The Asian Review of Civil Engineering
ISSN: 2249-6203 (P); 2583-7893 (E)
Vol.13 No.1, 2024, pp.16-21

© Centre for Research and Innovation
www.crijournals.org
DOI: https://doi.org/10.70112/tarce-2024.13.1.4228

Analysis of Pollution Sources and Control Measures for the Karatoa River: A Comprehensive Study on Water Quality and Remediation Strategies

S. H. Mahmud and K. K. Islam
Département of Civil Engineering, Pundra University of Science and Technology, Bangladesh
E-mail : hayathmahmud@gmail.com, kazikamrulislam@gmail.com
(Received 30 November 2023; Revised 27 January 2024; Accepted 13 March 2024; Available online 21 March 2024)

Abstract **- This paper examines the properties of pollution sources in the Karatoa River and possible measures to control it. In today's world, more than 70% of the freshwater in liquid form in Bangladesh is unfit for consumption. This problem is not unique to Bangladesh, as other countries are also facing similar issues. The paper provides a clear explanation of this problem with the help of a considerable number of references. It studies various sources of pollution such as sewage discharge, industrial effluents, and agricultural runoff, and their potential impact. The Karatoa River is severely polluted from different wastewater sources, which are properly investigated here, and remedial measures are described with graphical representation. It explains various prescribed standards for different categories of inland water. It identifies the potential and extent of various components that pollute the water. Finally, the paper shows the effects of water pollution in a nutshell. The remedial measures suggested include pollutant traps, water treatment plants, gross pollutant traps, bio-retention basins, and effluent treatment.**
Keywords: **Karatoa River, Pollutions, Solid Wastes, Environment, Remedies**

I. INTRODUCTION

Industrial discharges, agricultural runoff, and plastic pollution have a huge impact on the Karatoa River and pose a threat to a balanced environment. Unplanned urbanization, excessive use of plastic, and industrial discharge contribute to increasing water pollution in the Karatoa River [1]. Therefore, it is necessary to identify the sources of pollution and their possible remedial measures to control pollution in the Karatoa River.

River pollution is the contamination of river water from human activity. Rivers naturally transport organic and inorganic pollutants [5]. Some examples of river pollution causes include nutrients (such as phosphorus and nitrate), chemicals (such as heavy metals), and groundwater pollutants (from pesticide use in agriculture).

From the above discussion, the following objectives are selected for the present study.

1. To investigate the sources of pollutions in Karatoa river.
2. To find out some measures for controlling pollution.
3. To impose some restrictions in such a way to remove pollution from Karatoa river.

Fig. 1 No proper management of wastes

Fig. 2 Solid wastes are disposed randomly

II. METHODOLOGY

The successive processes are to be done in order to accomplish the necessary objectives, have shown in Figure 3.

This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

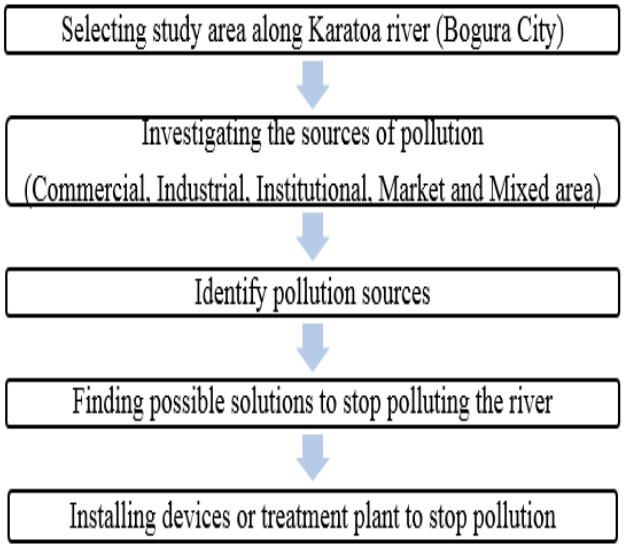

Fig. 3 Workflow diagram

A. Field Investigation

The field investigation will concentrate on evaluating the existing wastewater treatment plants along the Karatoa River. The evaluation will include assessing the infrastructure, operational efficiency, and compliance with environmental standards [4]. The objective is to identify any shortcomings or areas for improvement in the treatment processes [6].

The assessment will cover the following aspects: effluent quality analysis, monitoring influent characteristics, operational practices and compliance, capacity and load assessment, infrastructure integrity and maintenance, technological feasibility study, community perception and involvement, and integration of nature-based solutions [8]. Different sizes and types of solid wastes are given in Table I which is very important to select appropriate opening size of gross pollutant traps.

TABLE I SIZES AND TYPES OF SOLID WASTES

Types of Wastes	Sizes (inch)
Polythene bag	6-12
Plastic bottle	<10
Coconut	8-10
Paper	Not recognized
Organic wastes	Not recognized
Shoes	4-10
Bamboo	7-20
Jute Bag	12-25

Fig. 4.Karatoa River (Chelopara)

Fig. 5 Solid wastes in Karatoa River

Fig. 6 Karatoa River (Foteh Ali Bridge)

B. Remedial Measures

The general approach for remediating pollution in the Karatoa River is comprehensive and forward-thinking. It involves a multipronged strategy that encompasses regulatory frameworks, community engagement, and collaborative efforts among diverse stakeholders [7]. The focus is not only on addressing existing pollution sources but also on instituting preventive measures to curb future contamination. At its core, the general approach seeks to create a sustainable and resilient framework that fosters the restoration of the Karatoa River ecosystem.

C. Pollutant Traps

Fig. 7 Pollutant Trap (Should be install at Chelopara and Fateh Ali Bridge)

Pollutant traps are crucial mechanisms that capture and filter pollutants before they enter the Karatoa River. These traps are strategically placed in storm water drains (Chelopara shown in Fig. 4) and water channels (Fateh ali Bridge shown in Fig. 6) to intercept debris, sediment, and other pollutants, thereby preventing them from reaching the river.

Benefits

1. Solid waste is effectively captured to prevent it from entering the river.
2. The inflow of debris, plastics, and other pollutants into the water body is reduced.
3. It is a low-cost and low-maintenance solution for immediate pollution control.

D. Water Treatment Plants

Fig. 8 Chemical removal technique

Fig. 9 Water treatment plant for effluent from chemical industry

Establishing water treatment plants along the Karatoa River (Hotels, ceramic industries and paper factories) is a comprehensive measure to purify contaminated water. These plants utilize advanced filtration and purification technologies to remove pollutants, chemicals, and harmful microorganisms from the river water. Effluent treatment plant should be installed at Paper Mills and Medical College where different types of chemicals are used every day.

Benefits

1. Ensuring the supply of clean and safe water to downstream communities.

2. Removing a wide range of pollutants, including heavy metals and industrial effluents.
3. Enhancing water quality for both environmental and domestic purposes.

E. Gross Pollutant Traps

Fig. 10 Closed GPTs

Fig. 11 GPTs for large debris, leaf & polythene

Gross Pollutant Traps (GPTs) are structures that are engineered to capture large debris and pollutants carried by storm water runoff. They are installed in drainage systems and tributaries to prevent oversized waste, such as plastics and vegetation, from entering the Karatoa River. Depending on sizes of solid wastes described in Table I the lowest size of trap is 4 inch selected.

Benefits

1. The system is designed to specifically target large pollutants that can cause blockages and environmental harm.
2. It is easy to install and maintain, which reduces the risk of storm water pollution.
3. The system enhances the overall efficiency of storm water management systems.

TABLE II ESTIMATE OF PERFORMANCE EFFICIENCIES FOR GPTS

Pollutant	Expected Removal
Litter	10-30%
Total suspended solids	0-10%
Total nitrogen	0%(negligible)
Total phosphorus	0%(negligible)
Coarse sediment	10-25%
Heavy metals	0%(negligible)

D. Bio-Retention Basins

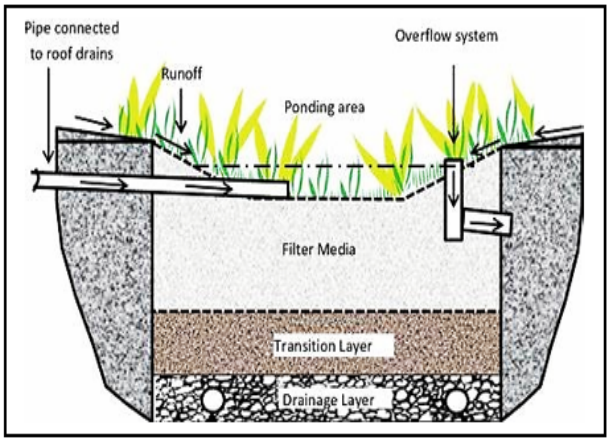

Fig. 12 Bio-retention basin for treatment of heavy metals from chemical industry

Bio-retention basins, also referred to as rain gardens, are landscaped areas that are designed to naturally filter and treat storm water. These basins incorporate vegetation, soil, and engineered structures to capture and absorb pollutants, promoting natural biological processes. Also constructed wetlands can be used for removal of heavy metals from wastewater. The efficiency of constructed wetlands is given in Table III. This type of bio-retention basin or constructed wetlands should be installed at ceramic industries or heavy industrial areas besides Karatoa River.

TABLE III REMOVAL EFFICIENCIES OF CONSTRUCTED WETLANDS

Pollutant	Expected Removal
Litter	> 95 %
Total suspended	65-95 %
solids	40-80%
Total nitrogen	60-85 %
Total	> 95%
phosphorus	55-95%
Coarse sediment	> 95 %
Heavy metals	65-95 %

Benefits

1. Wetlands help filter pollutants naturally by absorbing and breaking them down.

2. They provide a habitat for local flora and fauna, which enhances biodiversity.
3. Wetlands are a cost-effective and aesthetically pleasing solution for pollution control.

E. Effluent Treatment Plants

Fig. 13 Treatment unit for industrial wastewater (Should be installed in heavy industrial zones near Karatoa River)

Effluent treatment plants play a crucial role in mitigating pollution caused by industrial discharges. These plants utilize advanced treatment processes to treat industrial wastewater, ensuring that only treated and environmentally safe effluents are released into the Karatoa River.

Benefits

1. Reduces the harmful effects of chemicals and pollutants released from industrial activities.
2. Complies with the effluent quality standards set by regulatory authorities.
3. Safeguards the aquatic ecosystems downstream from the detrimental effects of industrial discharges.

F. Community Engagement Programs

Community engagement programs are essential in promoting environmental responsibility among local residents. These programs aim to educate and mobilize individuals to actively participate in pollution control initiatives, given that the river serves as a vital resource for communities along its banks. Awareness campaigns are designed to communicate the importance of responsible waste disposal, the impact of pollutants on water quality, and the collective role of the community in preserving the river ecosystem.

Workshops, seminars, and outreach events serve as platforms for dialogue, empowering residents to adopt sustainable practices and become stewards of their local environment. Collaborative efforts between community members, local authorities, and environmental organizations can contribute significantly to the success of pollution control endeavors.

G. Regulatory Framework Enhancement

The effectiveness of pollution control in the Karatoa River is heavily dependent on the strength and implementation of regulatory frameworks. Enhancing existing regulations and enforcement mechanisms is crucial for holding industries accountable and preventing harmful discharges. Regulatory enhancements may include stricter monitoring, regular audits, and stringent penalties for non-compliance. Additionally, incentivizing industries to adopt eco-friendly practices through tax breaks or other rewards can encourage a shift towards sustainable operations. By aligning regulations with the specific challenges faced by the Karatoa River, the regulatory framework can create a more robust system to address pollution at its source.

H. Research and Innovation

Research and innovation are crucial for developing customized solutions to combat pollution in the Karatoa River. Collaborative efforts between research institutions, environmental agencies, and local industries can lead to the discovery of innovative technologies and practices. Research initiatives may focus on understanding the specific pollutants affecting the river, identifying sources of contamination, and assessing the environmental impact. Innovations could include advanced wastewater treatment technologies, eco-friendly industrial processes, and sustainable waste management strategies. By supporting and investing in research, the Karatoa River can benefit from context-specific solutions that address its unique challenges.

I. Adaptive Monitoring Systems

Adaptive monitoring systems are essential for real-time assessment and response to pollution in the Karatoa River. These systems use cutting-edge technologies such as sensor networks, satellite imagery, and water quality modeling to continuously monitor critical parameters. This dynamic approach enables the detection of sudden changes in water quality and provides timely information for decision-making. The adaptive nature of monitoring systems allows adjustments based on evolving environmental conditions, ensuring that pollution control measures remain effective. Implementing such systems in the Karatoa River enhances the ability to proactively address pollution events and facilitates data-driven management strategies for long-term environmental sustainability.

J. Conclusion for Remedial Measures

A comprehensive pollution control strategy for the Karatoa River involves the implementation of pollutant traps, water treatment plants, gross pollutant traps, bio-retention basins, and effluent treatment plants. These measures can effectively intercept, treat, and manage both point and non-point source pollutants, thereby contributing to the restoration and preservation of the river's ecological integrity.

V. RECOMMENDATIONS

1. Integrated Regulatory Frameworks: Develop and enforce comprehensive regulatory frameworks that address pollution at its source. Monitor industry standards, waste disposal guidelines, and enforce penalties for non-compliance.

2. Community Involvement: Promote community awareness through educational programs and participatory activities. Empower communities to play a vital role in pollution prevention and environmental stewardship.

3. Technological Innovations: Invest in innovative technologies, including advanced water treatment plants and efficient pollutant traps. Implement sustainable waste management systems to address pollution at its root.

4. Cross-Sectoral Collaboration: Foster collaboration among government bodies, environmental agencies, industries, and local communities. Encourage a unified approach to tackle pollution comprehensively and address interconnected challenges.

5. Continuous Monitoring and Adaptation: Establish robust monitoring mechanisms to regularly assess water quality and pollution levels. Implement adaptive management strategies to ensure ongoing effectiveness and adaptability to changing environmental conditions.

6. Research and Development: Support research initiatives focusing on identifying emerging pollutants and understanding their impact. Devise targeted solutions through continuous research and development efforts.

7. Public Advocacy: Encourage public advocacy for the protection of the Karatoa River. Mobilize support from civil society, non-governmental organizations, and advocacy groups for sustained environmental conservation efforts.

8. Informed Decision-Making: Utilize the study's insights as a foundation for informed decision-making in environmental management. Implement strategic interventions based on a thorough understanding of pollution challenges in the Karatoa River. By adhering to these recommendations, stakeholders can collectively work towards safeguarding the environment.

VI. CONCLUSION

The study highlights the complex pollution challenges faced by the Karatoa River, which is polluted by various sources such as solid waste, industrial effluents, and plastics. This necessitates a comprehensive approach to mitigate the pollution. The study experimentally classifies pollutants into distinct categories, shedding light on the specific threats posed by solid waste, industrial wastewater, large debris, and plastic pollution. The possible measures to control pollution present a holistic strategy, incorporating pollutant traps, water treatment plants, gross pollutant traps, bio-retention basins, and effluent treatment plants, reflecting a multi-faceted and integrated remediation approach. The workability of pollution control measures is contingent on collaborative efforts among various stakeholders, emphasizing the need for cross-sectoral cooperation and sustained commitment.

REFERENCES

[1] J. K. Abaychi, "Concentrations of trace elements in aquatic vascular plants from Shatt al-Arab river, Iraq," *Journal of Biological Sciences Research*, vol. 18, no. 2, pp. 123-129, 1987.

[2] M. Agami, M. Litav, and Y. Waisel, "The effects of various components of water pollution on the behaviour of some aquatic macrophytes of the coastal rivers of Israel," *Aquatic Botany*, vol. 2, pp. 203-213, 1976.

[3] I. C. Agrawal and H. C. Srivastava, "Pollution survey of major drains discharged into river Ganga and Yamuna at Allahabad," *Institution of Public Health*, 1984.

[4] N. and P. N. K. Nambisan, "Effect of pulp paper effluent on the water quality of Muvattupuzha River emptying into Cochin backwaters," *Indian Journal of Marine Sciences*, vol. 15, pp. 253-259, 1986.

[5] D. J. Balmforth, "The pollution aspects of storm sewage overflows," *Water and Environmental Management*, vol. 4, no. 3, pp. 219-226, 1990.

[6] J. T. Bandy, "Water characteristics," *Journal of Water Pollution Control Federation*, vol. 56, no. 6, pp. 544-548, 1984.

[7] K. Bansho and A. Miyazaki, "Analysis of wastewater and effluents," *Bunseki Kagaku*, vol. 11, pp. 862-868, 1983.

[8] A. K. Basu, "Studies in effluents from pulp paper mill and its role in bringing the physico-chemical changes around several discharge points in the Hooghly Estuary," *Indian Journal of Industrial Engineering*, vol. 46, pp. 108-116, 1966.

[9] L. C. Das and S. H. Mahmud, "Assessment of Water Pollution in the Korotoa River: Implications for Ecosystems and Human Welfare in Bogura, Bangladesh," *TARCE*, vol. 12, no. 2, pp. 30-34, Dec. 2023.