QUICK ASSESSMENT ON METHANE FROM LANDFILLS IN DHAKA AND RECOMMENDATIONS FOR INTEGRATING LOWERING ORGANIC WASTE METHANE IN NDC

ESDO

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Quick Assessment on Methane from Landfills in Dhaka and Recommendations for Integrating Lowering Organic Waste Methane in NDC

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About ESDO

Environment and Social Development Organization- ESDO is an action research-oriented non-profit and non-government organization based in Bangladesh. It is an environmental action research group dedicated to a toxic-free, zero-waste planet. This entails fighting pollution and building regenerative solutions in cities through local campaigns, shifting in policy and finance, research and communication initiatives, and movement building. ESDO is working relentlessly to ensure biological diversity since its formation in 1990. It is the pioneer organization that initiated the anti-polythene campaign in 1990 which later resulted in a complete ban on polythene shopping bags throughout Bangladesh in 2002.

About GAIA

GAIA is a network of grassroots groups as well as national and regional alliances representing more than 1000 organizations from 92 countries.
We envision a just, zero-waste world built on a respect for ecological limits and community rights, where people are free from the burden of toxic and plastic pollution, and resources are sustainably conserved, not burned or dumped.

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PREFACE

Over the past three decades, the Environment and Social Development Organization (ESDO) has been at the forefront of the environmental and social justice movement in Bangladesh. Founded in 1990, ESDO was established with the vision of creating a sustainable and equitable world, free from environmental degradation and social injustices. Our journey began with a deep commitment to protecting the environment and advocating for the rights of marginalized communities, and this commitment has only grown stronger with time.

Throughout these years, ESDO has been actively involved in a wide array of initiatives that address some of the most pressing environmental challenges of our time. From pioneering campaigns against plastic pollution to advocating for safe and sustainable waste management practices, our work has always been driven by the understanding that true development cannot occur at the expense of the environment or the people who depend on it. As we reflect on our journey, it is clear that the principles of environmental justice have become central to our mission.

In recent years, ESDO has intensified its focus on issues related to methane emissions and the pursuit of zero waste. Methane, a potent greenhouse gas, poses a significant threat to our climate and the health of our communities, particularly those living near landfills and other waste disposal sites. The need to address this issue is more urgent than ever, as Bangladesh grapples with the challenges of rapid urbanization and increasing waste generation. Our focus on methane emission reduction and zero waste stems from a deep concern for the well-being of present and future generations. We believe that by promoting sustainable waste management practices, we can not only mitigate the impacts of climate change but also ensure a healthier and more just environment for all.

This report is a testament to ESDO's unwavering commitment to these principles. It delves into the complexities of waste management in Dhaka, highlighting the environmental justice issues faced by waste pickers and communities living near landfills, while also providing a critical analysis of the gaps in policy, legal frameworks, and budget allocations. By shedding light on these issues, we aim to drive meaningful change that aligns with our vision of a zero-waste society, where the health of our planet and its people is prioritized above all else.

As we continue to advocate for environmental justice, we hope this report will serve as a valuable resource for policymakers, stakeholders, and all those who share our commitment to creating a sustainable and equitable future. Together, we can build a Bangladesh that is not only resilient in the face of environmental challenges but also just and inclusive for all its citizens.

Siddika Sultana
Executive Director
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Executive Summary

Waste management in Bangladesh is a pressing issue, exacerbated by rapid urbanization and substantial population growth. The nation, with approximately 171.3 million inhabitants, 40% of whom live in urban areas, faces escalating waste management challenges, particularly in major cities like Dhaka[2]. Urban areas alone produce around 25,000 tons of solid waste daily—a figure that has surged dramatically from 6,500 tons in 1991 to 13,300 tons in 2005.[4] Projections indicate that per capita waste generation will continue to rise, reaching 0.60 kg per person daily by 2025.[5]

The global impact of waste on climate change is substantial, with methane emissions from landfills significantly contributing to greenhouse gas concentrations. Methane is a short-lived potent greenhouse gas with a global warming potential 28-34 times greater than that of carbon dioxide over a 100-year period and 82.5 times greater over a 20-year period.**Error! Bookmark not defined.** It is released primarily through the anaerobic d ecomposition of organic waste in landfills. Methane emissions are a significant component of Bangladesh's greenhouse gas profile, positioning the country as the 16th largest emitter globally. In 2020, Bangladesh's methane emissions were approximately 88.904 million tons of CO2 equivalent, with the waste sector alone contributing about 830 kilotons annually.[14] The Intergovernmental Panel on Climate Change (IPCC) has set ambitious targets, recommending a 30-60% reduction in global methane emissions by 2030 to meet climate goals. In response, Bangladesh has committed to reducing methane emissions by at least 30% from 2020 levels by 2030, as part of the Global Methane Pledge.[15]

In Bangladesh, organic materials constitute 68-81% of municipal solid waste, leading to considerable methane emissions. Dhaka's landfills, notably Matuail and Amin Bazar, are major sources of these emissions. Using the IPCC Default Method, the study reveals that the Matuail landfill emits about 31.54 gigagrams (Gg) of methane annually, while the Amin Bazar landfill releases around 36.80 Gg annually. This substantial methane output exacerbates climate change and local environmental degradation.

The situation is further complicated by the absence of proper sanitary arrangements at many landfill sites. Without adequate waste management infrastructure, the environmental and health impacts are severe. Methane emissions from these landfills contribute to global warming and pose local risks, such as soil and groundwater contamination. Leachate from landfills can pollute water sources, affecting agriculture and local communities.

Addressing methane emissions is crucial for mitigating climate change. The Nationally Determined Contributions (NDC) 2021 of Bangladesh targets significant methane emission reductions by 2030 through improved waste management, waste-to-energy projects, modern landfill technologies, Alternate Wet and Dry-AWD techniques in rice cultivation, and better livestock management. But waste-to-energy and incineration projects release pollutants that degrade air quality and contribute to CO2 emissions, contradicting climate mitigation efforts. These methods also eliminate the possibility of recycling and composting valuable materials, which are more sustainable waste management practices. Moreover, the waste sector has significant potential for fast action on methane reduction and climate justice. Methane from organic waste constitutes a considerable portion of emissions, and there are considerable reduction possibilities by 2030.

Integrating waste pickers into formal systems also offers livelihood opportunities and supports a just transition, ensuring that environmental and social benefits are equitably shared. Addressing these issues requires a holistic approach that integrates environmental justice principles, ensures equitable distribution of impacts, and supports sustainable waste management practices. This approach will contribute to reducing environmental impacts, enhancing public health, and aligning with global climate goals.

This study suggests several strategies to mitigate these emissions, including short-term and medium-term recommendations and strategies. In the short term, integrating organic waste methane management strategies such as more sustainable practices like improved waste segregation at source, composting, and methane capture systems into the NDC is essential for mitigation. Additionally, the use of biocovers in landfills, which are both effective and cheaper than landfill gas collection systems, should be prioritized. Advocating for national policies and securing budgetary support for decentralized waste management systems will be vital. Emphasizing principles of environmental justice ensures that waste management policies' impacts are distributed equitably, especially among vulnerable communities. Additionally, preparing for a Low Methane initiative in Dhaka will align local and national policies to support methane reduction efforts. Infrastructure development should prioritize establishing community composting centers and decentralized materials recovery facilities to enhance organic waste management and support recycling initiatives.

Medium-term recommendations focus on integrating waste pickers into formal waste management systems, which involves mobilizing, organizing, and providing capacity-building programs, along with social security measures. Successful examples from cities like Bangalore, India, and Malabon City, Philippines, highlight the benefits of formalizing waste pickers' roles and improving their working conditions. Promoting zero waste principles and adopting comprehensive waste reduction strategies will be crucial. Establishing systems for food waste prevention and recovery, including targeted interventions and recovery systems, will help minimize food loss and redistribute surplus food. Moreover, integrating Materials Recovery and Biological Treatment (MRBT) for landfill restoration and encouraging agroecological practices and urban farming will strengthen waste management and sustainability goals. The MRBT focuses on recovering valuable materials and stabilizing organics without producing refuse-derived fuel (RDF) for burning.

These measures seek to develop a waste management system in Dhaka that is both sustainable and equitable, leading to reduced methane emissions and improved waste management practices. Executing these recommendations effectively will have a positive impact on the environment, public health, and global climate targets.

1. Waste and Climate Crisis in Bangladesh

Waste is any product, substance, or object that is no longer suitable for its intended use and is discarded or intended to be discarded.[1] It can be broadly categorized as hazardous or non-hazardous materials. Hazardous wastes include industrial, medical, and electronic (e-waste) materials. Non-hazardous wastes include municipal waste, such as household and commercial garbage and debris from demolishing buildings and other structures. Waste can be solid or liquid, requiring different disposal and management methods. If not collected and treated, both hazardous and non-hazardous waste can pose serious threats to the environment and human health.

With approximately 171.3 million people, comprising 40% of the total population, living in urban areas, Bangladesh is one of the fastest urbanizing economies in South Asia.[2] This rapid urbanization has led to an increase in waste quantity and its management complexity, especially in major cities like Dhaka. Sustainable Development Goal 11 aims to "reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and waste management by 2030". This target is closely linked to the achievement of other SDGs, such as sustainable energy through waste recycling contributing to SDG 7, which aims to "ensure access to affordable, reliable, sustainable and modern energy for all".

The United Nations (1997) defined solid waste management as "the supervised handling of waste material from its generation at the source through recovery processes to disposal." Municipal solid waste is a significant challenge in cities due to its volume and management issues.[3] Approximately 25,000 tons of solid waste are generated daily in urban areas of Bangladesh, with 170 kilograms (kg) per capita per year.[4] The volume of waste doubled from 6,500 tons in 1991 to 13,300 tons in 2005. Due to rapid urbanization and economic transitions, the per capita daily urban solid waste generation is projected to increase to 0.60 kg by 2025 from 0.49 kg in 1995.[5]

Globally, climate change (expressed in ferocious storms, rising sea levels, and deluges, among other phenomena) is mainly driven by greenhouse gas emissions into the atmosphere. Rapid population growth, industrialization, and urbanization have caused enormous waste to pile up in landfills. As a result, the world already made 1.3 billion metric tons of waste in 2010, and that

[1] INTOSAI Working Group on Environmental Auditing. (n.d.). Auditing waste management. Retrieved from https://sisu.ut.ee/waste/book/11-definition-and-classification-waste

[2] The World Bank. (n.d.). Urban population (% of total population) - Bangladesh. Retrieved from https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=BD

[3] United Nations Environment Programme (UNEP). (n.d.). Solid waste management. Retrieved from https://www.unep.org/explore-topics/resource-efficiency/what-we-do/cities/solid-waste-management

[4] Ahmed, N. (2019, October 7). When the garbage piles up. The Daily Star. Retrieved from https://www.thedailystar.net/opinion/environment/news/when-the-garbage-piles-1810375

[5] Dhaka Tribune. (2017a, April 25). Waste management down in the dumps. Dhaka Tribune. Retrieved from https://www.dhakatribune.com/bangladesh/dhaka/2017/04/25/wastemanagement-dumps

number is expected to rise to 2.2 billion metric tons by 2025 and 4.2 billion metric tons by 2050[6]. Meanwhile, methane gas emissions increased from 700 to 1808 parts per billion over the preceding two centuries, totaling 22.16 parts per billion each year.[7]

Like other developing countries, Bangladesh has ignored its solid waste management program, making this country a sacred place of greenhouse gasses (GHGs). Meanwhile, an alarming fact is that Dhaka's solid waste doubled in size between 2014 and 2021. Thus, this incorrect disposal of solid waste and mismanagement of landfill procedures have resulted in methane production, which can degrade the ecosystem.[8]

1.1. Composition of Waste in the Landfills of Bangladesh

In Bangladesh, most municipal solid waste (MSW) is organic (68–81%) and decomposes anaerobically. When municipal solid waste MSW is disposed in landfills, the organic material is degraded anaerobically by methanogens, releasing methane into the atmosphere. As organic waste accounts for 68–81% of total waste, this means that a significant amount of landfill gas (LFG) is produced daily in our landfills, whereas methane accounts for 55–60% of total volume of LFG and poses negative environmental impacts on air, land, and water, such as global warming , soil contamination, and groundwater pollution. Following that, landfill methane emissions are carried through the landfill by pressure, concentration gradients, and permeability. Additionally, landfills are significantly influenced by solid waste composition, the amount of oxygen in the landfill, the amount of moisture, and the temperature.[24] Compounding these issues is the poor management of landfills across Bangladesh. Nine out of twelve city corporations have designated dumping sites. Still, these do not have appropriate landfill operation and management units, they are merely open-air dumpsites without sanitary arrangements, yet they are still used as landfills. Despite being initially established away from human settlements, communities have settled within 500 meters of these sites over time, heightening health and environmental risks.[9]

[6] Ayodele, T. R., Alao, M. A., & Ogunjuyigbe, A. S. O. (2018). Recyclable resources from municipal solid waste: Assessment of its energy, economic, and environmental benefits in Nigeria. Resources, Conservation and Recycling, 134, 165-173. https://doi.org/10.1016/j.resconrec.2018.03.026

[7] Toha, M., & Rahman, M. M. (2023). Estimation and prediction of methane gas generation from landfill sites in Dhaka city, Bangladesh. Case Studies in Chemical and Environmental Engineering, 7, 100302. https://doi.org/10.1016/j.cscee.2023.100302

[8] Abdel-Shafy, H. I., & Mansour, M. S. M. (2018). Solid waste issue: Sources, composition, disposal, recycling, and valorization. Egyptian Journal of Petroleum, 27(4), 1275-1290. https://doi.org/10.1016/j.ejpe.2018.07.003

[9] Islam, S. (2021*). Urban Waste Management in Bangladesh: An Overview with a Focus on Dhaka*. Background Paper for the 23rd ASEF Summer University. ASEF Education Department.

Country's Situation of the Dumpsites/ Landfills[9]						
Name of City Corporation	**Landfill location**	**Landfill Size (Acre)**	**Proximity of Population Settlement**	**Establish ment Year**	**Amount of Dumped Waste (Tonnes per year)**	**Presence of sanitary arrangement**
Dhaka Dhaka	Amin Bazar	52	within 10Km	2009	15 million	Not functional
	Matuail	100		1995		Not present
Chittagong	Halishahar	15	-	1960s	6 million	Not present
	Arefin Nagar	19.5	-	2010	3.5 million	
Sylhet	Beside Highway	7	Within 1 Km	1995	1.8 million	Not Present
Rajshahi	City Bypass	15.98	Close to 500m	2004	1.5 million	Not Present
Barishal	-	-	Within 500m	2005	0.7 million	Not Present
Comilla	Jhakuni Para	10	Within 500m	2008	0.5 million	Not Present
Khulna	Mathabhanga	25	-	2015	-	Not Present
	Shaila	17	-	2008	-	Not present
	Rajbad	20	-	1987	-	Not present

The above data shows that Dhaka has the highest methane emission rate among all cities in Bangladesh. Again, in Dhaka, Matuail Landfill has a higher methane emission than Amin Bazar.

2. Greenhouse Gas Emission in Bangladesh

In Bangladesh, greenhouse gas emissions are significantly influenced by various sectors, with methane emissions from landfills contributing notably to the country's greenhouse gas profile. As of 2020, Bangladesh was the 16th largest emitter globally, with methane emissions amounting to approximately 88.904 million tons of CO2 equivalent, primarily from waste decomposition, agriculture, and energy production.[14] The waste sector alone contributes about 830 kilotons of methane annually, exacerbating climate change and environmental degradation.[12] Addressing these emissions is critical for meeting global climate targets, with the IPCC recommending a 30-60% reduction in methane emissions by 2030. Bangladesh has committed to this goal through the Global Methane Pledge, aiming to reduce methane emissions by at least 30% from 2020 levels by 2030.[15]

2.1 GHG Emissions in Bangladesh: Projected BAU Scenario for 2030

Total Projected Emissions

By 2030, Bangladesh's GHG emissions under the Business as Usual (BAU) scenario are estimated to reach 409.4 million tons of CO2 equivalent (CO2e).

- **Energy Sector**

Projected Emissions: 312.54 million tons CO2e.

The energy sector is the largest contributor, driven by the country's dependence on fossil fuels for electricity generation, transportation, and industrial processes. Economic growth and urbanization significantly increase emissions in this sector.

- **Agriculture, Forestry, and Other Land Use (AFOLU)**

Projected Emissions: 55.01 million tons CO2e.

Major sources include rice cultivation, livestock production, and deforestation. Methane emissions from rice paddies and enteric fermentation in livestock are substantial contributors.

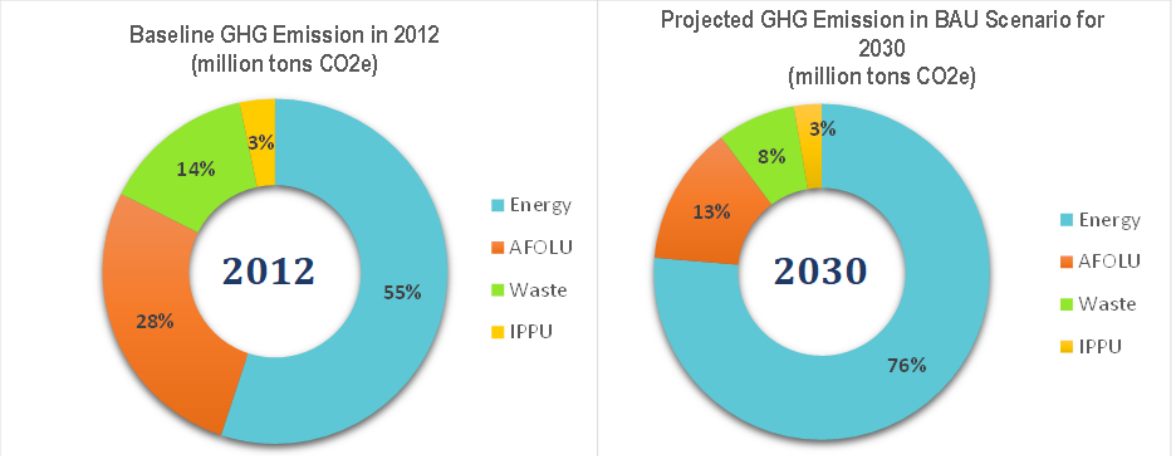

Figure 1 GHG Emission in the Base Year vs Projection of Probable Emission in BAU by 2030 according to NDC 2021 of Bangladesh

- **Waste Sector**

Projected Emissions: 30.89 million tons CO2e.

Emissions arise from solid waste disposal and wastewater management. Rapid urbanization and inadequate waste management practices contribute to higher methane emissions.

- **Industrial Processes and Product Use (IPPU)**

Projected Emissions: 10.97 million tons CO2e. Emissions from the production and use of industrial products such as cement, chemicals, and metals are expected to increase with industrial growth.

3. Methane Emission in Bangladesh

Methane (CH4), a primary component of natural gas, is a significant greenhouse gas that profoundly impacts the Earth's climate system and temperature regulation. Emissions of methane stem from various human activities, such as landfills, oil and natural gas operations, agriculture, coal mining, combustion processes, wastewater treatment, and certain industrial activities. Additionally, natural sources like wetlands also contribute to methane emissions.

Methane's global warming potential (GWP), a measure of how much heat a greenhouse gas traps in the atmosphere over a specific period compared to CO2 is approximately 28-34 times greater than that of carbon dioxide over a 100-year period and 82.5 times greater over a 20-year period. This means that methane can trap significantly more heat per molecule than carbon dioxide, contributing to more immediate and intense warming. When methane is released into the atmosphere, it absorbs terrestrial infrared radiation that would otherwise escape into space. This trapped heat warms the atmosphere, contributing to the greenhouse effect and climate change. Although methane has a shorter atmospheric lifespan (about 12 years) compared to CO2, its immediate impact on warming is much stronger.

Global climate change has emerged as a critical international issue, with numerous studies highlighting Bangladesh as particularly susceptible to the adverse effects of global warming and rising sea levels. In response to these environmental challenges, Bangladesh became a signatory to the United Nations Framework Convention on Climate Change (UNFCCC) during the Earth Summit in June 1992.[10] The Bangladeshi government, alongside its scientific community, is committed to understanding the causes and consequences of climate change and formulating effective strategies to mitigate its potential impacts.[11]

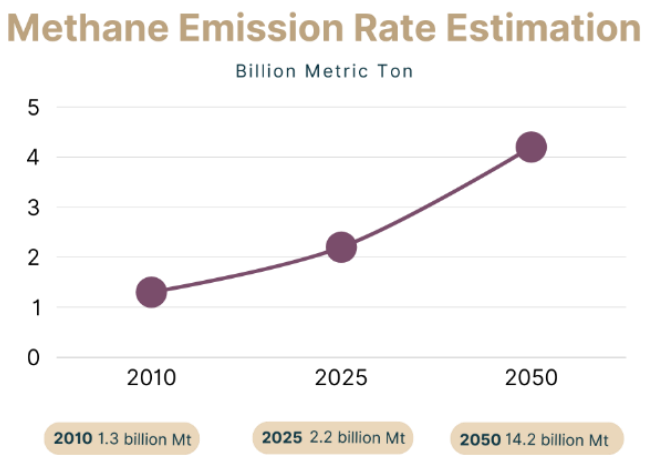

Figure 2 Estimation of Global Methane Emission Rate

[10] Department of Environment, Government of Bangladesh. (2020). [Report]. Retrieved from https://doe.portal.gov.bd

[11] U.S. Environmental Protection Agency (EPA). (n.d.). The importance of methane. Retrieved from https://www.epa.gov/gmi/importance-methane

Methane is the second most prevalent anthropogenic GHG after carbon dioxide (CO2), accounting for roughly 20% of global GHG emissions. Over the last 200 years, atmospheric methane levels have more than doubled, primarily due to human activities. Due to its potent greenhouse effect and relatively short atmospheric lifespan compared to CO2, reducing methane emissions could rapidly and significantly mitigate global warming.[12]

Recent research underscores that Bangladesh's vulnerability to climate change is compounded by its geographic location, low-lying topography, and high population density. The nation faces heightened risks of severe flooding, cyclones, and salinization of water resources, which jeopardize agriculture, infrastructure, and livelihoods. Efforts to address these challenges include enhancing coastal defenses, improving disaster response systems, and promoting sustainable agricultural practices.[13]

The Intergovernmental Panel on Climate Change (IPCC) has emphasized reducing methane emissions as part of a comprehensive climate strategy. According to the IPCC, global methane emissions must be reduced by 30-60% below 2020 levels by 2030 to be consistent with least-cost pathways of limiting global warming to 1.5°C this century. Substantial simultaneous reductions of all climate forcers such as carbon dioxide and short-lived climate pollutants must accompany this reduction.[14] Targeting methane reduction can provide immediate benefits for air quality and human health, alongside its climate advantages.[15] In October 2022, Bangladesh signed the Global Methane Pledge, committing to reducing global methane emissions by at least 30% from 2020 by 2030. This initiative, introduced at COP26, aims to catalyze global action and strengthen support for existing international methane emission reduction efforts.[16] Effective strategies include improving waste management, upgrading oil and gas infrastructure to prevent leaks, and adopting more sustainable agricultural practices.[17] [18]

By addressing emissions of both CO2 and methane, Bangladesh and the global community can work towards mitigating climate change and protecting vulnerable populations from its most severe impacts. Reducing methane emissions can therefore have a rapid and significant effect on mitigating global warming. Strategies to reduce methane emissions include improving waste management practices, capturing and utilizing methane from landfills, enhancing efficiency in the fossil fuel industry, etc.[19]

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[12] U.S. Environmental Protection Agency (EPA). (n.d.). The importance of methane. Retrieved from https://www.epa.gov/gmi/importance-methane#:~:text=Methane%20is%20the%20second%20most,trapping%20heat%20in%20the%20atmosphere.

[13] United Nations. (n.d.). Bangladesh on the frontline of climate change. United Nations Chronicle. Retrieved from https://www.un.org/en/chronicle/article/bangladesh-frontline-climate-change

[14] The World Bank. (n.d.). Climate risk profile: Bangladesh. Retrieved from https://www.worldbank.org/en/topic

[15] Intergovernmental Panel on Climate Change (IPCC). (2018). Global warming of 1.5°C. Retrieved from https://www.ipcc.ch/sr15/

[16] Global Methane Pledge. (n.d.). [Webpage]. Retrieved from https://www.globalmethanepledge.org/

[17] [Document]. (n.d.). Reducing methane emissions: Opportunities and challenges.

[18] United Nations Environment Programme (UNEP). (2021). Global methane assessment: Benefits and costs of mitigating methane emissions.

[19] Global Methane Initiative (GMI). (n.d.). [Webpage]. Retrieved from https://www.globalmethane.org/

3.1. Major Sources of Methane Emission in Bangladesh

Increasing methane emissions are a major contributor to the rising concentration of greenhouse gases in Earth's atmosphere, and are thought to contribute up to one-third of near-term global heating.[20]

The production and use of fossil fuels led to nearly 120 million tons (Mt) of methane emissions in 2023 globally, while an additional 10 Mt came from bioenergy, primarily due to the traditional use of biomass. Emissions have stayed at this level since 2019, when they reached a record high.

In 2022, Bangladesh's waste-related methane (CH4) emissions were equivalent to nearly 31 million metric tons of carbon dioxide ($MtCO_2e$).[21]
Bangladesh's methane emissions were 89.8 million MtCO2e in 2019, placing Bangladesh as the 16th worst Methane emitter globally. Where the per capita methane emission is 0.54 $MtCO_2$.[22] Methane emissions in Bangladesh increased from 71.171 Mt of CO2 equivalent in 2001 to 88.904 Mt of CO2 equivalent in 2020 growing at an average annual rate of 1.18%.[23]

The main sources of methane gas emissions in Bangladesh are:[24]

1. **Agriculture:** Contributing approximately 2401 kt of methane annually. The anaerobic conditions in flooded fields lead to significant methane production.
2. **Waste**: Methane emissions from decomposing organic waste in landfills are estimated at around 830 kt annually.
3. **Energy Sector:** Methane emissions from coal mining and storage are significant, though specific figures for Bangladesh are not well-documented; globally, this sector contributes around 267 kt annually.

[20] Global Methane Initiative (GMI). (n.d.). Mitigation factsheet. Retrieved from https://www.globalmethane.org/documents/gmi-mitigation-factsheet.pdf
[21] Statista. (2023). Waste-related methane emissions from Bangladesh. Retrieved from https://www.statista.com/statistics/1418133/waste-related-methane-emissions-from-bangladesh/
[22] World Economics. (n.d.). Methane emissions - Bangladesh. Retrieved from https://www.worldeconomics.com/ESG/Environment/Methane-Emissions/Bangladesh.aspx
[23] Knoema. (n.d.). Methane emissions - Bangladesh. Retrieved from https://knoema.com/atlas/Bangladesh/topics/Environment/Emissions/Methane-emissions
[24] International Energy Agency (IEA). (n.d.). Methane tracker. Retrieved from https://www.iea.org/data-and-statistics/data-tools/methane-tracker#total-comparison-sources

4. **Others:** Other sources of methane emission include 53 kt annually.

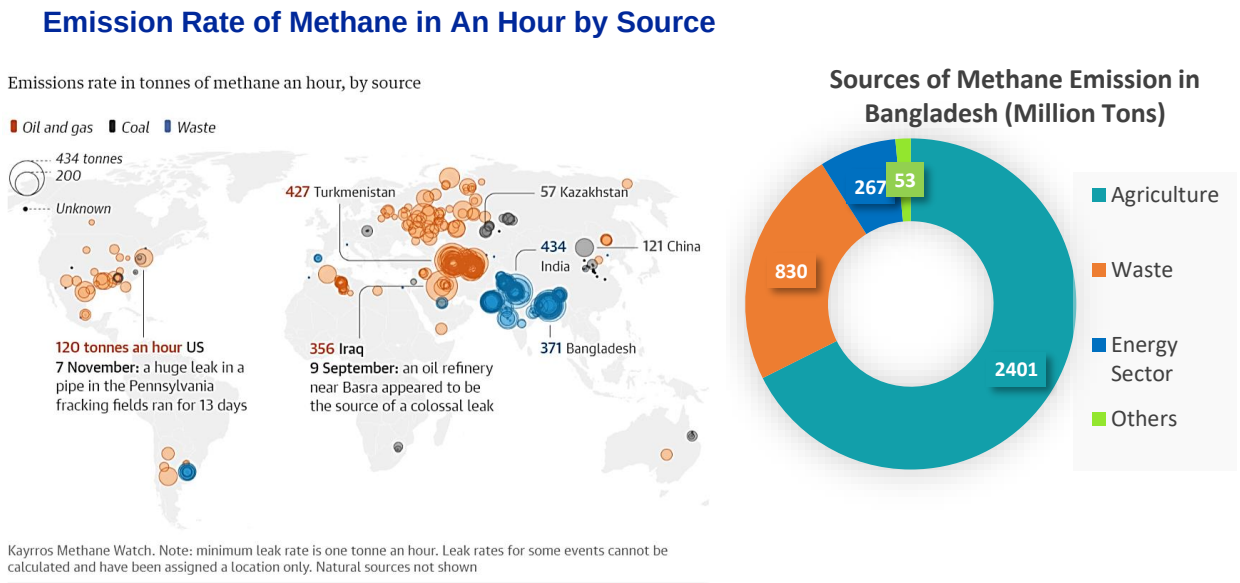


Figure 3 Sources of Methane Emission in Bangladesh

More than 1,000 human-caused methane super-emitter events were detected worldwide in 2022.[25]

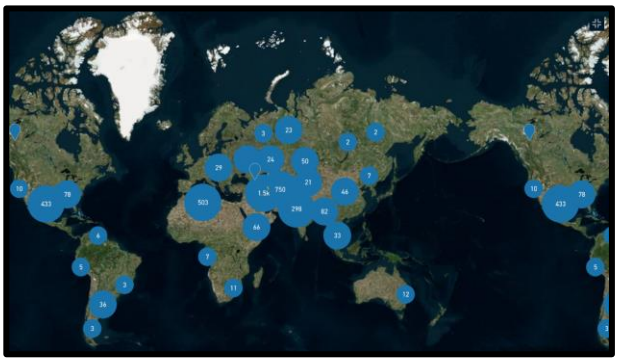


Figure 4 Rate of Methane Emission (T/H) from different sectors (oil and gas, coal, waste)

Figure 5 Rate of Methane Emission (T/H) generated from Waste

From the above figure, we can see that the main source of global methane emission as well as in Bangladesh is Waste i.e. the landfills.

[25] iguru.gr. (n.d.). 1,000 bombs of methane causing 25% of global warming. Retrieved from https://en.iguru.gr/1-000-vomves-methaniou-pou-prokaloun-25-tis-pagkosmias-thermansis/

3.2. Landfill Methane Emission

Landfills, particularly in urban settings like Dhaka, pose significant threats to both human health and the environment due to substantial methane emissions. Methane is a short-lived potent greenhouse gas with a global warming potential 28-34 times greater than that of carbon dioxide over a 100-year period and 82.5 times greater over a 20-year period. In addition to methane, landfills emit other harmful gases such as hydrogen sulfide and volatile organic compounds (VOCs), which can cause respiratory problems, headaches, dizziness, and chronic health conditions like asthma and bronchitis. Leachate, a liquid formed when rainwater filters through waste, can carry harmful substances into the soil and groundwater, contaminating crops and water sources and posing serious health risks to nearby communities.

The environmental impact of landfills extends beyond air pollution. Leachate from landfills like Amin Bazar, which is located near agricultural land and water bodies, can lead to widespread soil and water contamination, affecting aquatic life and the health of communities relying on these resources for irrigation, fishing, and domestic use. Furthermore, the expansion of landfill sites in densely populated regions like Dhaka exacerbates land scarcity, leading to the conversion of agricultural and natural lands and resulting in habitat destruction and loss of biodiversity. Despite being a common waste disposal method, landfills are not a sustainable solution due to their environmental and health impacts.

Waste-to-energy or incineration projects, often proposed as solutions, release pollutants that degrade air quality and contribute to CO2 emissions, contradicting climate mitigation efforts. These methods also eliminate the possibility of recycling and composting valuable materials, which are more sustainable waste management practices. Therefore, incorporating more sustainable practices like improved waste segregation, composting, and methane capture systems into Bangladesh's Nationally Determined Contributions (NDC) and National Action Plan (NAP) is crucial for achieving a healthier and more sustainable future. Additionally, the NDCs and NAP could introduce specific targets to recover source-separated organic waste, further enhancing methane reduction and promoting circular economy principles. These sustainable practices can help mitigate the adverse effects of methane emissions from landfills, align with global emission reduction targets, and protect public health and the environment.

3.3. Waste Management Scenario in Bangladesh

Waste management in Bangladesh is characterized by significant challenges, especially in urban centers like Dhaka. The country generates around 25,000 tons of solid waste daily, with Dhaka alone producing approximately 7,000 tons. A large portion of this waste is organic, contributing to methane emissions when disposed of in landfills like Matuail and Amin Bazar. Despite efforts, the waste collection system remains inefficient, with only about 50% of waste being collected in Dhaka. The remaining uncollected waste is often dumped in open spaces, drains, and water bodies, leading to environmental pollution and public health risks.

The infrastructure for waste management is inadequate to handle the increasing waste generation rates. Landfills, the primary waste disposal method, are rapidly filling up, and waste segregation

at the source is minimal. Recycling efforts are limited, and the informal sector, which plays a significant role in waste management, lacks proper support and regulation. This has resulted in the ineffective management of waste, leading to issues such as the contamination of soil and water resources, air pollution from open burning, and the release of greenhouse gases, particularly methane, from decaying organic waste.

Bangladesh's National 3R (Reduce, Reuse, Recycle) Strategy, introduced in 2010, aimed to promote sustainable waste management practices. However, this strategy is increasingly becoming obsolete due to its limitations in addressing the complexities of modern waste management. The 3R strategy primarily focuses on end-of-life waste management, emphasizing the reduction, reuse, and recycling of waste after it has been generated. While these are essential waste management components, the strategy does not adequately address upstream activities, such as the design, production, and consumption patterns contributing to waste generation.

Moreover, the 3R strategy has not been effectively implemented due to a lack of infrastructure, public awareness, and enforcement mechanisms. The strategy also overlooks the need for recovering value from waste, such as producing energy through anaerobic digestion of organic waste, which could significantly reduce the volume of waste sent to landfills and lower methane emissions.

Figure 6 The Zero-Waste Hierarchy

The 4R (Reduce, Reuse, Recycle, Recover) and 5R (Refuse, Reduce, Reuse, Recycle, Recover) strategies offer more comprehensive and sustainable approaches to waste management than the traditional 3R method. The inclusion of "Recover" within the 4R framework supports Bangladesh's urgent need to extract value from waste through a zero-waste approach, focusing on the recovery of organic materials for composting and biogas production. This not only reduces landfill reliance but also helps in significantly lowering methane emissions.

The 5R strategy further enhances waste management by emphasizing "Refuse," which prioritizes preventing waste generation at the source. This is a critical element of the Zero Waste Hierarchy, which advocates for the elimination of unnecessary products and packaging, and the redesign of systems to prevent waste before it is even created.

Adopting these zero-waste strategies aligns with Bangladesh's goals outlined in the National Adaptation Plan, which focuses on reducing greenhouse gas emissions, cutting reliance on landfills, and enhancing climate resilience. By integrating the principles of zero waste, including source separation, recovery of valuable materials, and organics diversion, Bangladesh can move towards a circular economy that not only promotes environmental sustainability but also delivers

economic benefits and improved public health. This comprehensive strategy fosters resource efficiency, waste reduction, and climate action, making it essential for the country's efforts to mitigate the impacts of climate change.

4. Scope of the Study

This study, conducted by ESDO in association with GAIA, aimed to comprehensively evaluate and address the issue of methane emissions from landfills in Dhaka city. The focus was on major waste dumpsites and landfills within and around the urban area, which are significant sources of methane emissions. The importance of this study lies in its potential to impact environmental and public health outcomes significantly. Methane is a potent greenhouse gas with a global warming potential significantly higher than carbon dioxide, making its reduction critical in mitigating climate change. Dhaka, being one of the largest and most rapidly growing cities, generates substantial amounts of waste, much of which ends up in landfills where it decomposes anaerobically, producing methane. By understanding and addressing the sources and management of waste, particularly organic waste, this study provided valuable insights that could inform policies and practices aimed at reducing methane emissions.

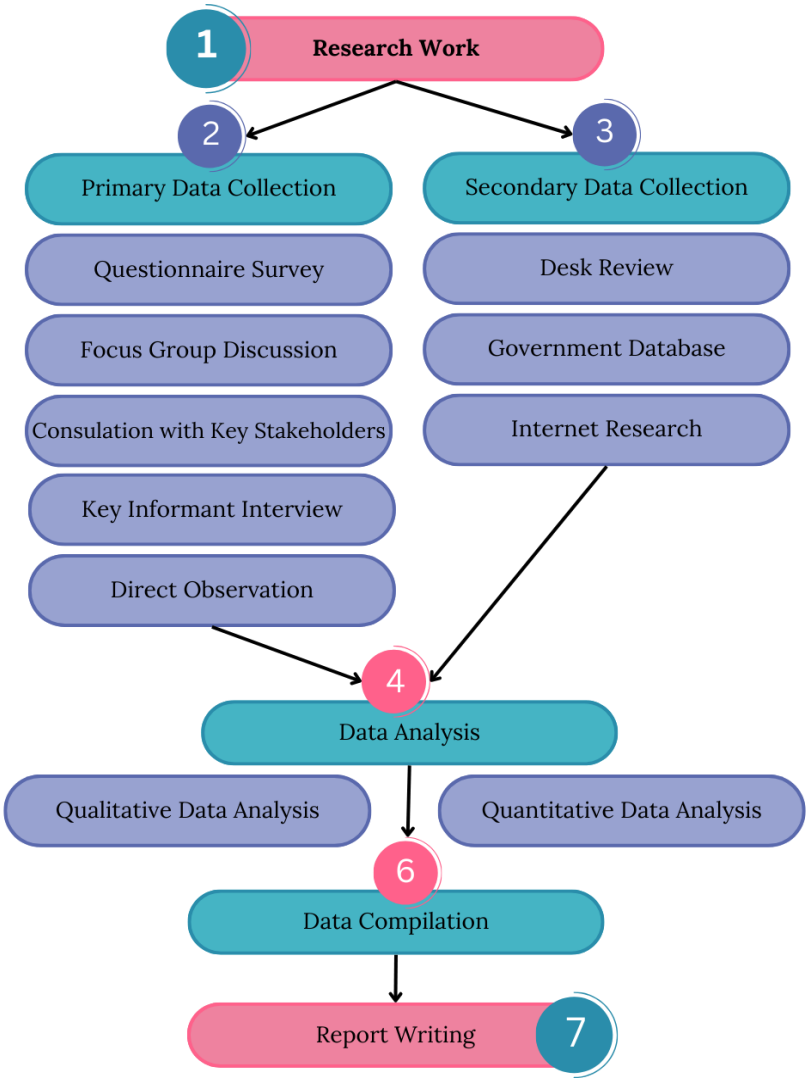
A detailed assessment was conducted to understand the volume and characteristics of waste generated in Dhaka, including how waste was collected, transported, and disposed of in landfills. This involved estimating both the stock of waste already present and the current inflow to understand the dynamics of waste management in the city.

The study also assessed methane emissions from organic waste in the municipal waste stream, estimating current emission levels and identifying potential reductions through improved waste management practices. Additionally, an analysis of Bangladesh’s Nationally Determined Contributions (NDC) and relevant national policies was conducted to identify gaps and opportunities for integrating methane reduction strategies into the NDC. Engaging with a wide range of stakeholders, including government officials, waste management authorities, and informal sector workers, was crucial to gather insights on current practices and opportunities for improvement.

The findings from this study can support policy advocacy efforts, helping to bridge gaps in current policies and enhance the effectiveness of waste management systems. Ultimately, the study aimed to promote sustainable waste management practices that could lead to significant environmental and public health benefits, contributing to the broader goals of climate change mitigation and sustainable urban development.

5. Research Methodology

A comprehensive research methodology was employed to achieve the study's objectives.



6. Landfills in Dhaka and Methane Emission

Dhaka, the capital city of Bangladesh, faces a formidable challenge in managing its municipal solid waste. The city generates vast amounts of waste daily, which are predominantly disposed of in the Matuail and Amin bazar landfills. This study delves into the intricate processes of waste management, the conditions at the landfill sites, the activities involved in waste collection and disposal, and the significant challenges posed by methane emissions.

Figure 7 Landscape view of Amin Bazar Landfill

The Amin Bazar landfill under the Dhaka North City Corporation (DNCC), situated in Savar upazila, 24 km northwest of Dhaka city, became operational in 2007 over 52 acres (21 ha) of land. This landfill covers almost five zones and 36 wards of the DNCC. The other landfill at Matuail, administered by the Dhaka South City Corporation (DSCC), about 8 km from Gulistan under the Matuail Union to the south of Dhaka, was established as an open dumping station of 50 acres (20 ha) in 1995, and 50 additional acres (20 ha) were added in 2006. It covers 57 wards under five zones of the DSCC.[26]

Figure 8 Landscape view of Matuail Landfill

The tertiary waste treatment of Dhaka city occurs in the Matuail and Amin Bazar landfills. The Matuail landfill is approximately 300 m from the central highway of Matuail, in the south-eastern part of Dhaka, and approximately 3.75 km from the center point Gulistan of Dhaka. This landfill occupies almost 100 acres (40.5 ha), with the acquisition of an extra 81 acres (32.8 ha) known from KII.[26] At the other end of Dhaka, the Amin Bazar landfill is approximately 1 km from the central

[26] SpringerLink. (n.d.). [Article]. Retrieved from https://link.springer.com/article/10.1007/s10163-023-01855-w

highway under ward number 9 situated in the north-western part of Dhaka.[27]

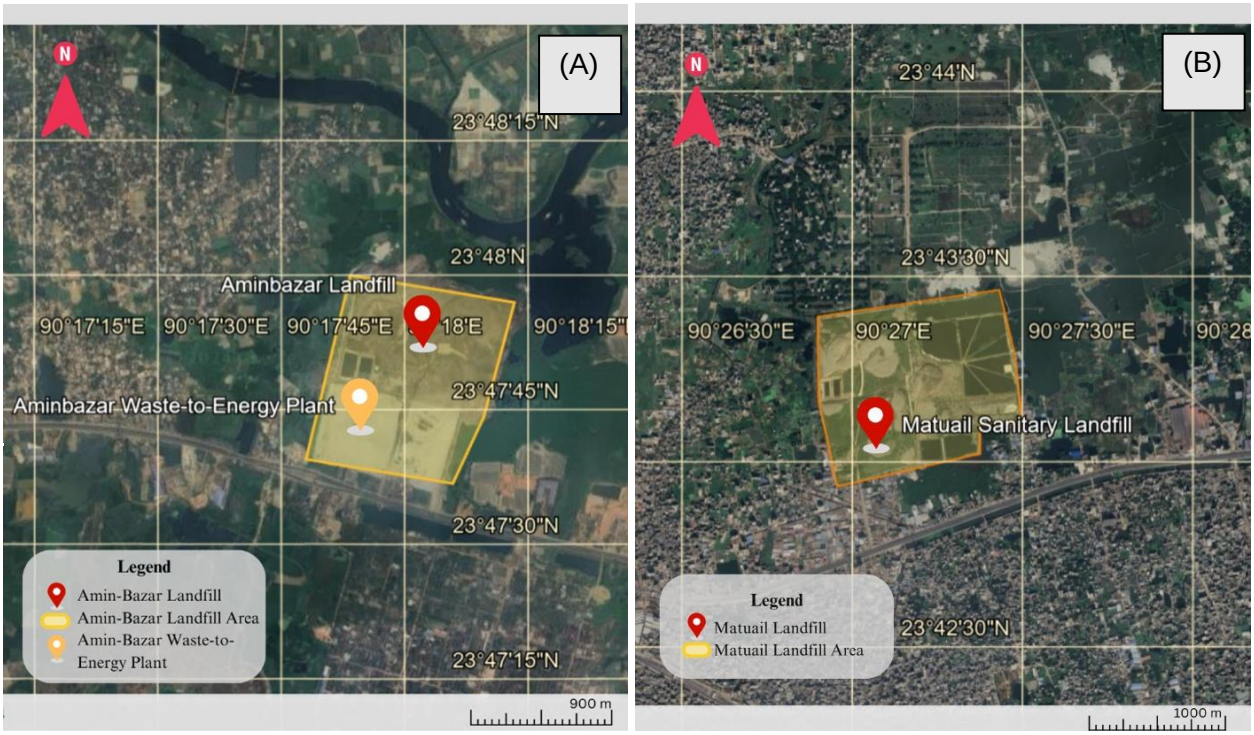


Figure 9 Satellite view of Amin Bazar (A) and Matuail (B) Landfill

The figure shows a large area of agricultural land near the Amin-Bazar Landfill. This agricultural land, susceptible to leachate permeation, supports the livelihood of many neighboring dwellers. Additionally, many shallow water bodies and Karnatali River are noticed on the eastern side and many settlements can be observed.

The second figure depicts the Matuail landfill. Although the adjacent areas of the landfill do not have as many waterbodies and agricultural land as Amin Bazar, many settlements and waterbodies are located near, especially on the south and south-western sides.

The situation is further complicated by a planned waste incineration project in Dhaka, which has sparked debate between the government and the contracting company regarding potential pollution from the facility. Bangladesh's daily per capita generation of solid waste is nearly 35,000 metric tons, with the two city corporation areas of Dhaka producing more than 7,000 metric tons of waste per day. This figure is expected to rise in the coming decades as the economy grows. In 1991, over 43 hectares (106 acres) of landfill were required annually to dump urban solid waste,

[27] The Business Standard (TBS). (n.d.). Aminbazar's wasteland story. Retrieved from https://www.tbsnews.net/environment/aminbazars-wasteland-story

while in 2021, this requirement surged to nearly 223 hectares (550 acres), putting immense pressure on land-scarce Bangladesh.[28]

6.1. Total Emission of Methane

Methane emissions from landfills pose a significant environmental threat. For every 1,000 tons (907 metric tons) of food waste landfilled, an estimated 34 metric tons of fugitive methane emissions (838 MtCO2e) are released.[29] For 152Mt of municipal solid waste, 1,186,094t of m ethane gas is emitted, according to a study in China.[30] An observation from the GHG emission calculation based on IPCC Guideline tier-1 revealed that 20.5 Gg and 16.96 Gg of methane is emitted from the landfill sites at Dhaka City from 1670 tons and 1375 tons municipal solid waste in 2005 and 2001[31]. Another study in 2014 assessed DNCC and DSCC collectively generate about 1.6 million tons of municipal waste per year, emitting approximately 1 million tons of GHG annually.[32]

Methane Emissions Calculation by IPCC Default Method

Methane emissions (Gg/year) = (MSWT×MSWF×MCF×DOC×DOCF×F×16/12−R) × (1−OX)

Default Values

MSWF: 1 (assuming all waste goes to the landfill)

MCF: 0.6 (default value for general landfill management)

DOC: 0.15 (typical value for mixed municipal solid waste)

DOCF: 0.77 (IPCC default value)

F: 0.5 (IPCC default value)

R: 0 (assuming no methane recovery)

OX: 0 (IPCC default value)

Our study found that almost 3000 tons and 3500 tons of municipal solid waste are dumped daily in the two major landfills of Dhaka city: Matuail and Amin-Bazar landfills, respectively.

Methane emissions from the landfills in Dhaka city can be estimated using the IPCC Guidelines' default method, which takes into account various factors such as the amount of waste generated, the fraction of waste disposed of in landfills, and the degradation characteristics of the organic content. From the calculation, we can find that the combined methane emissions from the Matuail

[28] Chowdhury, K.R. Bangladesh incinerator project sparks row between government, contractor. Mongabay News. Published June 30, 2024. Retrieved from: https://news.mongabay.com/2024/06/bangladesh-incinerator-project-sparks-row-between-government-contractor/#:~:text=

[29] U.S. Environmental Protection Agency (EPA). (2023). Food waste landfill methane... Retrieved from https://www.epa.gov/system/files/documents/2023-10/food-waste-landfill-methane-10-8-23-final_508-compliant.pdf

[30] ScienceDirect. (n.d.). [Article]. Retrieved from https://www.sciencedirect.com/science/article/pii/S1674927814500147

[31] Bo-Feng, C., Jian-Guo, L., Qing-Xian, G., Xiao-Qin, N., Dong, C., Lan-Cui, L., Ying, Z., & Zhan-Sheng, Z. (2014). Estimation of methane emissions from municipal solid waste landfills in China based on point emission sources. Advances in Climate Change Research, 5(2), 81-91 https://doi.org/10.3724/SP.J.1248.2014.081

[32] Chowdhury, D. A. H., Mohammad, N., Haque, M. R. U., & Hossain, D. T. (2014). Developing 3Rs (reduce, reuse, and recycle) strategy for waste management in the urban areas of Bangladesh: Socioeconomic and climate adoption mitigation option. IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT), 8(5), 9-18. http://benjapan.org/iceab10/62.pdf

and Amin-Bazar landfills are approximately **187 tons/day,** resulting in annual emissions of about **68.34 Gg.**

The Matuail Landfill emits approximately **31.54 gigagrams of methane annually**, which equates to around **86.4 tons per day**. In comparison, the Amin Bazar Landfill produces about **36.80 gigagrams of methane each year**, translating to roughly **100.8 tons per day**. Both landfills contribute significantly to methane emissions, indicating a pressing need for enhanced waste management strategies to address these environmental impacts.

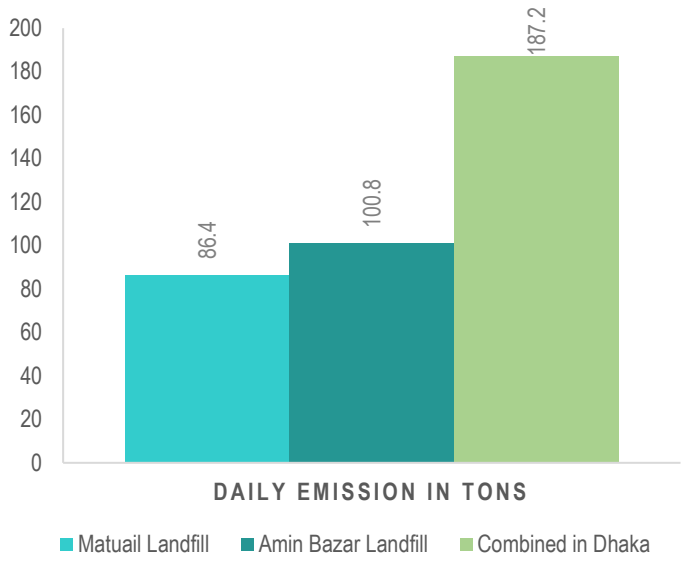


Figure 10 Estimated Methane Emission per Day from Landfills in Dhaka

Despite the significant environmental impact, awareness of methane emissions and their effects remains low among workers and the community including at the policy level. Key informant interviews have revealed several ongoing and planned initiatives to address this issue. These include covering landfills with soil, installing methane capture systems to track and treat the gas, and converting waste into energy. A proposed 30-acre plant aims to process 3,500 tons of waste daily, converting it into energy. These efforts highlight the importance of effective waste management strategies in mitigating methane emissions and their environmental impacts. But waste-to-energy incineration is the most expensive waste management approach, with three times the costs of landfills and up to five times the cost of recycling and composting and a polluting method that contributes to climate change and is an obstacle to zero waste solutions.[33]

Emission Potential of Organic Waste Generated in the Country

The methane emission potential of organic waste generated in Bangladesh is substantial, reflecting a critical area for intervention in greenhouse gas mitigation efforts. Organic waste, primarily comprising food scraps, yard waste, and agricultural residues, which constitute about 61-81% of the total waste generated in Bangladesh, significantly contributes to methane emissions.[34] Organic waste, primarily composed of food-related materials, undergoes anaerobic decomposition in landfills, leading to the production of methane. This high percentage is typical

[33] Zero Waste to Zero Emissions Report. (2022). [Report]. Retrieved from https://www.no-burn.org/wp-content/uploads/2022/11/zero-waste-to-zero-emissions_full-report.pdf

[34] Islam, M. K., Khatun, M. S., Arefin, M. A., Islam, M. R., & Hassan, M. (2021). Waste to energy: An experimental study of utilizing the agricultural residue, MSW, and e-waste available in Bangladesh for pyrolysis conversion. *Heliyon*, *7*(12), e08530. https://doi.org/10.1016/j.heliyon.2021.e08530

for developing cities where organic waste dominates the waste stream due to the significant consumption of fresh produce and minimal packaging waste.

To arrive at an estimation, we can reference studies and data on the total waste generation in Bangladesh. For example, it is estimated that the country generates approximately 25,000 to 30,000 tons of solid waste per day.[35] Based on 80% organic content, the organic waste generated daily would range between 17,500 to 21,000 tons. Annually, this translates to roughly **6.4 to 7.7 million tons of organic waste**. Based on IPCC guidelines, the estimated methane emissions from organic waste in Bangladesh range from **approximately 638.8 million to 766.5 million cubic meters annually**.

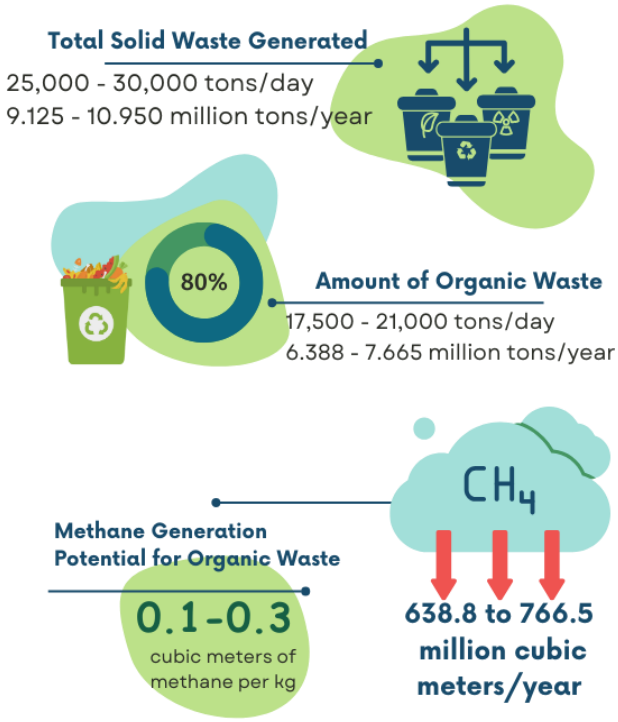


Figure 11 Emission potential of organic waste

The high proportion of organic waste is a critical factor in the environmental impact of waste management practices in Bangladesh. The significant volume of organic waste underscores the importance of implementing effective waste management strategies, such as composting, anaerobic digestion, and enhanced landfill management, to mitigate methane emissions and reduce the environmental footprint of waste disposal in Bangladesh.

6.2 Methane Emission Reduction Potential by 2030 based on Bangladesh NDC

Government Budget Allocation

In 2014, Bangladesh adopted the Climate Fiscal Framework (CFF), updated in 2020, to integrate climate considerations into its Public Financial Management system. For the fiscal year 2022-23, the cumulative budget allocation of the most relevant twenty-five Ministries/Divisions accounts for 55.82% of the total national budget, with climate-relevant allocations making up 8.07%. Over the past eight years, these climate-related allocations have increased two and a half times, from TK 12,163 crore (about US$ 1.44 billion) in FY2015-16 to TK 30,531.98 crore (about US$ 3.08 billion) in FY2022-23.

[35] Mostakim, K., Arefin, M. A., Islam, M., & Shifullah, K. (2021). Harnessing energy from the waste produced in Bangladesh: Evaluating potential technologies. Heliyon, 7. https://doi.org/10.1016/j.heliyon.2021.e08221

The government's budget reflects a strategic investment in key sectors to meet the NDC targets:

- **Waste Management**: Funding is allocated to improve solid waste disposal systems and upgrade wastewater treatment facilities. This includes initiatives to capture methane emissions and promote waste-to-energy projects.
- **Agriculture**: Investments are directed towards sustainable practices in rice cultivation and livestock management. These include introducing alternate wetting and drying techniques in rice farming and enhancing manure management to reduce methane emissions.

GHG Emission Reduction Strategies in NDC

The 2021 NDC highlights several key strategies for reducing GHG emissions:

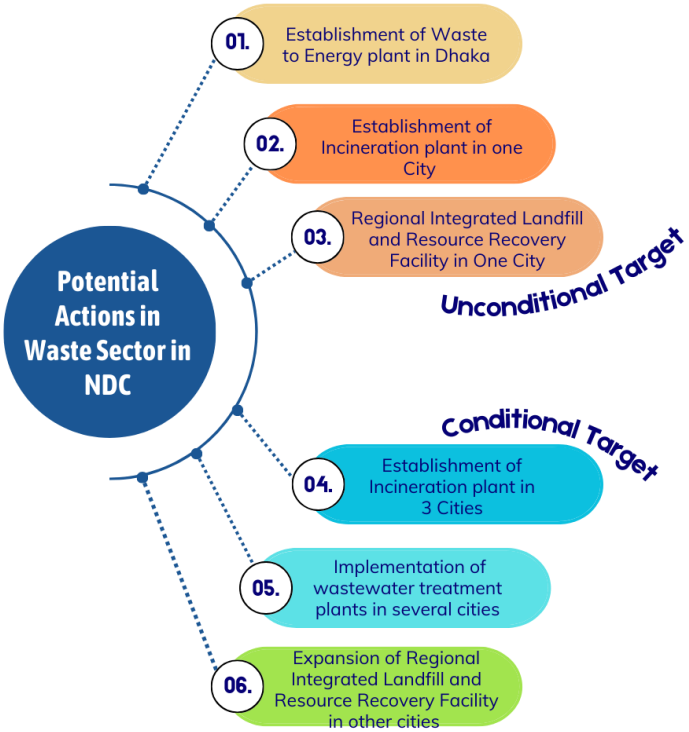


Figure 13 NDC strategies for reducing GHG emissions

• **Unconditional Target:** In the unconditional scenario, GHG emissions would be reduced by 27.56 Mt CO2e (6.73%) below BAU in 2030 in the respective sectors. 26.3 Mt CO2e (95.4%) of this emission reduction will be from the Energy sector while 0.64 (2.3%) and 0.6 (2.2%) Mt CO2e reduction will be from AFOLU (agriculture) and waste sector respectively. There will be no reduction in the IPPU sector.

• **Conditional Target:** In the conditional scenario, GHG emissions would be reduced by 61.9 Mt CO2e (15.12%) below BAU in 2030 in the respective sectors. The conditional mitigation measures will be implemented by Bangladesh, only if there is external financial/technology support. The conditional scenario has 59.7Mt CO2e (96.46%) emission reduction from the Energy sector, while 0.4 (0.65%) and 1.84 (2.97%) Mt CO2e reduction will be from AFOLU (agriculture) and Waste Sector respectively. There will be no reduction in the IPPU Sector.

Sectoral Initiatives:

Methane emissions, a significant component of GHG emissions in Bangladesh, come primarily from the waste and agriculture sectors. These sectors present unique challenges and opportunities for mitigation.

- **Waste Sector:** In 2012, methane emissions from the waste sector accounted for 24.11 million tons of CO2e, which is 14.26% of the total emissions. Methane in this sector mainly comes from solid waste disposal and domestic wastewater management.
- **Agriculture Sector:** Agriculture contributes significantly to methane emissions, mainly from rice paddies, enteric fermentation in livestock, and manure management. This sector accounted for 45.87 million tons of CO2e or 27.13% of total emissions in 2012.

According to the NDC 2021, Bangladesh has targeted to achieve significant methane emission reductions by 2030 through improved waste management, waste-to-energy projects, modern landfill technologies, Alternative Wetting and Drying (AWD) techniques in rice cultivation, and better livestock management.

These efforts aligning with global initiatives such as the Global Methane Pledge is targeted to a reduction of **27.31 million tons of CO2e**, 10.81 million tons of CO2e (6.18 unconditional + 4.63 conditional) from the Waste Sector, and 16.50 million tons of CO2e (11.00 unconditional + 5.50 conditional) from Agriculture Sector, contributing substantially to global methane mitigation goals.

Figure 14 Emission Reduction Potential of Bagladesh According to the NDC

However, reliance on waste-to-energy and incineration projects, which are portrayed as solutions, may have negative environmental consequences. Incineration processes emit toxins and contribute to air pollution, undermining climate goals. A more sustainable focus would be on zero waste strategies, such as composting and recycling, which align with methane reduction goals without the negative environmental impact.

The False Solutions!

Bangladesh's NDC and National Action Plan propose various measures to address methane emissions, including **waste-to-energy/ incineration projects**. However, these approaches have several drawbacks:

- **Environmental Impact**: Waste-to-energy projects can result in significant pollution and environmental degradation. These methods often fail to address the root

causes of waste and methane emissions, exacerbating air quality issues and greenhouse gas emissions.

- **High Costs**: Incineration and waste-to-energy technologies are costly compared to alternatives like recycling and composting. Their high operational costs divert funds away from more sustainable and cost-effective waste management solutions.
- **Inefficiency in Emission Reduction**: These technologies may not significantly reduce methane emissions compared to comprehensive waste management strategies. They often focus on energy recovery rather than reducing overall waste and methane generation and offset emissions, increasing the emissions of CO2.

Given these concerns, it's crucial to reconsider the role of waste-to-energy and incineration in the NDC. The focus should shift towards more sustainable practices that can effectively reduce methane emissions and promote a circular economy.

The Potential of the Waste Sector for Fast Action on Methane and Climate Justice

1. **Methane from Organic Waste**
   - **Quantitative Impact**: Organic waste, a major source of methane, contributes significantly to greenhouse gas emissions. By 2030, addressing methane from organic waste could lead to substantial reductions. Effective waste management strategies could potentially reduce methane emissions by up to 27.31 million tons of CO2 equivalent (CO2e), with specific reductions from the waste sector estimated at 10.81 million tons of CO2e and from the agriculture sector at 16.50 million tons of CO2e.
   - **Reduction Possibilities**: Improving waste segregation and implementing separate collections are the foundations for reducing methane emissions from organic waste. Additionally, preventing food waste and loss, promoting composting, anaerobic digestion, and the use of black soldier fly can further enhance these efforts. Also using organic waste as animal feed could contribute to waste reduction and methane mitigation.
2. **Scope for Livelihood Opportunities**
   - **Integration of Waste Pickers**: Incorporating waste pickers into formal waste management systems can enhance recycling rates and organic waste recovery, reducing landfill pressure. Recognizing and supporting waste pickers provides livelihood opportunities and improves waste management efficiency.
3. **Need for Just Transition**
   - **Equitable Transition**: A just transition involves ensuring that workers in the waste sector, particularly informal workers, receive support as the waste management system evolves. This includes providing training, fair wages, and safety measures, ensuring equitable and inclusive transition to sustainable practices.

By focusing on these areas, Bangladesh can enhance its methane reduction efforts, promote climate justice, and support a more sustainable and inclusive waste management system.

6.3 Environmental Justice Issues Around the Waste Pickers and People Living Around Landfills

Waste pickers and transporters are integral to Dhaka's waste management system but operate under hazardous conditions. Key issues include:

Respecting Planetary Boundaries and Ensuring Intergenerational Equity

The principle of respecting planetary boundaries emphasizes the need to manage resources within the Earth's capacity to regenerate and absorb waste, ensuring that future generations can inherit a healthy and sustainable environment. In Dhaka, landfills contribute to environmental degradation by exceeding the planet's natural limits. The excessive generation of waste, combined with inadequate waste management practices, leads to significant methane emissions, soil degradation, and water contamination, all of which strain the planet's ability to recover. The persistent odor, declining air quality, and loss of soil fertility in areas surrounding landfills reflect a system that fails to operate within ecological limits. This not only damages the environment but also disproportionately impacts marginalized communities, who are often left to bear the brunt of pollution. To honor intergenerational equity, it is crucial to adopt sustainable waste management practices that respect the planet's boundaries, ensuring that future generations inherit a livable environment.

Ensuring Respect and Inclusion for Waste Pickers and Workers

Waste pickers and transporters in Dhaka are essential to the waste sector but often face disrespect and marginalization, violating the principles of respect and inclusion. The hazardous environment in which they operate, particularly around landfills, contributes to environmental degradation that undermines the health and well-being of current and future generations. The pervasive odor and air pollution resulting from landfill emissions deteriorate local air and water quality while declining soil fertility adversely affects agricultural productivity in surrounding communities. By failing to address these environmental harms, the system perpetuates inequities, leaving marginalized communities to bear the brunt of pollution and compromised living conditions.

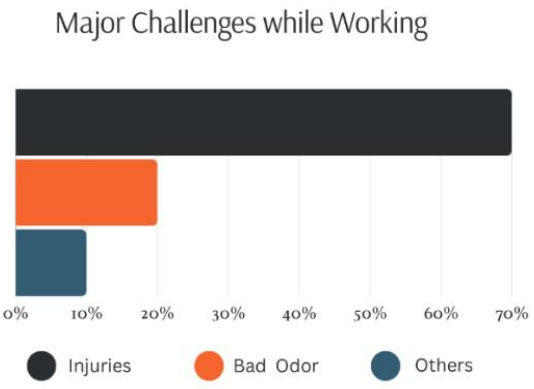


Figure 15 Major Challenges of Respondents

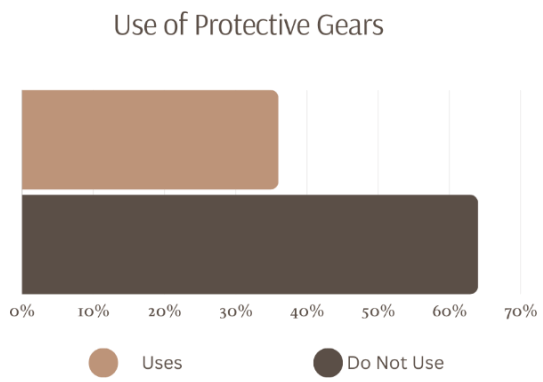


Figure 16 Using rate of protective gears

Approximately 70% of waste workers report injuries, such as cuts from handling sharp objects, and 80% suffer from respiratory problems due to exposure to hazardous materials. Despite these risks, only 36% of workers have access to protective gear like gloves, boots, and masks, often due to insufficient education and training. Ensuring that all workers are equipped with necessary safety measures and recognizing their contributions is vital to creating a more equitable and just waste management system. Additionally, engaging them in the decision-making process, paying them for their services, and providing land and equipment for the sorting of materials are essential steps toward achieving a fair and inclusive approach to waste management.

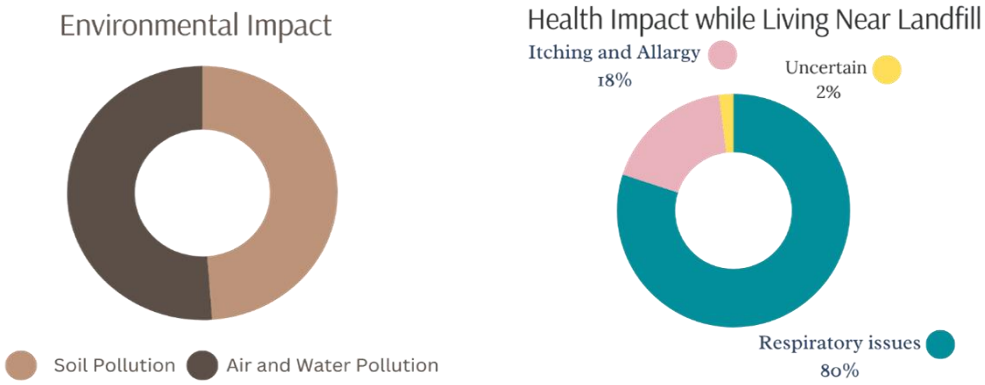


Figure 17 Environmental and Health Impact on the Respondents

Accountability and Holistic Solutions for Environmental Harm

The environmental degradation affecting communities living near Dhaka's landfills calls for accountability and holistic solutions. Residents face severe odor issues and a decline in soil fertility, with 64% reporting negative impacts on local agriculture. These challenges highlight the need for a systems change that addresses pollution and environmental harm with accountability, supporting not only the health of waste pickers and residents but also the integrity of the ecosystem. Integrating local knowledge into waste management practices and ensuring that communities have a voice in decision-making processes are crucial steps toward achieving environmental justice and supporting sustainable, long-term solutions for waste management in Dhaka.

6.4. Gaps in the City Solid Waste Management Systems

Figure 18 Waste Management Scenario in Dhaka

Responsibility of Waste Management

The city corporations (DNCC and DSCC) are responsible for waste management in Dhaka. They oversee waste collection, transportation, and disposal operations. However, there are challenges in coordination and accountability between various stakeholders, including private contractors and city authorities. This fragmentation leads to inefficiencies and gaps in the overall waste management system.

Waste Collection and Transportation

Waste collection starts at the household level, where private contractors known as Primary Collection Service Providers (PCSPs) or primary waste collection service providers (PWCSP) use vans and dump trucks to transport all type of waste to Secondary Transfer Stations (STSs). From these stations, the city corporations take over, utilizing an array of vehicles, including dump trucks, compactor trucks, and armed roll carriers. Each landfill receives waste from 500–550 trucks daily. Compactor trucks, prevalent in DNCC, make one to four trips to the Amin Bazar landfill, taking about 75 minutes per trip. The DSCC primarily uses container carriers and open trucks. There are four different types of secondary collection receptacles: concrete bins, containers, arm roll containers, and compactors for direct transport without waste storage. Open curbside waste accumulation is sometimes used at designated points for areas in which container placement is not suitable. The accumulated waste at STSs is then transported to final disposal by dump trucks and compactors. The efficiency and timeliness of waste collection and transportation are often hampered by traffic congestion and logistical challenges. It takes roughly 24 hours for waste to reach the landfill from households.

Interim Storage

Interim storage facilities are available at Secondary Transfer Stations (STSs) where waste is temporarily held before being transported to landfills. There are 48 STSs in the DNCC and 19 in DSCC. However, these facilities are often overwhelmed by the high volume of waste, leading to delays and inefficiencies in waste management. The lack of adequate interim storage capacity results in waste piling up in residential areas, causing health and environmental hazards.

Landfill Management and Condition of Land

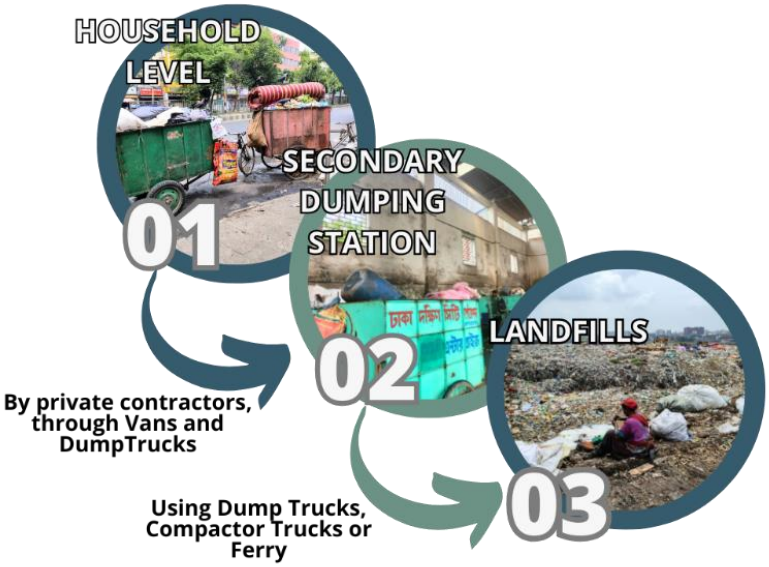


Figure 19 Waste flow from household to landfills

Matuail and Amin-bazar landfills are the main waste disposal sites for Dhaka, with Matuail handling approximately 3000 tons and Amin-bazar handling 3,500 tons of waste daily (from questionnaire survey and KII). The waste management operations at these sites are complex and multi-faceted. Waste collection starts at the household level to secondary dumping stations. From these stations, the city corporation takes over, utilizing an array of vehicles to ferry waste to the landfills.

The landfills are substantial in size, with the Aminbazar landfill reaching an imposing height of nearly 80 feet. Given Dhaka's high population density and limited available land, expanding these landfills or creating new ones presents significant challenges. The management strategy includes layering the waste with soil to curtail the release of greenhouse gases (GHGs). Additionally, leachate treatment plants are operational to process the liquid byproducts of waste decomposition, ensuring that these do not contaminate surface water sources.

Waste Disposal and Segregation

The waste composition at these landfills is diverse, encompassing organic matter, plastics, paper, glass, and medical waste. While 66% of surveyed respondents indicated that waste is directly stacked in the landfills, the remaining respondents noted that some degree of sorting is performed, particularly for plastics destined for recycling. Measures are reportedly in place to separate plastic waste that could be recycled from other types, with 90% of respondents acknowledging this practice. However, the effectiveness and consistency of these measures can vary widely.

Figure 20 Waste Disposal and Segregation Situation

Waste Recovery and Recycling

Municipal solid waste, collected from STSs by various trucks, is transported to landfills with compactors prevalent in DNCC and container carriers and open trucks more common in DSCC. Each landfill receives waste from 500-550 trucks daily, with compactor trucks making one to four trips to the Amin bazar landfill, taking about 75 minutes per trip. It takes roughly 24 hours for waste to reach the landfill from households. The weight of garbage is determined by weighing trucks before and after dumping, with manual recording of registration numbers, and both DSCC and DNCC exchange this data. Waste is not separated at the dumping platforms, and machinery like excavators, bulldozers, payloaders, and dumpers ensure uniform waste distribution. Despite the scale of these operations, there is a significant lack of awareness among waste workers about the environmental impacts, particularly methane emissions, a potent GHG with a global warming potential many times that of carbon dioxide.

Informal recycling activities are common, with waste pickers sorting recyclables like plastics and metals. However, formal recycling facilities and organized waste recovery systems are inadequate. The recycling process is fragmented, with informal workers playing a crucial role but lacking support and recognition. This leads to missed opportunities for resource recovery and reduced landfill pressure. In addition to supporting waste pickers and enhancing recycling infrastructure, promoting or mandating source separation could significantly boost recycling and composting rates, while also improving the working conditions of waste pickers.

Waste Reduction Policies

While there are policies and guidelines aimed at waste management, there is a lack of robust policies specifically focused on waste reduction. Existing regulations emphasize waste management but lack comprehensive enforcement mechanisms and incentives for reducing

waste at the source. The absence of strong policy frameworks hampers efforts to minimize waste generation and promote sustainable practices.

Although measures are in place to encourage waste segregation, it is not consistently enforced or mandatory. Public awareness and compliance with waste segregation practices are still low. This leads to mixed waste being transported to landfills, increasing the difficulty of effective waste management and resource recovery.

6.5. Gaps in Policy, Legal Frameworks, and Budget Allocation for Waste Management in Bangladesh

Gaps in the Policy and Legal Frameworks

Inadequate Enforcement: Existing waste management policies, such as the National 3R Strategy, face weak enforcement and ineffective monitoring mechanisms. This has resulted in inconsistent application and limited impact of waste management practices. For example, the National 3R Strategy emphasizes waste segregation but lacks robust enforcement mechanisms to ensure compliance.

Lack of Comprehensive Legislation: Current legal frameworks, including the Environment Conservation Act (1995) and the Waste Management Rules (2006), do not comprehensively address all aspects of waste management. Specifically, they fall short in managing methane emissions from landfills and other waste treatment processes, leading to insufficient measures for capturing and reducing these emissions.

Fragmented Regulations: Policies related to waste management are dispersed across various sectors and agencies, leading to overlaps and inconsistencies. For instance, waste management responsibilities are divided between the Ministry of Environment, Forest and Climate Change (MoEFCC), local government bodies, and other entities, resulting in fragmented efforts and regulatory gaps.

Absence of Incentives: There is a lack of financial and regulatory incentives to encourage industries and municipalities to adopt environmentally friendly waste management practices. The National 3R Strategy outlines the need for incentives but lacks specific mechanisms to provide these incentives, hindering the adoption of sustainable practices.

Gaps in the NDC Regarding the Waste Sector

Limited Focus on Waste Sector: The Nationally Determined Contribution (NDC) of Bangladesh places a stronger emphasis on energy and industrial emissions, with a limited focus on the waste sector. The NDC's primary targets are reducing emissions from energy and industrial sectors, leaving the waste sector underemphasized despite its significant contribution to methane emissions.

Lack of Specific Targets: The NDC does not include clear, specific targets for reducing methane emissions from the waste sector. This lack of specificity makes it challenging to measure progress and implement targeted strategies. For example, while the NDC outlines overall emission reduction goals, it does not set distinct targets for methane reductions from landfills and wastewater treatment.

Insufficient Integration: The waste sector is not well integrated into Bangladesh's overall climate strategy. The NDC focuses predominantly on energy and industrial emissions, missing opportunities to address waste management comprehensively and coordinate efforts across sectors.

Underestimation of Methane Impact: The NDC underestimates the significant impact of methane emissions from landfills and waste treatment processes. With methane being a potent greenhouse gas with a global warming potential over 25 times that of CO2, the lack of urgency in addressing these emissions diminishes the overall effectiveness of the NDC.

Gaps in Budget Allocation

Inadequate Funding: The budget allocation for waste management in FY2022-23 is TK 30,531.98 crore (about US$ 3.08 billion), but this is insufficient for implementing necessary infrastructure and technology upgrades. For instance, while funding is allocated for improving solid waste disposal and upgrading wastewater treatment, it falls short of addressing comprehensive needs for methane capture and reduction.

Skewed Priorities: Budget priorities often favor waste-to-energy projects and incineration over more sustainable practices such as composting and recycling. This misallocation can undermine efforts to establish a circular economy. For example, despite the growing focus on waste-to-energy projects, there is insufficient funding for initiatives like recycling and composting, which are more environmentally friendly and lead to greater GHG emissions reductions.

Lack of Long-Term Investment: There is a deficiency in long-term financial commitment to sustainable waste management practices. The current investments are often short-term, leading to temporary solutions rather than fostering a resilient waste management system. Long-term investments in technologies and infrastructure are needed to ensure sustainable waste management.

Absence of Support for Local Initiatives: Local governments and municipalities frequently lack the financial support needed to implement effective waste management practices. This gap impacts the ability of local entities to carry out community-level waste management and recycling initiatives effectively.

Scope for Integration of Different Departments and Agencies

Enhanced Coordination: There is significant potential for improving coordination between various government departments, such as environment, health, and urban development. A unified approach could streamline waste management efforts and enhance overall effectiveness.

Centralized Waste Management Authority: Establishing a centralized authority to oversee waste management could ensure consistent policy implementation and better coordination across sectors. This could address the fragmented approach currently in place.

Public-Private Partnerships: Encouraging public-private partnerships can lead to innovative solutions and increased investment in sustainable waste management practices. Collaborative efforts can leverage private sector expertise and resources to complement government initiatives.

Community Involvement: Engaging communities and local organizations in waste management initiatives can improve policy effectiveness and encourage public participation. Community-based approaches can enhance waste segregation, recycling, and overall management efforts.

7. Consultation with the Stakeholders, Policymakers, and Waste Workers

The consultations with waste workers and the stakeholder workshop provided crucial insights into improving waste management practices and working conditions. Waste workers emphasized the need for enhanced safety measures, better equipment, and fair wages to improve their working environment and efficiency. Meanwhile, the stakeholder workshop, which included policymakers and industry experts, highlighted the importance of strengthening regulations, investing in advanced technologies, and fostering public-private partnerships. Both consultations underscored the necessity of comprehensive research, policy development, and community engagement to address the complex challenges of waste management and methane emissions effectively. The key recommendations from the consultations include:

Methane Emission Management from Landfills:

Key recommendations include prioritizing anaerobic digestion for methane reduction and discontinuing incineration at the government level. Effective waste management requires stringent source segregation and improved communication among government sectors. Engaging the private sector, NGOs, communities, and researchers, and securing financial support are crucial for successful implementation.

Research and Policy Development:

Advances in research methodologies should focus on accurate methane quantification using satellite imaging and collaboration with local authorities. Recent data shows a significant increase in methane emissions, highlighting the need for better waste generation data. Policies should integrate circular economy models, enhance 3R practices, and promote biogas plants. Environmental education and public awareness are essential for effective policy enforcement.

Challenges and Recommendations for Dhaka:

Waste management in Dhaka faces significant challenges including physical hazards, unpleasant odors, and health risks for workers. Recommendations to address these issues include

encouraging households to segregate waste, improving waste collection efficiency, and providing better protective gear and health check-ups for workers. Public awareness campaigns and accelerated waste-to-energy projects are also recommended to reduce methane emissions and overall waste volume.

Overall Recommendations:

Enhancing anaerobic digestion, composting, and waste segregation practices are crucial for reducing methane emissions. The integration of biochar in agriculture and the expansion of biogas use are important for sustainability. Strengthening regulations, improving institutional coordination, and fostering public-private partnerships will support these efforts. Investing in modern technologies, educating the public, and developing financial mechanisms will drive progress in waste management and emission reduction.

These recommendations focus on improving methane emission management, advancing research and policy development, and leveraging stakeholder collaboration to enhance waste management practices and reduce environmental impact.

8. Recommendations for Waste Management and Methane Emission Reduction

8.1. Short-Term Recommendations

Policy Integration and Framework Enhancement

- **Incorporate Organic Waste Methane in NDC**: Integrate strategies for *preventing* methane emissions from organic waste into the Nationally Determined Contributions (NDC) through food waste and loss prevention, source separation, and recovery of organic waste via composting and anaerobic digestion. Additionally, set specific zero-waste targets to gradually reduce waste going to landfills by implementing measures such as separate collection, composting, recycling, reuse, and other sustainable practices. This also includes expanding the environmental justice framework to ensure equitable benefits and transitions for vulnerable communities.
- **National Policy and Budget Support**: Advocate for immediate budgetary support and national policies focusing on decentralized solid waste management (SWM) systems. This will enable effective capturing and processing of organic waste at the source, reducing methane emissions. Furthermore, Waste-to-Energy projects should be removed from the NDC as a proposed solution for waste management. Instead, promote sustainable alternatives, such as biogas production and decentralized composting. The focus should shift to waste prevention, reduction, and the circular economy, ensuring that organic waste is diverted from landfills and managed sustainably.

- **Adopt Environmental Justice Principles**: Integrate principles of environmental justice (EJ) to ensure that the impacts of waste management policies are equitably distributed and do not disproportionately affect marginalized communities.
- **Prepare for LOW Methane Partnership for Dhaka**: Initiate preparations for a partnership aimed at significantly reducing methane emissions in Dhaka. This involves aligning local and national policies to support methane reduction efforts.
- **Integrate Departments and Agencies**: Enhance coordination among various government departments and agencies involved in waste management to streamline efforts and improve policy effectiveness.

Infrastructure Development

- **Decentralized Composting Centers**: Establish composting centers at the community level to manage organic waste locally, thereby reducing the burden on landfills and mitigating methane emissions.
- **Support Source-Level Management**: Enforce mandatory source segregation of waste at the household, institutional, and industrial levels to improve segregation, separate collection and processing of organic waste, minimizing the volume of waste sent to landfills. Organic waste should be separated from other waste streams to prevent contamination and enable effective processing.
- **Create Decentralized Materials Recovery Facilities (MRFs)**: Develop decentralized MRFs to facilitate efficient sorting and recycling of waste materials, promoting circular economy practices and reducing landfill dependency.

8.2. Medium-Term Recommendations and Vision for 2030

Waste Picker Integration Mobilization and Capacity Building

Integrate waste pickers into formal waste management services by mobilizing, organizing, and providing capacity-building programs, along with social security measures. The processes can be replicated from Hasiru Dala in Bangalore, India, where formal identification cards for waste pickers have enabled access to banking, education loans, and health insurance. In the Philippines, waste workers have been formally integrated into zero-waste programs, improving wages and working conditions. Similarly, in Malabon City, Philippines, waste pickers have transitioned from earning minimal amounts from recyclables to receiving regular salaries while continuing to collect recyclables.[36]

[36] Salazar, M. (2019). Route to zero waste: A flood-prone city shows how it's done. Zero Waste Cities Asia. Global Alliance for Incinerator Alternatives

Develop a collaborative mechanism that allows waste pickers to actively participate in the development of zero waste initiatives and to benefit from new opportunities, either as employees or as entrepreneurs. In cities where informal recyclers belong to historically marginalized communities, ending lengthy discriminatory practices may be necessary.

Zero Waste Cities and Adoption of Zero Waste Approaches

Promote the adoption of zero waste principles in cities to minimize waste generation and maximize recycling and composting. Examples from Kamikatsu, Japan, and Capannori, Italy, demonstrate the effectiveness of comprehensive waste reduction strategies in achieving zero waste goals.[33]

The Environment and Social Development Organization-ESDO also launched a project named “Building Zero Waste Communities for a Pollution-Free Environment in Bangladesh” project in 2020. The project aims to build a Zero Waste community model to eliminate environmental health risks, promote community well-being, and accelerate the circular economy in Bangladesh. To minimize food loss, control waste, and create a sustainable future, ESDO promotes zero waste as a solution. For instance, in Rangpur, ESDO launched projects to build biogas plants and educate the public on organic food production and sustainable soil management. These initiatives support households by implementing waste management systems that produce biogas from organic waste, reducing methane emissions and generating electricity. Through the 4R strategy (Refuse, Reduce, Reuse, Refill), ESDO educates Bangladesh's rural population on the importance of waste segregation, reducing environmental pollution, and enhancing their capacity to adapt to climate change.

In Dhaka City, implementing Zero Waste principles could transform how waste is managed. By encouraging households, businesses, and industries to adopt practices that minimize waste generation and maximize recycling and composting, the amount of waste requiring disposal in landfills can be significantly reduced. This approach not only mitigates methane emissions from decomposing organic waste but also contributes to the circular economy by recovering valuable resources.

Furthermore, integrating biogas plants into waste management systems can convert source seperated organic waste into clean energy, further reducing methane emissions while providing renewable energy sources for the city. Education and awareness campaigns will be crucial in engaging the public and stakeholders, fostering a culture of waste reduction and sustainable consumption.

Food Loss and Waste Prevention

- **Interventions and Recovery Systems:** Implement targeted interventions to prevent food loss and waste throughout the food supply chain. Develop programs that address food waste at the production, distribution, and consumption stages. Successful interventions include

community-based food waste reduction programs and food waste audits that significantly reduce waste.[37]

- **Systems for Recovery of Food Waste:** Establish systems for the recovery and redistribution of food waste. Create infrastructure to collect surplus food and redistribute it to those in need. Programs like the Food Rescue Network in Canada efficiently redirect edible food to communities, reducing waste and supporting local needs. Cities must create user-friendly systems with consistent signage and outreach programs to ensure high compliance rates. Composting is the most straightforward, cost-effective, and scalable solution for organic waste.

Materials Recovery and Biological Treatment (MRBT) for Methane Prevention and Landfill Rehabilitation

Incorporating **Materials Recovery and Biological Treatment (MRBT)** for landfill restoration can significantly reduce methane emissions by preventing organic waste from reaching landfills in the first place. This method focuses on recovering valuable materials and stabilizing organic waste without producing refuse-derived fuel (RDF) for incineration. MRBT, used in facilities across Italy and Germany, prioritizes methane prevention by promoting source separation and treatment of waste before landfilling. When combined with agroecological practices and urban farming, MRBT can help improve both waste management efficiency and sustainability. This approach aligns with recommendations from Zero Waste Europe, which advocates for methane prevention over post-landfill capture.

Agroecology and Urban Farming

Encourage agroecological practices and urban farming to integrate sustainable agricultural methods with waste management. Projects by ESDO in Bangladesh and organic farming initiatives in India highlight the benefits of combining sustainable agriculture with waste reduction efforts.

The need for urgent action on climate change is more critical than ever. The scientific community has clearly stated that we are not doing enough to limit global warming to the crucial 1.5°C threshold. However, we do have solutions at our disposal. This report demonstrates that we have made significant progress in identifying the most effective strategies for both people and the planet. The current challenge is to mobilize the political will to swiftly and extensively implement these solutions, ensuring the inclusion of all stakeholders and upholding justice throughout the process.

[37] Barboza, Luís Gabriel Antão, A. Dick Vethaak, Beatriz R. B. O. Lavorante, Anne-Katrine Lundebye, and Lúcia Guilhermino. 2018. "Marine Microplastic Debris: An Emerging Issue for Food Security, Food Safety and Human Health." Marine Pollution Bulletin 133 (August): 336–48. https:// doi.org/10.1016/j.marpolbul.2018.05.047.

These recommendations aim to create a more sustainable and equitable waste management system in Dhaka, addressing methane emissions, improving waste segregation and recycling, and enhancing the overall effectiveness of waste management practices.

8. Conclusion

The findings of this study underscore the critical need for transformative changes in waste management practices in Bangladesh, particularly in urban centers like Dhaka, where the pressure on landfills is immense. The study reveals that the Matuail and Amin Bazar landfills are significant sources of methane emissions, largely due to the high proportion of organic waste. With daily methane emissions reaching approximately 187 tons and annual emissions amounting to about 68.34 gigagrams, the environmental impact is profound and poses a significant challenge to Bangladesh's climate goals.

The current waste management practices, characterized by inadequate segregation, improper landfill management, and reliance on open dumping, exacerbate the problem. The high methane emissions from the organic fraction of waste not only contribute to global warming but also represent a missed opportunity for resource recovery through more sustainable practices like composting and biogas production. The report highlights the necessity of integrating improved waste management strategies, such as enhanced landfill operations, methane capture technologies, and broader adoption of recycling and composting, and a zero-waste strategy that emphasizes waste reduction, resource recovery, and the sustainable management of materials throughout their lifecycle to reduce the environmental burden.

Moreover, the study emphasizes the need for a collaborative approach involving government agencies, local communities, waste workers, and policymakers to address the challenges posed by waste management. Policy interventions must align with international commitments, such as the Global Methane Pledge and the Nationally Determined Contributions (NDC), to effectively mitigate greenhouse gas emissions and promote sustainable development. By focusing on the organic waste sector, Bangladesh can make substantial progress in reducing methane emissions, improving public health, and contributing to global efforts to combat climate change.

In conclusion, the report calls for urgent and coordinated action to reform waste management practices in Bangladesh. The findings provide a clear mandate for stakeholders to prioritize sustainable solutions that address both environmental and public health concerns. Through concerted efforts, Bangladesh can transform its waste management systems, reduce methane emissions, and move closer to achieving its climate and sustainability goals.

Annexures

Research Methodology

Literature Review

The study began with a thorough review of existing literature on waste management practices, methane emissions from landfills, and relevant policies. This review provided a foundation of knowledge and identify best practices and lessons learned from similar contexts.

Study Area

Municipal solid waste (MSW) in Dhaka is primarily managed by two municipal corporations. The Amin-Bazar landfill (Latitude: 23° 47’ 42.86’’ N, Longitude: 90° 17’ 25.69’’ E) falls under the jurisdiction of the Dhaka North City Corporation (DNCC), while the Matuail landfill (Latitude: 23° 42’ 53.31’’ N, Longitude: 90° 27’ 10.01’’ E) is managed by the Dhaka South City Corporation (DSCC). These two landfill sites were the primary locations selected for the data collection survey.

Additionally, other areas such as Dhanmondi, Jatrabari, Gabtoli, Mirpur, Mohammadpur, Kolabagan, Sutrapur, Shantinagar, Mouchak, Malibagh and Gulistan were surveyed to collect comprehensive information on the waste collection and transportation processes. These stations act as transfer points where waste collected from nearby neighborhoods is consolidated before

Fig (A): Amin Bazar Landfill

Fig (B): Matuail Landfill

Figure 21 Study Area

being transported to larger disposal sites like Amin-Bazar and Matuail.

Data Collection

Primary Data Collection:

Interviews: Structured and semi-structured interviews like key informant interviews and FGDs were conducted with key stakeholders involved in waste management in Dhaka. These interviews gathered insights from government officials, municipal workers, and informal sector workers.

Stakeholders from Dhaka north and south city corporations were reached for KII to gather information on the waste management in the city.

Field Surveys: Questionnaire surveys are carried out at major waste dumpsites and landfills to collect data on the quantity, composition, and management practices of waste. These surveys provided firsthand information on the current state of waste management.

60 questionnaire survey was carried out in each landfill area. 30 were on waste collection, transportation, and disposal in Dhaka. The other 30 were with people and informal sector workers around landfills to understand the quantity and characteristics of waste dumped and the scope of livelihood.

Direct Observation: Observations of waste collection, transportation, and disposal processes were made to gather real-time data. This helped to identify inefficiencies and areas for improvement in the waste management system.

Secondary Data Collection: Existing reports, studies, and databases

Figure 22 Data Collection through Field Survey

related to waste generation, collection, and disposal in Dhaka were reviewed. Data were collected from government agencies, non-governmental organizations, and academic institutions to supplement primary data and provide a comprehensive picture of the waste management landscape.

Data Analysis:

- **Quantitative Analysis:** Statistical methods used to analyze the data collected on waste quantity, composition, and GHG emissions from the questionnaire surveys. Methane emissions from organic waste in landfills are estimated by comparing it with secondary data.
- **Qualitative Analysis:** Qualitative data from interviews and observations were analyzed to understand the challenges and opportunities in current waste management practices and policy implementation. This analysis provided context and depth to the quantitative findings.

Policy Review and Gap Analysis: A detailed review of Bangladesh's NDC and national policies related to waste management and GHG emissions is conducted. This review identified gaps in current policies and opportunities for integrating methane reduction strategies into the NDC. The aim is to ensure that national policies support effective and sustainable waste management practices.

Consultations and Recommendations: High-level consultations with government officials and other stakeholders were organized to discuss the study's findings and gather feedback. Based on these consultations, a set of recommendations for preventing and reducing methane emissions from organic waste is developed. These recommendations are aimed at integrating effective waste management strategies into Bangladesh's NDC, ensuring alignment with national and international climate goals.

This descriptive approach ensures that the study covers all necessary aspects of waste management and methane emission reduction in Dhaka, providing a comprehensive foundation for policy advocacy and strategic planning.

Pictorials: Landfill, Infrastructures and Waste Management Practices


Figure 23 Matuail Landfill

Figure 24 Amin Bazar Landfill


Figure 25 Waste Transportation and Storage


Figure 26 Interim Storage (Secondary Transfer Stations)



Figure 27 Waste Segregation and Recycling

Pictorials: Study, Survey, and Consultation Meetings

Figure 28 Preparing Volunteers for the Surveys

Figure 29 Survey with Waste Workers and People Living Around the Landfill

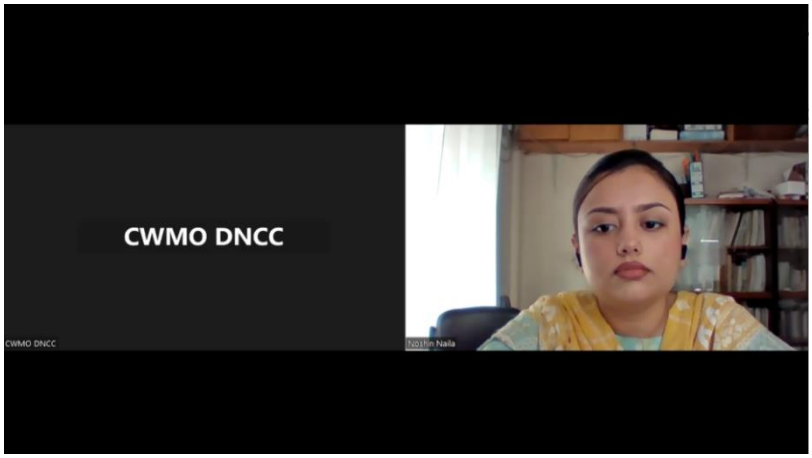


Figure 30 KII with Policy Makers

Figure 31 Consultation workshop with Stakeholders and Policy Makers

Figure 32 Zero Waste Initiative Case Story Preparation

Figure 33 Zero-Waste Initiative by ESDO

Lowering Organic Waste Methane Initiative (LOW-Methane)

The Lowering Organic Waste Methane (LOW-Methane) initiative, launched at COP28, aims to significantly reduce methane emissions from the waste sector, responsible for about 20% of global methane emissions. By engaging with 40 subnational jurisdictions, the initiative seeks to achieve at least 1 million metric tons of annual methane reductions, unlocking over $10 billion in investments and providing innovative tools for data and technology deployment.

Participation in LOW-Methane aligns with Bangladesh's commitments to global climate agreements and its Nationally Determined Contributions (NDCs), enhancing its credibility on the international stage. Additionally, the initiative offers substantial financial resources to upgrade waste management infrastructure and adopt innovative methane reduction technologies. Furthermore, being part of this consortium allows Bangladesh to benefit from knowledge sharing and collaboration with jurisdictions that have successfully implemented similar strategies. This engagement can foster local capacity building and the adoption of best practices.

Ultimately, reducing methane emissions will yield direct health benefits for communities living near waste disposal sites, contributing to improved air quality, soil health, and water resources. By participating in LOW-Methane, Bangladesh can take crucial steps towards sustainability and resilience.

Calculation of Methane Emission from Landfills

To calculate the daily and annual methane emissions from the Matuail and Amin-Bazar landfills in Dhaka, we used the provided IPCC equation and default values. Here's a breakdown of the calculation:

- **Daily waste dumped in Matuail landfill**: 3000 tons= 3 Gg/day
- **Daily waste dumped in Amin-Bazar landfill**: 3500 tons= 3.5 Gg/day

Total MSW generated (MSWT)

Total MSWT (annual)=
(3 Gg/day+3.5 Gg/day) ×365 days/year

Total MSWT (annual)=6.5 Gg/day×365

Total MSWT (annual)=2372.5 Gg/year

Default Values

- **MSWF**: 1 (assuming all waste goes to the landfill)
- **MCF**: 0.6 (default value for general landfill management)
- **DOC**: 0.15 (typical value for mixed municipal solid waste)
- **DOCF**: 0.77 (IPCC default value)
- **F**: 0.5 (IPCC default value)

- **R**: 0 (assuming no methane recovery)
- **OX**: 0 (IPCC default value)

Methane Emissions Calculation

Methane emissions (Gg/year) = (MSWT×MSWF×MCF×DOC×DOCF×F×16/12−R)×(1−OX)

Methane emissions (Gg/year) = (2372.5×1×0.6×0.15×0.77×0.5×16/12−0)×(1−0)

Methane emissions (Gg/year) = 68.34Gg/year

Daily Methane Emissions

Daily methane emissions=0.187 Gg/day

Daily methane emissions=187 tons/day

Matuail Landfill:

- **Annual methane emissions**: 31.54 Gg/year
- **Daily methane emissions**: 86.4 tons/day

Amin Bazar Landfill:

- **Annual methane emissions**: 36.80 Gg/year
- **Daily methane emissions**: 100.8 tons/day

Case Studies

Zero-Waste Initiatives by ESDO, Bangladesh

The Zero Waste concept is a philosophy and design principle that extends beyond recycling to embrace a "whole system" approach to the management of resources and waste in human society. It promotes the imitation of sustainable natural cycles, where discarded materials serve as resources for others.

In urban areas, Bangladesh produces 25,000 tons of solid waste daily, a number projected to reach 47,000 tons per day by 2025. This uncollected waste poses significant risks to human health by polluting surface and groundwater, soil, and air. To combat this issue, the Environment and Social Development Organization (ESDO) initiated the "Building Zero Waste Communities for a Pollution-Free Environment in Bangladesh" project in 2020.

The project aims to build a Zero Waste community model to eliminate environmental health risks, promote community well-being, and accelerate the circular economy in Bangladesh. To minimize food loss, control waste, and create a sustainable future, ESDO promotes zero waste as a solution. For instance, in Rangpur, ESDO launched projects to build biogas plants and educate the public on organic food production and sustainable soil management. These initiatives support households by implementing waste management systems that produce biogas from organic waste, reducing methane emissions and generating electricity.

To promote sustainable farming practices, ESDO encouraged 300 families in Betagari Union and Rangpur to use the "Twin Pit Earth Composter," an efficient tool for managing soil health and producing organic food. Through the 4R strategy (Refuse, Reduce, Reuse, Refill), ESDO educates Bangladesh's rural population on the importance of waste segregation, reducing environmental pollution, and enhancing their capacity to adapt to climate change.

Read More: https://zerowaste.esdo.org/

Circular Economy Initiatives by KKPKP in Pune, India

The Kagad Kach Patra Kashtakari Panchayat (KKPKP) has been a leading force in advancing circular economy practices in Pune, India. Their efforts focus on integrating circular economy principles into urban waste management to foster a more sustainable environment. This case study explores KKPKP’s strategies, achievements, and challenges in implementing these practices within Pune.

KKPKP's approach includes several key strategies. The organization has been instrumental in improving waste segregation at the source by encouraging residents to separate waste into organic (wet), hazardous, sanitary, and recyclable (dry) categories. This segregation facilitates more efficient recycling and composting. Additionally, KKPKP has set up community-based composting units to manage organic waste, providing residents with composting tools and guidance. They have also developed and upgraded waste management infrastructure, including recycling centers and waste collection systems. Community engagement is a cornerstone of their

strategy, involving educational campaigns to raise awareness and collaborations with local businesses and public institutions to promote sustainable practices.

The initiatives have led to several notable achievements. KKPKP has significantly increased recycling rates and reduced the volume of waste sent to landfills through effective composting programs. Enhanced community participation in waste management practices has been realized through targeted education and outreach. Despite these successes, KKPKP has faced challenges such as infrastructure limitations, which have hindered its ability to meet growing waste management needs. Additionally, resistance to changing long-standing waste disposal habits among residents has required ongoing efforts in education and motivation. Policy gaps have also affected the effectiveness of their circular economy practices.

To address these challenges and build on their successes, KKPKP recommends expanding recycling facilities to handle increasing volumes of recyclables, enhancing public awareness through continued education, and advocating for stronger policy frameworks and enforcement to support circular economy initiatives. KKPKP's work in Pune demonstrates the potential of integrating circular economy principles into waste management and provides valuable insights for other cities aiming to adopt similar practices.

Read More: https://swachcoop.com/

Zero Waste Implementation by Hasiru Dala, Bengaluru, India

Hasiru Dala launched a zero-waste project in Ward 177, Bengaluru, from June 2019 to March 2020, aiming to enhance waste management through source segregation, composting, and recycling while engaging the community.

The project aimed to reduce landfill waste to zero by improving waste segregation, establishing composting programs, and boosting recycling efforts. Engaging the community was also a key goal, promoting sustainable waste management practices through education and involvement.

An important aspect of their strategy was implementing waste segregation at the source, establishing community composting for organic waste, and improving recycling for dry waste materials. These measures effectively managed and reduced the volume of waste sent to landfills. The project resulted in a significant reduction in landfill waste and increased community participation in waste management practices. Notable outcomes included improved sanitation and reduced environmental impact.

However, they also encountered challenges such as limited infrastructure and resources for comprehensive waste management and difficulties in changing established waste disposal habits among residents. The project's success suggests that scaling these practices to other areas could enhance overall waste management. Stronger policy support and investment in infrastructure are needed, along with ongoing community education to sustain and expand zero waste efforts.

Hasiru Dala's zero waste project in Ward 177 demonstrates the effectiveness of targeted waste management strategies and community involvement. The initiative's success provides a model for other regions, highlighting the importance of overcoming challenges to achieve zero waste goals. **Read More: https://hasirudala.in/initiatives/zero-waste/**

Survey Questionnaires

Interview On Waste Collection, Transportation, And Disposal In Dhaka

Respondents Demographic Profile			
Ethnicity:		**Locality:**	
Name:		**Sex:**	Male/Female/Others
Age:		**Educational Qualification:**	
Occupation:		**Contact:**	

1. How long have you been working around this landfill? (আপনি কতদিন যাবত এই ল্যান্ডফিলে কাজ করছেন?)

a. <5 years b. 5-10 years c. 10-15 years d. 15-20 e. >20 years

2. How would you describe the current waste collection process in your area? (আপনি আপনার এলাকায় বর্তমান বর্জ্য সংগ্রহ ব্যাবস্থা কেমন বলে মনে করেন?)

a. Very good b. Good c. Moderate d. Bad e. Very Bad

3. Can you explain how waste is transported from households to the disposal sites? (বসতবাড়ি থেকে ল্যান্ডফিল পর্যন্ত বর্জ্য পরিবহন প্রক্রিয়াটি কি?)

Ans:

4. Where does the waste go after dumping in the landfill? (ল্যান্ডফিলে ফেলার পর বর্জ্যগুলো কি করা হয়?)

Ans:

5. How many trucks/vans of waste are dumped in the landfills every day? (Mention the amount) (প্রতিদিন কত ট্রাক/ভ্যান বর্জ্য ল্যান্ডফিলে ফেলা হয়?)

a. 10-15 b. 15-20 c. 20-25 d. 25-30 e. Others

Ans:

6. What is the size of the truck/van used for waste collection? (বর্জ্য সংগ্রহের জন্য ব্যবহৃত ট্রাক/ভ্যানের আকার বা ধারনক্ষমতা কতটুকু?)

a. 2-3 ton b. 5 ton c. 7 ton d. Others

7. How many days a week are the wastes dumped? (সপ্তাহে কতদিন বর্জ্য ল্যান্ডফিলে ফেলা হয়?)

a. 4 days b. 5 days c. 6 days d. 7 days e. Others

8. What types of waste do you usually see being dumped here? (Organic, plastic, paper, etc.) (সাধারণত কি ধরনের বর্জ্য এখানে ডাম্প করা হয়?)

a. Organic b. Plastic c. Paper d. Glass e. Others

Ans.

9. Do you estimate how much organic waste is disposed of in landfills? If yes, then how? (ল্যান্ডফিলে পতিত জৈব বর্জ্যের পরিমাপ করা হয় কি না? করা হলে কীভাবে?)
   a. Yes b. No

Ans:

10. Are there any measures in place to separate organic waste from other types of waste during or after collection? If yes, then what are the measures explain in details? (সংগ্রহের সময় বা পরে অন্য বর্জ্য থেকে জৈব বর্জ্য আলাদা করার জন্য কোন ব্যবস্থা আছে কি? যদি হ্যাঁ, তাহলে ব্যবস্থাগুলি কি বিস্তারিতভাবে ব্যাখ্যা করুন?)
    a. Yes b. No

Ans:

11. Are there any recycling activities happening in this area? (Organic waste, plastic waste, medical waste, Glass waste, and others) (এখানে কি বর্জ্য রিসাইকেল করার জন্য কোন কার্যক্রম আছে? থাকলে কোনগুলো রিসাইকেল করা হয়?)

    a. Yes b. No

a. Organic waste, b. Plastic waste, c. Medical waste, d. Glass waste, e. Others

12. Do you have any idea of Methane emission (feel any musty smell or gas) from the landfills? If yes, then explain in details. (আপনার কি ল্যান্ডফিল থেকে মিথেন নির্গমন (কোনও ঝাঁঝালো গন্ধ বা গ্যাস অনুভব) সম্পর্কে কোন ধারণা আছে? যদি হ্যাঁ, তাহলে বিস্তারিত ব্যাখ্যা করুন।)
    a. Yes b. No

Ans.

13. Are there any specific initiatives or programs aimed at reducing methane emissions from organic waste? If yes, please mention the program. (জৈব বর্জ্য থেকে মিথেন নির্গমন কমানোর লক্ষ্যে কোন নির্দিষ্ট উদ্যোগ বা কর্মসূচি আছে কি? যদি হ্যাঁ, উল্লেখ করুন.)

    a. Yes b. No

Ans:

14. What are the major challenges faced while working here and how do you handle them? (এখানে কাজ করার সময় কি কি সমস্যার সম্মুখীন হন এবং কীভাবে সেগুলো মোকাবিলা করেন?)

Ans:

15. If you are provided with masks, gloves, and boots, will you use them? Explain according to your answer. (যদি আপনাকে মাস্ক, গ্লাভস এবং বুট দেওয়া হয়, আপনি কি সেগুলি কাজের সময় ব্যবহার করবেন? উত্তর ব্যাখ্যা করুন।)

a. Yes b. No

Ans:

16. What more improvements could be made here to make it more conducive to work?(কাজ করা পরিবেশ আরও সুবিধাজনক করতে এখানে আরও কী উন্নতি করা যেতে পারে?)

Ans:

17. If you are given the opportunity to switch your job, or to stay here with all the necessary arrangements, will you care for an alternative livelihood? Explain according to your answer. (যদি আপনাকে আপনার চাকরি পরিবর্তন করার সুযোগ দেওয়া হয়, অথবা প্রয়োজনীয় সমস্ত ব্যবস্থা করে এখানে থাকার সুযোগ দেওয়া হয়, আপনি কি বিকল্প জীবিকা বেছে নিবেন? উত্তর ব্যাখ্যা করুন।)

a. Yes b. No

Ans.

Interviews With People And Informal Sector Workers Around Landfills To Understand The Quantity And Characteristics Of Waste Dumped And The Scope Of Livelihood

Respondents Demographic Profile			
Ethnicity:		**Locality:**	
Name:		**Sex:**	Male/Female/Others
Age:		**Educational Qualification:**	
Occupation:		**Contact:**	

1. How long have you lived or worked near the landfill? (আপনি কতদিন ধরে ল্যান্ডফিলের কাছাকাছি থাকেন বা কাজ করেছেন?)

a. <5 years b. 5-10 years c. 10-15 years d. 15-20 e. >20 years

2. Have you noticed any environmental or health changes since living/working here? What are those, explain in detail. (এখানে বসবাস/কাজ করা অবস্থায় আপনি কি আপনার পরিবেশগত বা স্বাস্থ্যগত কোন পরিবর্তন লক্ষ্য করেছেন? সেগুলি কী, বিস্তারিত ব্যাখ্যা করুন)

a. Yes b. No

Ans:

3. How does the landfill affect your daily life/work? (এই ল্যান্ডফিল কীভাবে আপনার দৈনন্দিন জীবন/কাজকে প্রভাবিত করে?)

a. Do not Affect b. Neutral c. Moderately Affects d. Extremely Affects

4. Are you aware of methane emissions from the landfill? (আপনি কি ল্যান্ডফিল থেকে মিথেন গ্যাস নির্গমন সম্পর্কে জানেন?)

a. Yes b. No

5. Have you experienced any respiratory issues or other health problems that you believe are related to the landfill? (আপনি কি কোনো শ্বাসকষ্টের সমস্যা বা অন্যান্য স্বাস্থ্য সমস্যার সম্মুখীন হয়েছেন যা আপনি মনে করেন যে ল্যান্ডফিলের কারনে হতে পারে?)

a. Strongly Agree b. Agree c. Uncertain d. Disagree e. Strongly Disagree

6. How do you think methane emissions from the landfill impact your community's overall health and well-being? Explain according to your answer. (ল্যান্ডফিল থেকে মিথেন নির্গমন আপনার লোকালয়ের সামগ্রিক স্বাস্থ্য-সুরক্ষাকে কিভাবে প্রভাবিত করে বলে আপনি মনে করেন? আপনার উত্তর অনুযায়ী ব্যাখ্যা করুন।)

a. Very good b. Good c. \Moderate d. Bad e. Very Bad

Ans:

7. Do you think improved waste management could positively impact your livelihood and community? Explain according to your answer. (উন্নত বর্জ্য ব্যবস্থাপনা আপনার এবং আপনার আশেপাশের সম্প্রদায়কে ইতিবাচকভাবে প্রভাবিত করতে পারে বলে কি আপনি মনে করেন? আপনার উত্তর অনুযায়ী ব্যাখ্যা করুন।)

a. Strongly Agree b. Agree c. Uncertain d. Disagree e. Strongly Disagree

Ans:

8. Have you noticed any changes in soil quality or fertility that you believe are related to methane emissions? If you agree then, what are those changes, please explain in detail. (আপনি কি মাটির গুণমান বা উর্বরতার কোন পরিবর্তন লক্ষ্য করেছেন যা মিথেন নির্গমনের সাথে সম্পর্কিত হতে পারে? যদি আপনি একমত হন, তাহলে সেই পরিবর্তনগুলি কী, অনুগ্রহ করে বিস্তারিত ব্যাখ্যা করুন।)

a. Yes b. No

Ans:

9. Have you noticed any pollution or smell in water and air that you believe is related to methane emissions? If you agree then, what are those changes, please explain in detail. (আপনি কি পানি এবং বাতাসে কোন দূষণ বা গন্ধ লক্ষ্য করেছেন যা মিথেন নির্গমনের সাথে সম্পর্কিত হতে পারে? যদি আপনি একমত হন, তাহলে সেই পরিবর্তনগুলি কী, অনুগ্রহ করে বিস্তারিত ব্যাখ্যা করুন।)

a. Yes b. No

Ans:

10. Do you have any suggestions or ideas for reducing methane emissions from the landfill? (ল্যান্ডফিল থেকে মিথেন নির্গমন কমানোর জন্য আপনার কোন পরামর্শ বা মতামত আছে?)

Ans:

11. Have you seen any efforts or initiatives in the community to address methane emissions or improve waste management practices? If yes, explain your answer. (মিথেন নিঃসরণ মোকাবেলা বা বর্জ্য ব্যবস্থাপনা উন্নত করার জন্য এলাকার মধ্যে কোন প্রচেষ্টা বা উদ্যোগ দেখেছেন? যদি হ্যাঁ, আপনার উত্তর ব্যাখ্যা করুন।)

a. Yes b. No

Ans:

12. Do you believe the landfill should be removed or kept in place? Explain your answer. (আপনার মতে ল্যান্ডফিলটি কি সরিয়ে ফেলা উচিত নাকি নিজ জায়গায় রেখে দেয়া উচিত? আপনার উত্তর ব্যাখ্যা করুন।)

Ans:

13. Do you believe that landfills are unnecessary if organic wastes are composted where they are generated and other wastes are recycled? (যদি জৈব বর্জ্য তার উৎপত্তিস্থলেই পচিয়ে সার বানানো হয় এবং অন্যান্য বর্জ্য পুনর্ব্যবহৃত হয় তবে কি ল্যান্ডফিলগুলোর প্রয়োজনীয়তা আছে বলে আপনার মনে হয়?)

a. Yes b. No

14. Do you or will you follow the processes of composting organic wastes and recycling other wastes in your household? (আপনি কি আপনার বাড়ির জৈব বর্জ্য কম্পোস্টিং এবং অন্যান্য বর্জ্য পুনর্ব্যবহার করার প্রক্রিয়াগুলি অনুসরণ করেন বা করতে রাজি আছেন?)

a. Yes b. No

Questionnaire for Policy Makers for KII

Name:	
Age:	
Occupation:	

1. Can you provide insights into the current waste management practices in Dhaka city?

Ans:

2. How would you describe the existing waste flow to Dhaka's landfill sites?

Ans:

3. What measures are currently in place to manage organic waste within the municipal waste stream?

Ans:

4. Could you estimate the current stock of waste in the landfill sites and the rate of inflow?

Ans:

5. What do you perceive as the major challenges in preventing or reducing methane emissions from organic waste in the municipal waste stream?

Ans:

6. How do you assess the impact of organic waste on greenhouse gas emissions within Dhaka city?

Ans:

7. Are there any specific initiatives or programs aimed at reducing methane emissions from organic waste? If yes, please mention the program.

a. Yes b. No

Ans:

8. What policies or regulations exist regarding waste management and methane emissions in Dhaka?

Ans:

9. In your opinion, what improvements could be made to enhance organic waste management and reduce methane emissions?

Ans:

10. Do you believe that landfills are unnecessary if organic wastes are composted where they are generated and recycled wastes go directly to the plant?

Ans:

11. Can any successful examples of organic waste management initiatives in Dhaka or elsewhere in Bangladesh be replicated?

Ans:

12. What are your thoughts on the Zero Waste mechanism?

Ans:

13. What could be done by the government and the people to initiate the zero waste mechanism?

Ans:

14. What measures could be taken for awareness and capacity building on proper waste management and the Zero waste initiative?

Ans:

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