



MANAGING THE CLIMATE IMPACT OF HUMAN WASTE

A study to understand the impact of methane emissions from fecal sludge and potential abatement approaches.

SUMMARY

Methane emissions are the second largest driver of global warming. Sanitation systems contribute to anthropogenic methane emissions if the biological decomposition of human feces is facilitated by anaerobic technologies. Climate action to curb methane emissions can extend to the sanitation sector.

The study aims to understand the current sources and drivers of methane emissions from sanitation systems in low- and middle- income country (LMIC) contexts, and identify promising approaches and interventions for adoption in urban LMIC contexts and relevant evidence gaps warranting further investigation.

WHY THIS MATTERS

Methane abatement has an outsized impact on the climate. While it is more than 25 times as potent as carbon dioxide at trapping heat in the atmosphere (United States Environment Protection Agency 2022), it also dissipates much quicker than carbon dioxide, with an average lifetime of around a decade, compared to centuries for carbon dioxide (Nature 2021). Hence, even if carbon dioxide emissions were reduced drastically today, its impact on the climate would only be felt much later in the century. However, reducing methane emissions today would have an impact on warming in the nearer term. Methane abatement can, therefore, add some much-needed buffer to the small remaining carbon budget—the maximum amount of carbon dioxide that can be emitted while still having a chance to limit warming to 1.5°C or 2.0°C (United Nations Environment Programme 2021).

Methane emissions from the sanitation sector have been estimated to contribute between 7.0% and 10.0% to global anthropogenic methane emissions (McKinsey and Company 2021). However, these estimates focus on wastewater from sewered sanitation systems and do not account for the emissions from non-sewered sanitation systems, typical in many LMICs. Emissions from these contexts are not well-quantified and may be significantly underestimated. There is also limited evidence on the approaches that can abate methane in sanitation, especially for LMIC contexts, where technical and financial resources to implement interventions may be limited.

How does this research connect to USAID's Action Research Initiative?

Under USAID's Global Water Strategy Action Research Initiative, the Urban Resilience by Building Partnerships and Applying New Evidence in WASH (URBAN WASH) project is working to understand the climate impacts of sanitation systems in low and middle income country contexts and identify options to abate emissions while scaling up access to safe sanitation.

The research addresses Strategic Objective 2 of USAID's Global Water Strategy, which aims to increase equitable access to safe, sustainable, and climate-resilient drinking water and sanitation services and supports sector practitioners to develop low-emissions sanitation solutions.

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METHODOLOGY

The study involved two phases of research:

Phase 1 aimed to identify and quantify the current sources and drivers of methane emissions from sanitation systems in urban LMIC contexts by developing an emissions model, taking urban sub-Saharan Africa (SSA), excluding South Africa, as a sample LMIC context.

Phase 2 aimed to identify promising interventions (including technologies, service models, and behavior changes) and evidence gaps for their adoption in urban LMIC contexts, based on key informant interviews with 22 experts and a targeted literature scan of ~230 documents.

FINDINGS



#1. Methane emissions from sanitation in LMICs are significant

Sanitation systems in urban sub-Saharan Africa contributed 3-5% to total anthropogenic methane emissions in 2020. This can grow to 8% in 2030, driven by the use of anaerobic containment and treatment technologies.



#2. Promising approaches and interventions already exist.

Some interventions (including technologies, service models, and behavior changes) can be adopted immediately. Others indicate potential but need additional implementation evidence before scaling.



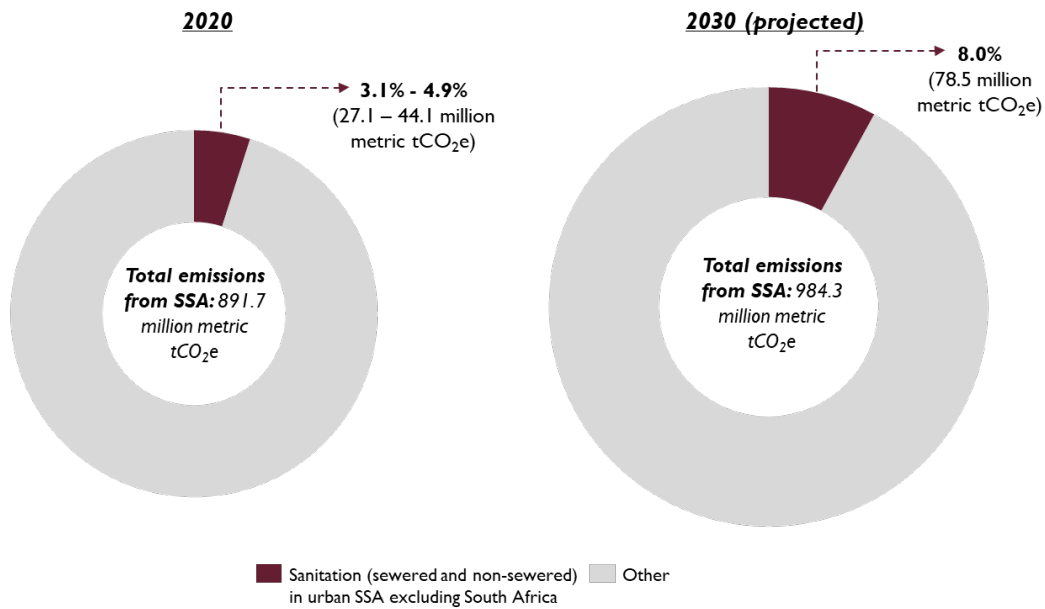
#3. Action is needed today for methane abatement in sanitation.

Promising interventions need to be either actively promoted or accelerated through implementation research. Innovation on select technological gaps, guidelines, financing mechanisms, and measurement and monitoring tools are also required.

SCALE OF THE PROBLEM

The contribution of sanitation to methane emissions in LMIC contexts **is significant and is likely to increase over time**. This study estimated that sanitation systems (both sewerred and non-sewerred) in urban SSA (excluding South Africa) contributed 3.1%–4.9% to the region’s total reported annual anthropogenic methane emissions in 2020. This is comparable to sectors like rice cultivation and coal mining, which are usually given more emphasis in discussions around methane abatement (McKinsey and Company 2021). This percentage is projected to grow to 8.0% of the projected total annual methane emissions in 2030 (see Figure 1).

Figure 1: Estimated emissions from sanitation in urban SSA (excluding South Africa) as a proportion of total annual anthropogenic methane emissions



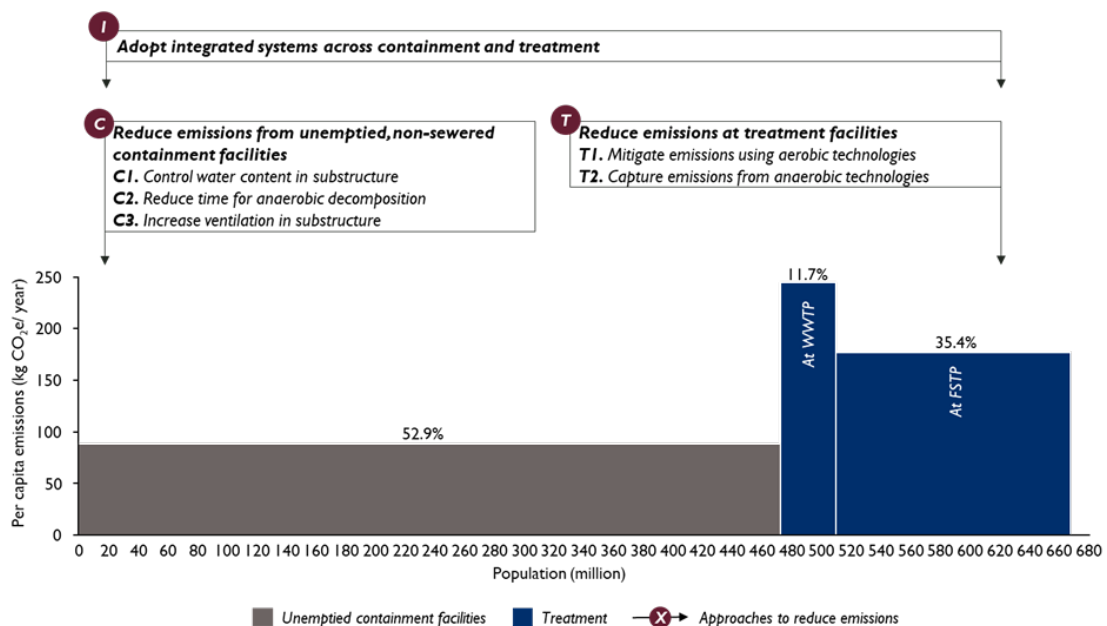
Acronyms: SSA: Sub-Saharan Africa

Current emissions from the sanitation sector are **driven by the high prevalence of non-sewered containment facilities** (~93.3%), which often remain unemptied and promote the anaerobic decomposition of the waste. The **projected growth** in emissions by 2030 is driven by: (a) **urban population growth** and (b) **achievement of Sustainable Development Goal (SDG) 6.2** through the adoption of the anaerobic containment and treatment technologies that are currently prevalent in urban SSA.

ASSESSMENT OF ABATEMENT APPROACHES

The study identified three categories of abatement approaches that can reduce emissions (refer to Figure 2).

Figure 2: Projected annual per capita methane emissions (kgCO₂e/year), population split (million) by source of emissions (2030), and approaches to reduce methane emissions in 2030



Acronyms: WWTP: Wastewater Treatment Plant; FSTP: Fecal Sludge Treatment Plant

The assessment of interventions across these three categories of approaches suggests that while methane abatement in sanitation is an emerging problem with relatively little focus so far, there are still **promising interventions that might be relevant for methane abatement**. However, many of them will need to be made fit-for-purpose as they were designed from a “safely managed sanitation” rather than a “methane abatement” principle. The key insights are:

A few existing interventions have high abatement and implementation potential and appear promising for adoption in LMICs in the immediate term, at least in specific contexts :

- Individual toilet usage and lining of pits in areas with low and high groundwater tables, respectively.
- Container-based sanitation for dense, informal settlements where households are willing to use non-permanent toilets.
- Wastewater treatment with clarifiers, activated sludge processes, and aerobic digesters where energy and technical expertise are available.
- Flaring of methane at fecal sludge treatment facilities with anaerobic technologies.
- Co-composting at treatment facilities where additional waste streams are available.

Other interventions appear highly promising but have evidence gaps for scaling in LMICs:

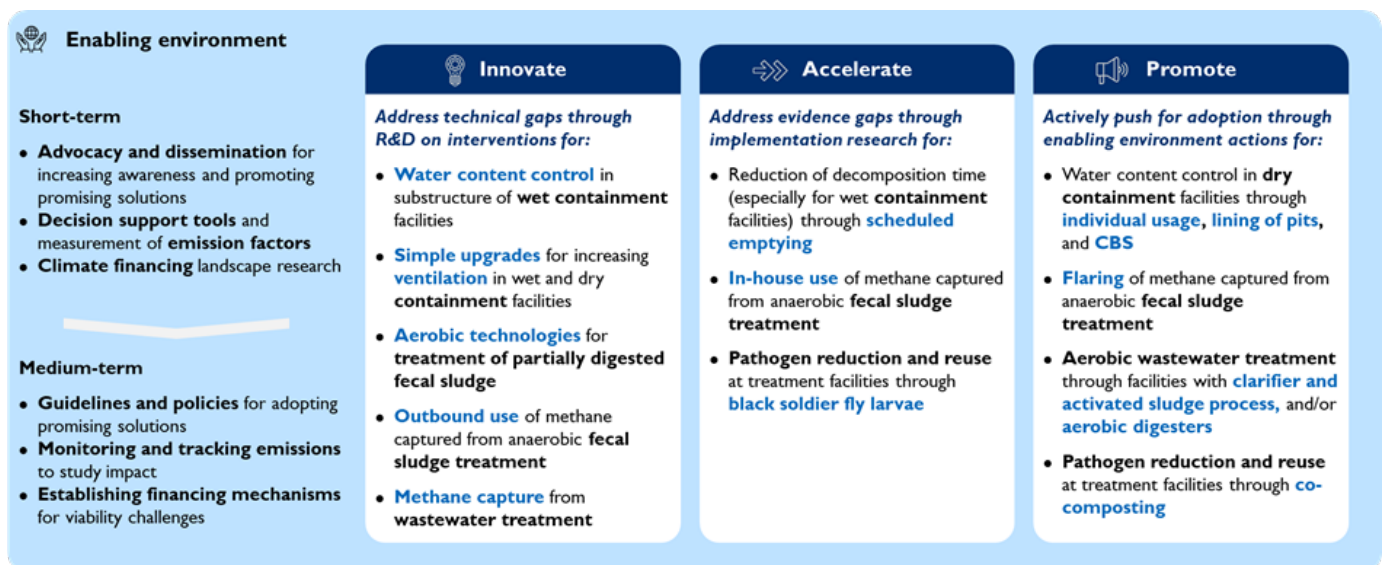
- Scheduled emptying services need abatement and implementation evidence from more and larger cities.
- In-house use of biogas (instead of release into the atmosphere) from fecal sludge treatment and BSF larvae treatment for pathogen reduction and reuse at treatment facilities require more evidence on their feasibility and viability at different scales.

Several intervention gaps also exist across the set of abatement approaches:

- Wet containment technologies to reduce the high water content in the substructure.
- Simple upgrades to increase ventilation and, therefore aerobic conditions for both dry and wet containment facilities.
- Aerobic technologies for treatment of partially digested fecal sludge.
- Outbound use of methane captured from fecal sludge treatment and methane capture from wastewater treatment in general.

RECOMMENDATIONS

- 1 **Promote** the immediate adoption of interventions that show abatement and implementation potential.
- 2 **Accelerate** the adoption of interventions that appear promising by generating evidence through implementation research.
- 3 **Innovate** to develop technologies for abatement approaches that lack interventions or have interventions with prohibitively high operational or financial barriers.
- 4 **Create a favorable enabling environment** to increase awareness of the climate impact of sanitation systems, and incentivize the adoption of more climate-friendly technologies/ services.



REFERENCES

1. United States Environment Protection Agency. 2022. "Importance of Methane." Retrieved July 2022. <https://www.epa.gov/qmi/importance-methane>
2. *Nature*. 2021. "Control Methane to Slow Global Warming – Fast." Retrieved 2022. <https://www.nature.com/articles/d41586-021-02287-y>
3. United Nations Environment Programme. 2021. "Methane Emissions are Driving Climate Change. Here's How to Reduce Them." Retrieved 2022. <https://www.unep.org/news-and-stories/story/methane-emissions-are-driving-climate-change-heres-how-reduce-them>
4. McKinsey and Company. 2021. "Curbing Methane Emissions: How Five Industries Can Counter a Major Climate Threat." <https://www.mckinsey.com/capabilities/sustainability/our-insights/curbing-methane-emissions-how-five-industries-can-counter-a-major-climate-threat/>

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