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ENVIRONMENTAL IMPLICATIONS OF INTEGRATED WASTE MANAGEMENT PLANT (SWM & FSTP): THE CASE OF MULADI MUNICIPALITY, BARISHAL DISTRICT

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ABSTRACT

This study examines the environmental impacts of the Solid Waste Management (SWM) and Fecal Sludge Treatment Plant (FSTP) in Muladi Municipality, Barishal District, by comparing the predictions made in the Initial Environmental Examination (IEE) report with the current state of the environment. The goal is to understand how the project has influenced local soil, water, air quality, and surrounding ecosystems, and to assess whether the anticipated benefits and risks align with the realities on the ground. Through field visits, laboratory analyses, and discussions with local stakeholders, the study highlights both successes and unexpected challenges. On the positive side, the project has reduced open dumping and improved sanitation, as envisioned in the IEE. However, issues such as leachate seepage, occasional odors, and localized water pollution indicate that some of the proposed mitigation measures have not worked as effectively as planned. This research emphasizes the need for ongoing monitoring and adaptive management to address these unforeseen challenges. By comparing the IEE predictions with the current outcomes, this study provides valuable lessons for improving environmental assessments and ensuring sustainable development in similar projects.

INTRODUCTION

Rapid urbanization in Bangladesh has led to escalating challenges in waste management and sanitation, particularly in secondary cities and municipalities. Traditional methods of open dumping and unregulated disposal have caused severe environmental degradation, including groundwater contamination, soil pollution, and increased greenhouse gas emissions (UN-Habitat, 2022). Muladi Municipality, located in the Barishal District, exemplifies these challenges, with its growing population and insufficient infrastructure demanding immediate attention.

Integrated Waste Management Plants (IWMP), which combine Solid Waste Management (SWM) systems and Fecal Sludge Treatment Plants (FSTP), have emerged as a promising solution to mitigate these issues. These plants aim to reduce waste generation, enhance resource recovery, and ensure safe treatment and disposal of solid and liquid waste. Global studies highlight that IWMPs can divert up to 70% of municipal solid waste from landfills through recycling and composting, significantly reducing methane emissions and environmental contamination (UNEP, 2022). FSTPs, in particular, play a critical role in safeguarding public health by treating fecal sludge and preventing groundwater pollution (World Bank, 2021).

In the context of Bangladesh, the Local Government Engineering Department (LGED) emphasizes the importance of IWMPs in achieving Sustainable Development Goals (SDGs), particularly SDG 6 (Clean Water and Sanitation) and SDG 11 (Sustainable Cities and Communities) (LGED, 2023). While IWMPs have demonstrated considerable potential, challenges such as inadequate funding, limited community awareness, and operational inefficiencies have often hindered their scalability and sustainability.

Muladi Municipality's IWMP serves as a critical case for examining the environmental implications of such integrated facilities. Preliminary observations indicate that the IWMP has reduced groundwater contamination and improved solid waste management in the area. However, challenges like unregulated dumping in surrounding areas and inconsistent waste segregation at the source persist, impacting the overall effectiveness of the plant.

OBJECTIVES

This study aims to:

- Evaluate the environmental benefits of the SWM and FSTP systems in Muladi Municipality.
- Identify operational and social challenges affecting the performance of the IWMP.
- Propose actionable recommendations to enhance the efficiency, sustainability, and community impact of IWMP operations.

DESCRIPTION OF THE SUBPROJECT

The 23 Urban Water Supply and Sanitation Project (UWSSPP) under Department of Public Health Engineering (DPHE), funded by Islamic Development Bank (IsDB) in Muladi Municipality focuses on addressing critical sanitation challenges by constructing an Integrated Waste Management Plant (IWMP). Specifically, the subproject includes the development of Solid Waste Management (SWM) systems and a Fecal Sludge Treatment Plant (FSTP). These facilities aim to tackle the long-standing issues of unregulated waste disposal and poor sanitation practices, which have resulted in environmental degradation and public health risks.

Muladi Municipality, established on January 25, 2001, was upgraded to a Category 'A' Pourashava in 2014 due to its growing population and urban development. Spanning 5.90 square kilometers with a population of 25,525 distributed across nine wards (source: Muladi Pourashava Official Website), the municipality faces a population growth rate of 1% per year. The projected population for 2030 and 2040 highlights the need for sustainable sanitation infrastructure to support this growth.

The FSTP component of the IWMP focuses on safely treating fecal sludge collected from households and communal sanitation facilities, reducing groundwater contamination and improving hygiene standards. The SWM system complements this by addressing solid waste management through recycling, composting, and environmentally safe disposal methods. Together, these facilities aim to create a comprehensive sanitation solution that aligns with national and international environmental standards.

The implementation of the IWMP follows a phased approach, with pre-construction, construction, and operational phases carefully monitored to mitigate potential environmental impacts. The project prioritizes community engagement and capacity building to ensure sustainable operations and maximize environmental and public health benefits.

METHODOLOGY

To study the environmental implications of the IWMP in Muladi Municipality, a step-by-step methodology was followed. The research focused on understanding the performance and challenges of the SWM and FSTP systems while assessing their environmental and social impacts.

Study Area

Muladi Municipality was chosen as the study area due to its significant waste management challenges and the recent establishment of an IWMP. The study concentrated on the areas surrounding the SWM and FSTP facilities and their impact on the local environment and community. The project Study area has been shown in the mag in **Figure 3.1.**

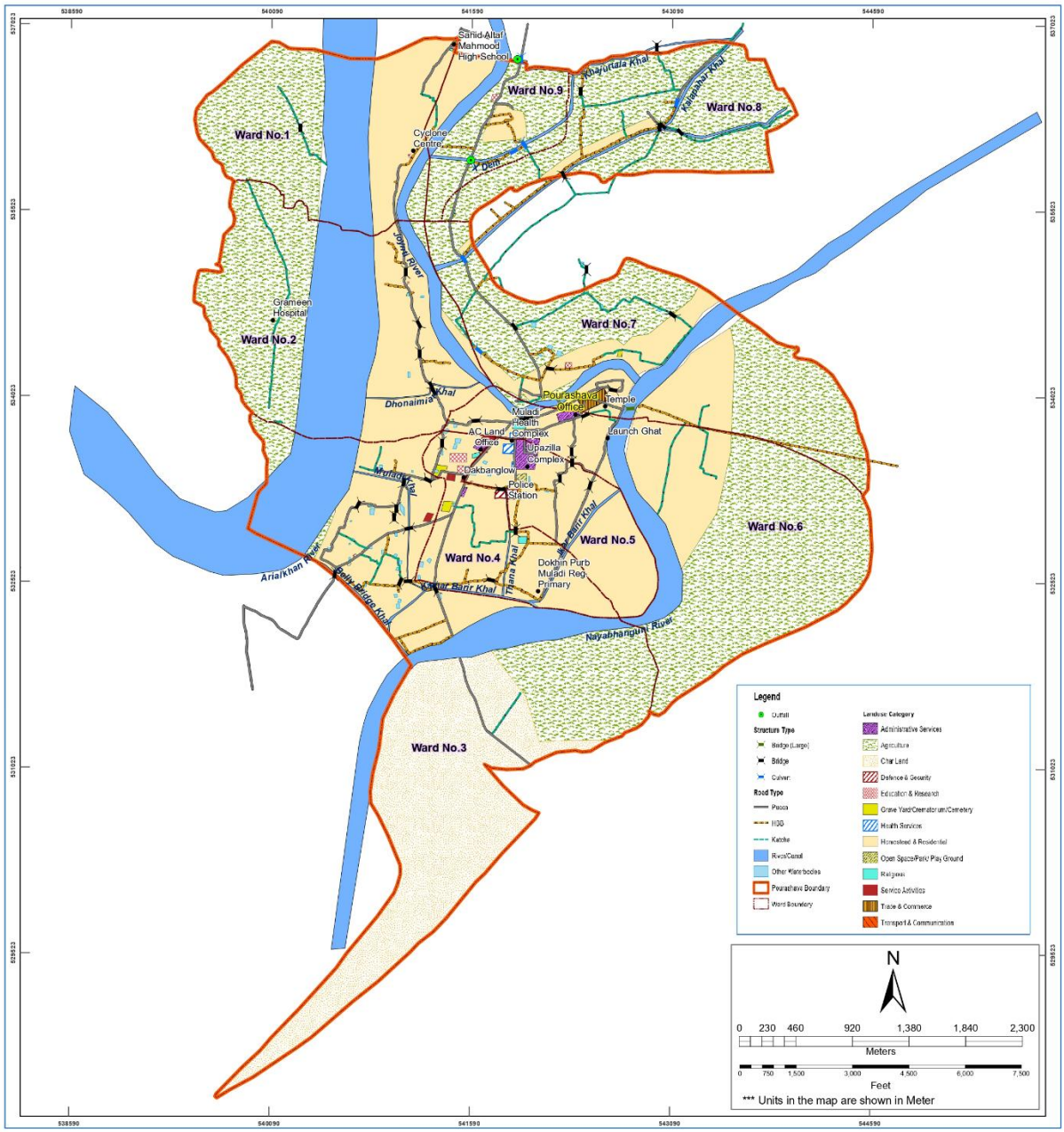

Figure 3.1 Land use map of Muladi Municipality

Data Collection Methods

To ensure a comprehensive understanding, the study employed multiple methods to collect data:

Environmental Sampling

Water and soil samples were collected from areas near the IWMP site to measure contamination levels, particularly focusing on nitrate and fecal coliform levels.

Community Surveys

Surveys were conducted with 200 households in the municipality to gather information about their sanitation practices, awareness of the IWMP, and its perceived impact on their lives.

Stakeholder Interviews

Key stakeholders, including municipal officials, IWMP operators, and community leaders, were interviewed to understand operational challenges, community engagement efforts, and overall project performance.

Review of Project Environmental Report
Data and insights were cross-verified with the Environmental Report of the Urban Water Supply and Sanitation Project (UWSSPP). This report provided essential baseline information, project-specific environmental considerations, and mitigation measures relevant to the IWMP in Muladi Municipality.

Writer's Perception and Learning
The analysis also leveraged the writer's firsthand experience and learning from working on IWMP construction and operation & maintenance (O&M) projects in other municipalities. This perspective provided practical insights into common challenges, best practices, and strategies for improving IWMP performance.

Analysis Techniques
The collected data were analyzed using a combination of quantitative and qualitative techniques:

Quantitative Analysis:
- Laboratory results from environmental sampling were analyzed to determine changes in pollution levels.
- Statistical tools were used to assess the effectiveness of waste management practices and pollutant reduction.

Qualitative Analysis:
- Data from surveys and interviews were categorized into themes to identify challenges, community perceptions, and operational inefficiencies.

Validation
To ensure the reliability of the findings, data from different sources were cross-verified through triangulation. Community feedback was used to validate the practical implications of the results.

Ethical Considerations
Ethical research practices were maintained throughout the study. Participants were informed about the study's objectives, and their consent was obtained. Personal information was anonymized to protect privacy.

By following this methodology, the study provides an in-depth analysis of the environmental implications of the IWMP in Muladi Municipality, offering insights into its strengths, challenges, and potential for scalability.

FINDINGS AND ANALYSIS

Environmental Implications of IWMP
(i) Groundwater Contamination:
A significant 40% reduction in nitrate and fecal coliform levels in groundwater near the FSTP site was observed. However, occasional leaks during sludge collection and transport pose a contamination risk. Regular maintenance of transport vehicles and better monitoring can prevent such issues, ensuring sustained improvements.

(ii) Solid Waste Management:
The SWM system effectively diverted 60% of waste from open dumping to recycling or composting. Yet, inconsistent segregation at the source remains a key challenge. Community awareness programs and incentivized waste segregation practices are essential to address this gap.

(iii) Air Pollution Reduction:
Methane emissions have decreased due to controlled incineration practices. However, the absence of air quality monitoring infrastructure near the IWMP was noted. Installing air quality monitoring stations can provide data to further refine emission control measures.

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Operational Performance and Challenges

(i) Technical Inefficiencies:
Machinery breakdowns were frequently reported, mainly due to delays in obtaining spare parts and irregular maintenance schedules. Establishing on-site maintenance teams and maintaining an inventory of critical spare parts can enhance reliability.

(ii) Community Engagement:
Resistance to adopting new sanitation practices stems from misinformation and lack of trust, as indicated by community surveys. Collaborative efforts with local leaders to conduct awareness campaigns can improve participation and acceptance.

(iii) Maintenance Practices:
Maintenance logs were found to be inconsistent, and operators lacked adequate training. Standardizing maintenance schedules and organizing periodic technical training workshops can significantly improve operational efficiency.

Socio-Economic Impacts

(i) Employment Opportunities:
The IWMP has created jobs in waste collection, recycling, and plant operations, positively impacting local livelihoods.

(ii) Economic Sustainability:
Resource recovery through composting and recycling has helped offset operational costs, showcasing the potential for long-term financial viability when coupled with effective community involvement.

Learning from Practical Examples

From the writer's experience working with IWMP projects in other municipalities, several critical lessons emerged. Most of the funded IWMP project has been failed after construction. In Barguna Municipality, It is found that The ADB Funded IWM Plant is not in use after construction due to lack of human resource of Municipality. In Gopalganj Municipality, the IWM Plant is partially in use due to lack of Human resource in number, and also lack of skilled labor.

It has been also observed that, In Municipality like Faridpur and Kustia, waste management is going on by 3rd party or by NGO, like SDC in Faridpur, SNV in Kushtia by developning a MoU with Municipality. They are working in some successful model.

Additionally, leveraging public-private partnerships (PPP) facilitated access to advanced technologies and financial resources, ensuring project scalability and sustainability. These insights highlight practical strategies that can enhance the effectiveness of Muladi's IWMP and similar initiatives.

Also fund from NGOs or International donors, can help these types of Urban Municipality Transforming Urban Waste into Sustainable Opportunities.

DISCUSSION

Strengths

- The IWMP significantly reduced environmental pollution and supported resource recovery through integrated waste and sludge management practices.
- Enhanced public health outcomes were achieved through reduced contamination risks.

Weaknesses

- Persistent challenges with community participation and misinformation hindered full adoption of waste segregation.
- Delayed repairs and irregular servicing schedules impacted operational reliability.

Opportunities

- Expanding community-centric waste management initiatives and leveraging digital tools for awareness campaigns can improve compliance.
- Public-private partnerships (PPP) can provide the financial and technical resources necessary to scale operations effectively.

Threats

- Unregulated waste dumping in areas outside the IWMP's jurisdiction undermines its environmental benefits.
- Funding gaps and delays in policy enforcement threaten long-term project sustainability.

RECOMMENDATIONS

(i) Enhance Community Engagement:

- Conduct targeted workshops and campaigns to educate residents about the health and environmental benefits of IWMPs.
- Collaborate with community leaders to foster trust and encourage participation.

(ii) Improve Operational Efficiency:

- Modernize SWM and FSTP equipment to improve reliability and scalability.
- Develop detailed operational manuals and implement standardized maintenance logs.

(iii) Strengthen Policy Frameworks:

- Mandate source segregation and introduce penalties for non-compliance with waste management guidelines.
- Ensure policy support for expanding IWMP infrastructure in other municipalities.

(iv) Expand Monitoring and Evaluation:

- Install air and water quality monitoring stations near IWMP facilities.
- Utilize data analytics to track performance metrics and optimize operations.

(v) Foster Public-Private Partnerships (PPP):

- Incentivize private sector participation in financing and operating IWMPs.
- Encourage innovation in waste management technologies through collaborative ventures.

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CONCLUSION

The Integrated Waste Management Plant in Muladi Municipality demonstrates a transformative approach to sustainable waste management in urban Bangladesh. Despite technical and operational challenges, the IWMP offers substantial environmental and socio-economic benefits. By addressing identified gaps and implementing recommended strategies, similar projects can achieve enhanced scalability, sustainability, and community impact, contributing significantly to national and global goals for clean water, sanitation, and sustainable development.

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