the working approach of this study.

A. Site Selection

Among the seven places discovered along the Korotoa River in Bogura, namely TMSS (Eco Park), Matidali, Jaypurpara, Dottobari, Chelopara, SP Bridge, Bejora Bridge, and Banani, an additional three locations were meticulously selected to complete the set of 10 sample sites. This selection procedure sought to guarantee a complete and well-rounded evaluation of water quality and contamination over the river's full course inside Bogura town. The selected locations were intentionally positioned to illustrate several portions of the river, considering the natural flow and features of the watercourse within the urban context. Careful attention was given to:

1. Geographic Distribution

The sample stations were distributed uniformly throughout the Korotoa River's route through Bogura, providing an accurate portrayal of water quality differences from the upstream to downstream sections.

2. Proximity to Pollution Sources

Sites located in close proximity to recognized pollution sources, including residential areas, industrial zones, and agricultural districts, were preferred. This approach permits for the measurement of pollutant levels near suspected contamination sources.

TABLE I SAMPLING SITES FOR WATER QUALITY ANALYSIS

Sl. No.	River Bank site location	Latitude	Longitude	Distance from Estuary (m)	Avg. River width (m)
1	TMSS (Eco Park)	$24^{0}38^{/}22^{//}$	$89^{0}22^{/}07^{//}$	200	425
2	Matidali	$24^{0}88^{/}52^{//}$	$89^{0}21^{/}43^{//}$	185	315
3	Jaypurpara	$24^{0}40^{/}24^{//}$	$89^{0}21^{/}54^{//}$	225	416
4	Dottobari	$24^{0}49^{/}29^{//}$	$89^{0}22^{/}25^{//}$	102	287
5	Chelopara	$24^{0}08^{/}04^{//}$	$89^{0}22^{/}54^{//}$	132	322
6	Bejora Bridge	$24^{0}34^{/}20^{//}$	$89^{0}23^{/}19^{//}$	203	409
7	Banani	$24^{0}72^{/}43^{//}$	$89^{0}22^{/}58^{//}$	125	320

Sample Collection Dates: 05/06/2023 to 07/07//2023, Source: Google Earth, 2023

B. Sampling Location

The selection of sample sites for this research was a meticulous procedure intended at obtaining a comprehensive representative of the Korotoa River's water quality across numerous key parameters. Industrial locations, regarded as potential sources of pollution, were strategically included in the sample strategy to analyze the effect of industrial discharges on the river. Residential regions and urban zones, prone to human activities and waste disposal, were also prioritized to evaluate the level of urban effect and identify pollution sources.

Fig. 1 Regions of High Pollution in the Korotoya River

The choice of these sites coincides with the study purpose of measuring water quality in regions directly influenced by human activity. Furthermore, accessibility and safety concerns played a vital role in establishing the sample sites, assuring the practicality of data collection while accentuating the well-being of the research team. This exhaustive approach to sample site selection offers a complex knowledge of the environmental dynamics in the Korotoa River, encompassing both human and industrial effects while emphasizing safety and accessibility.

IV. EXPERIMENTAL EXPLORATION

A. Physical Exploration

An examination of the Korotoa River's physical characteristics has shown a complex web of contamination hazards to the river's ecology. The water quality of the river has drastically diminished due to the reckless discharge of effluent and solid pollutants from various sections of the city via five canals, caused by a lack of adequate sanitation and waste management systems. There are two landfills that contribute to contamination by lodging the collected solid materials that are located next to the estuary of the Korotoa River. According to Ahmed and Rahman [1], river water pollution levels in urban areas are four to 10 times greater than in rural regions. The river also encounters biological contaminants, like as blood and viscera, from the 400 or so animals that were slaughtered at the slaughterhouses in Feringi Bazar and Dewan Hat. Notable industrial discharges include heavy metals like mercury, lead, chromium, cadmium, and arsenic that percolate into the river from locations like the Bogura Chemical Complex (BCC), BCL Paper Mills (BCLPM), plastic factories, tanneries, dyeing and painting operations, and a urea fertilizer factory. The Korotoa River has become less wide due to land seizures, which has reduced its depth and increased the likelihood of siltation, making it more difficult to navigate at low tide. Watercraft, launches, and steamers also contribute to marine pollution via the discharge of waste oil spillage and bilge cleansing, which has a negative impact on coastal fisheries in terms of both quality and quantity. In light of the many distinct physical threats to the Korotoa River, this in-depth analysis highlights the critical necessity of finding complete remedies promptly.

B. Sampling Operations

Sampling activities for the Korotoa River included a meticulous approach to assure the quality and dependability of obtained data. At each selected site, water samples were routinely gathered from two unique locations during both high tide (Rainy session) and low tide (Dry session) circumstances. These sample stations were meticulously selected at the junction of canals and the river, as well as the midway of the river along the confluence point. To minimize the potential of contamination and debris interference, samples were hand collected from a depth of 0.1 meters using plastic vials with screw closures. Special care was taken to utilize fresh or completely purified vessels before collecting, assuring their cleanliness and absence from any objectionable items. This severe approach to sampling procedures sought to acquire representative and uncontaminated water samples, assuring the robustness of the following testing done in the environmental laboratory.

C. Examination and Testing of Samples

The acquired water samples were subsequently sent to the environmental laboratory at Pundra University of Science & Technology for examination. Each sample received testing for critical characteristics, including 5-day Biochemical Oxygen Demand (BOD_5), dissolved oxygen (DO), alkalinity, pH, and total dissolved solids (TDS). Subsequently, the laboratory results were juxtaposed against the established standard values outlined in the Environment Conservation Rules [10] of 1997 and the guidelines set by the Environmental Protection Agency (EPA) for the support of aquatic life and the utilization of inland surface water, as detailed in Table II.

TABLE II CRITERIA AND STANDARDS FOR WATER QUALITY IN SUPPORT OF AQUATIC LIFE AND INLAND SURFACE WATER UTILIZATION

Quality Parameter	Standard for Aquatic Life	Inland Surface Water Use Standard			
		Drinking Water Supply	Recreational Activity	Irrigation	Various Process and Cooling Industry
BOD_5	<3 mg/l	<2 mg/l	<3 mg/l	<10 mg/l	<10 mg/l
DO	5 mg/l	>6 mg/l	>5 mg/l	>5 mg/l	>5 mg/l
PH	6.5 to 9	6.5 to 8.5	6.5 to 8.5	6.5 to 8.5	6.5 to 8.5
Alkalinity	>20 mg/l	-	-	-	<500 mg/l
TDS	Varies with fishes	<250 mg/l	-	Varies	-

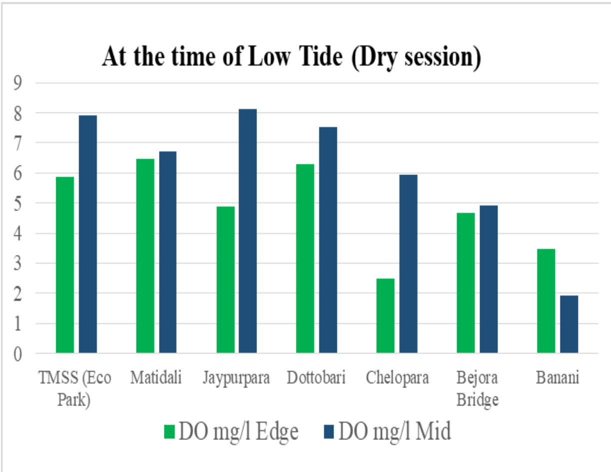
Source: ECR, 1997 and EPA, 1976

TABLE III PARAMETERS AND VALUES FOR WATER QUALITY IN THE KOROTOA RIVER

Location's Name	BOD_5 mg/l		DO mg/l		Alkalinity mg/l		P^H		TDS mg/l	
	Edge	Mid	Edge	Mid	Edge	Mid	Edge	Mid	Edge	Mid
At the Time of Low Tide (Dry Session)										
TMSS (Eco Park)	0.58	1.81	5.88	7.93	110	167	7.04	7.08	1663	2173
Matidali	0.18	1.01	6.48	6.73	125	107	6.99	6.91	1529	2003
Jaypurpara	0.58	2.21	4.88	8.13	130	157	6.99	6.43	1485	1923
Dottobari	1.78	1.61	6.28	7.53	105	137	6.39	6.13	1447	1898
Chelopara	1.18	1.01	2.48	5.93	55	72	7.14	7.03	1267	1129
Bejora Bridge	0.78	0.61	4.68	4.93	40	42	7.09	6.93	1001	1073
Banani	0.38	0.51	3.48	1.93	70	85	7.29	7.13	777	1083
At the Time of High Tide (Rainy Session)										
TMSS (Eco Park)	0.18	1.01	7.68	6.93	90	112	7.04	7.18	17477	22483
Matidali	0.18	1.41	7.28	6.93	100	97	7.12	6.93	17231	20343
Jaypurpara	0.18	2.01	5.68	7.93	100	102	7.25	6.43	14637	18173
Dottobari	1.98	1.01	5.88	7.93	90	97	7.42	5.93	11238	17673
Chelopara	0.98	1.41	7.68	5.13	33	34	7.04	6.98	9445	9046
Bejora Bridge	0.78	0.81	4.08	5.13	23	28	7.04	6.98	9109	8467
Banani	1.58	1.01	5.48	5.73	26	30	7.89	7.25	8083	8396

V. OUTCOMES AND ANALYSIS

The findings of laboratory tests done on samples obtained from disparate locations along the Korotoa River are displayed in Table III. Examination of the data indicates changes in Dissolved Oxygen (DO) levels, with a minimum of 1.93 mg/l found at the confluence of Banani during low tide (Dry season) and a maximum of 8.13 mg/l recorded at the midstream near Joypurpara during high tide (Rainy season). Additionally, Biochemical Oxygen Demand (BOD5) values demonstrated a variation from a maximum of 1.78 mg/l during low tide (Dry season) to a minimum of 0.18 mg/l during high tide (Rainy season) at distinct sites. The negative link between BOD5 and DO is evident, as increased BOD5 loadings correlate to decreasing DO readings, indicating of bacterial use of available oxygen [9]. The concentration of DO in particular Korotoa River areas (depicted in Fig. 2) is considerably low, implying possible hazards to the survival of certain fish species and other aquatic animals. This study emphasizes the vital relevance of resolving water quality concerns to preserve a favorable habitat for diverse aquatic life forms. Further examination of the data indicates a key interaction between Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD5) levels, revealing insights into the ecological health of the Korotoa River. The observed range of DO levels from 1.93 mg/l to 8.13 mg/l shows large variability across diverse locales and tidal circumstances. During low tide in the dry season, the confluence of Banani exhibits a limited DO concentration, whereas the midstream near Joypurpara during high tide in the monsoon season records a substantially higher DO level.



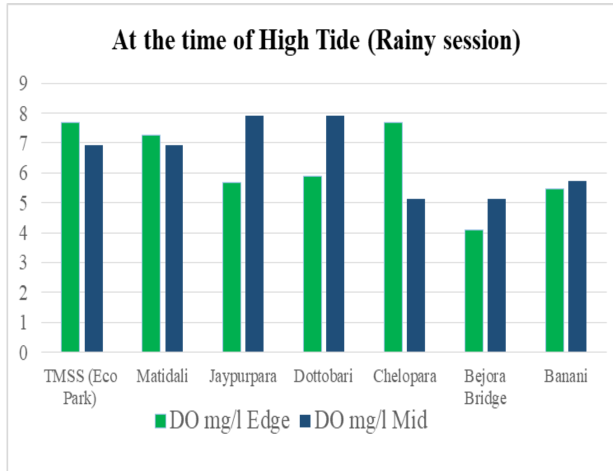


Fig. 2 Dissolved Oxygen Levels in the Korotoa River

VI. CONCLUSION

In conclusion, the gathered data on water quality parameters in the Korotoa River suggest a severe state of pollution, particularly at the canal confluence sites, where a majority of the samples fail to meet the requirements laid out by ECR, 1997, and EPA. While the impact of tidal effects and self-purification processes leads to an improvement in conditions at mid-river, the total pollution situation remains highly concerning. Notably, several locations have parameter values within the normal limits, underscoring the possibility for targeted interventions. However, the persistence of contamination highlights the need for prompt attention and action. To restore the ecological integrity of the aquatic environment in the Korotoa River, vital for both aquatic animals and fisheries, it is necessary to increase awareness about water quality concerns through diverse educational channels, regular monitoring programs, and sustained research efforts. The authorities responsible must prioritize this concern and implement essential actions to stop and prevent additional contamination of the Korotoa River, ensuring the long-term health and sustainability of this critical water resource.

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