Treatment technologies in practice

On-the-ground experiences of faecal sludge and wastewater treatment

SNV

UTS Institute for Sustainable Futures

About SNV

SNV Netherlands Development Organisation is a not-for-profit international development organisation that makes a lasting difference in the lives of people living in poverty by helping them raise incomes and access basic services. Driven by the Sustainable Development Goals, we are dedicated to an equitable society in which all people are free to pursue their own sustainable development. Through our work in the Agriculture, Energy, and Water, Sanitation and Hygiene (WASH) sectors, we help realise locally owned solutions that strengthen institutions, kick-start markets, and enable people to work their way out of poverty well beyond the scope of our projects. SNV has a long-term, local presence in over 25 countries, and is supported by over 1,300 staff around the world.

For more information: **www.snv.org**

About ISF-UTS

The Institute for Sustainable Futures (ISF) was established by the University of Technology, Sydney (UTS) in 1996 to work with industry, government and the community to develop sustainable futures through research and consultancy. Our mission is to create change toward sustainable futures that protect and enhance the environment, human well-being and social equity. We adopt an inter-disciplinary approach to our work and engage our partner organisations in a collaborative process that emphasises strategic decision-making. In international development we undertake strategic research and engagement in the areas of development effectiveness, water, sanitation and hygiene, climate change, urban development and energy policy and planning.

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This compilation of case studies was produced as part of SNV's Urban Sanitation and Hygiene for Health and Development (USHHD) programme, which is currently implemented across 20 cities in the world. It documents real-life faecal sludge and wastewater treatment practices narrated by plant owners, operators, and SNV staff in Bangladesh, Indonesia, Kenya, and Zambia. Accounts from Malaysia, India, South Africa, and Benin are also shared.

Each case study was reviewed by Antoinette Kome and Rajeev Munankami (SNV). Contributors from countries are acknowledged at the back of each case study. This publication was edited and managed by Anjani Abella (SNV). It was designed by ThompsonStenning Creative Group.

For more information on SNV's USHHD approach:
www.snv.org/sector/water-sanitation-hygiene/product/urban-sanitation-hygiene

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Foreword

Urban sanitation is one of the biggest challenges of the Sustainable Development Goals (SDGs). With more than half the world's population now living in urban areas, coverage is barely keeping up with population growth. With the growing realisation that only a minor part of that coverage is safely managed, an environmental health emergency is staring us in the face. The effects of climate change will make this challenge even bigger.

This means that making the 'right' decisions on urban sanitation investments is becoming more important than ever. Clearly, our infrastructure needs to be designed for a broader range of extreme events. But in parallel, we need to recognise that the adaptive capacity of our management structures and government systems will be stretched.

For a long time, sewers were seen as the main, often only, option to address the management of human waste (faeces and urine) in urban settings. Yet, construction of sewers and related treatment is highly capital intensive. So, in the absence of the requisite funding, many cities simply continued with the status quo of unregulated, informal emptying and unsafe disposal. Recently, interest in non-sewered and low-cost sewer solutions has increased. There is a growing recognition that, in most settings, citywide sanitation services will need to involve a mix of sewered, decentralised, and non-sewered options. Developing and integrating these operationally, financially, and in technically appropriate ways is a priority in these contexts.

SNV has been working in urban sanitation for almost 10 years; striving to develop an approach that addresses the whole sanitation value chain, all people, and all areas of a city in an integrated, sustainable way.[1] ISF-UTS has been our knowledge partner and together, we have been developing a range of knowledge outputs,[2] spanning topics from sanitation planning and financing, to enforcement and slums, and others. We have also been organising a range of learning events.[3] However, we felt that there was a gap around treatment of wastewater and faecal sludge. This was not so much in terms of technical guidance on treatment options, but rather information on the day-to-day reality and perspectives of people involved. Factors which we believe could help local governments and/or utilities reflect on the different options available.

Discussions on urban sanitation investments are very treatment plant centred. Funding and construction of treatment plants is often perceived as the intervention that will solve the urban sanitation problem in a city; too little thought is given to getting all waste to the treatment plant (whether for wastewater, or for faecal sludge). Where treatment plants do get built however, functionality rates are low – this is particularly the case with faecal sludge treatment plants. I have seen more non-functional and abandoned faecal sludge treatment plants than operational ones.

In seeking out cases for this book, we wanted to include some of the success stories on faecal sludge re-use that we saw presented at multiple international conferences. We asked our country teams to drive to the sites and were saddened to find that some of these projects had completely disappeared.

This makes me wonder whether we are at risk of creating parallel realities in our sector – one reality with fabulous success stories about innovation and circular economy, being financially viable, and environmentally and socially sustainable; the other reality being the one in which most of the urban sanitation infrastructure is struggling. Isn't it time for us to take stock and ground all these expectations in order to come up with a more realistic narrative around treatment and re-use?

While a narrow focus on 'treatment only,' re-use and disposal rarely results in sustainable solutions, this is no doubt an important part of the urban sanitation puzzle. We need to understand better how decisions were made around the building of all these plants, and why there are so many problems today.

There are tools and compendiums describing different technology options, but when speaking to municipalities or utilities, decision-making on their infrastructure has not always been made as an 'informed choice'. Rather, decisions were based on recommendations by a consultant or designs pre-defined by a multi-lateral development bank or NGO; replicated from a neighbouring city or built because it fit within one municipal budgeting cycle. While municipalities and utilities were happy to secure investment for their treatment plants, they were less aware of what it would entail to keep these plants operational. Yet, these are the very same people who are expected to operate and maintain that infrastructure for 20 years or longer, and with the expectation of seeing the benefits this would bring to their cities or towns. They are also the very same people expected to bear the burden of repaying any loans via which the infrastructure may have been funded.

SNV's mission is to contribute to a society in which all people have the freedom to pursue their own sustainable development. That means that we do not promote one specific technology

[1] SNV, "Urban Sanitation and Hygiene for Health and Development (USHHD)", *Capability statement*, The Hague, SNV, 2020, https://snv.org/cms/sites/default/files/explore/download/ushhd-capability-statement_0.pdf, [accessed 3 May 2021].
[2] View some of SNV and ISF-UTS' collaborative learning papers and briefs here, https://interactive.snv.org/snv-urban-sanitation-publications#196515 and https://interactive.snv.org/snv-urban-sanitation-publications#195070.
[3] Documentation on SNV-organised USHHD learning events available for download here, https://interactive.snv.org/snv-urban-sanitation-publications#257720.

over another, but rather facilitate a process of 'informed choice' that explores several relevant technologies. As a rule of thumb, this means that more than one technology option should be explored. Presenting only one option leaves city authorities with no comparison and no alternative(s) to choose from.

While comparing options has the benefit of deepening people's understanding, it should of course also be done (a) in consideration of the service delivery system for the entire city (or region if it concerns a regional utility), and (b) while incorporating relevant data and possible scenarios over time. These are complex considerations which, in the absence of any additional efforts, risk becoming technical discussions among a restricted group. Thus, informed choice is also about translating data into accessible information, so that stakeholders can participate meaningfully in both discussions and decision-making.

Facilitating informed choice for decision-making by an individual is complex enough. However, facilitating informed choice by a local authority intersects with their duties of realising rights, good governance and accountability. They are not making these informed decisions for themselves, but for the population of their city; those who will benefit from the service; those who pay the taxes that repay the loan; and those who live in the surroundings of the treatment plant and may be affected by it. This is an added complexity. Moreover, city authorities are responsible, directly or indirectly, for the working conditions of sanitation workers at the plant. Hence, in addition to understanding the treatment options, informed choice in this context means understanding and weighing up the implications of treatment options for different stakeholder groups within their cities.

Unfortunately, the understanding and also the interest of city authorities and other stakeholders in treatment technologies is generally limited. The information is considered too technical and the stories presented either too theoretical or miraculous in their success.

The day-to-day reality in both faecal sludge and wastewater treatment plants is less clean and rosy. The learning curve is often much steeper and creating the enabling conditions requires a lot of hard work. What we need are real-life stories that help stakeholders to reflect on these aspects. Only then will the much-needed innovation in the urban sanitation sector become a reality. In this book, we present a collection of these day-to-day stories. I hope you will read it, share it, use it, and that you will commit to ensuring more informed choices about treatment and re-use. If you only take away one message, remember that functional treatment is hard work and that there is no magic bullet.

Antoinette Kome

SNV Global Sector Head, WASH

Introduction

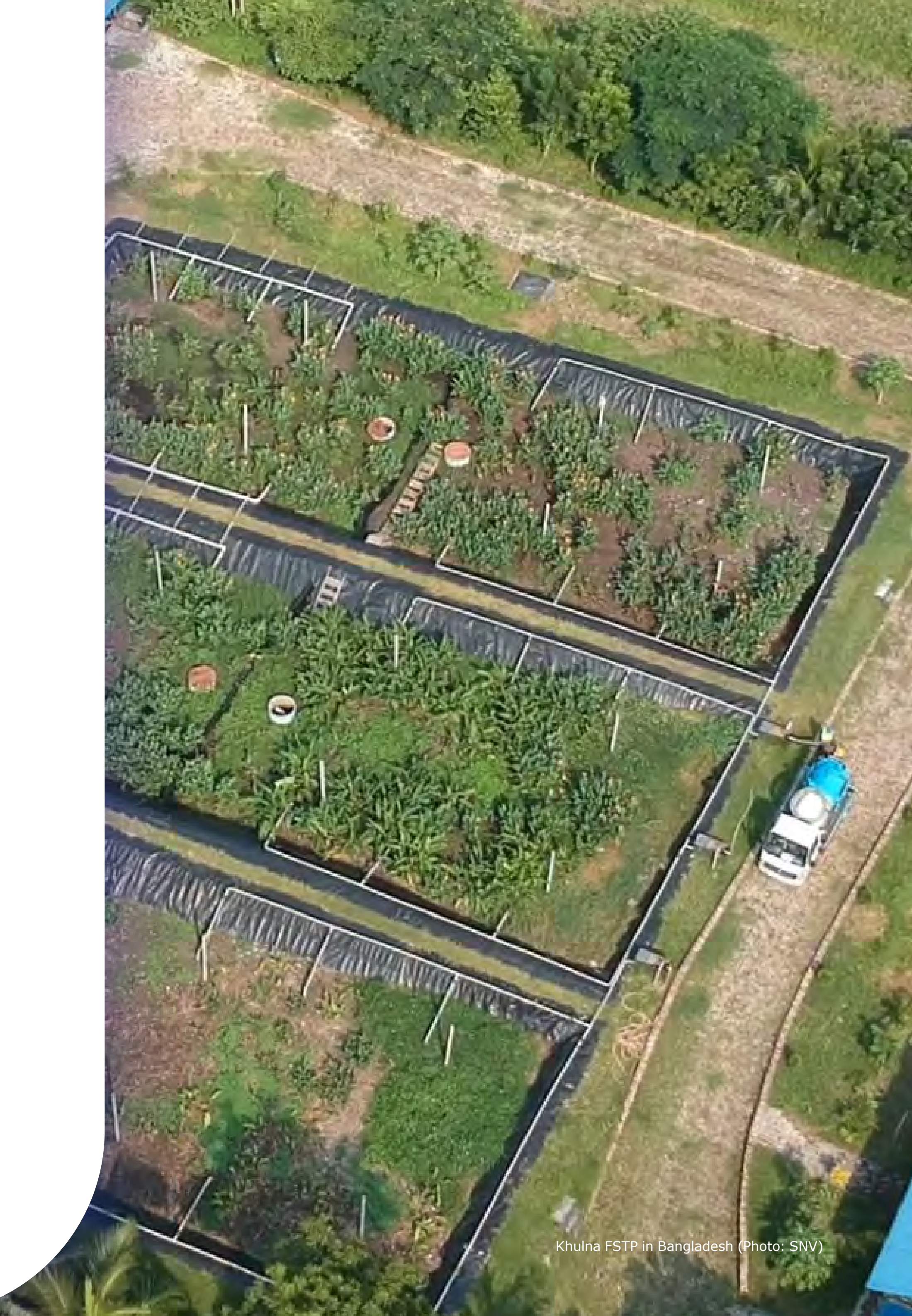
The operation of faecal sludge and wastewater treatment plants rarely plays out as they are described in a manual or textbook. Yet little has been documented on the real-life practical challenges involved. This gap limits the ability of planners and decision-makers to make the right investment choices. This compilation of case studies makes accessible the experiences and realities faced by people involved in the operation of faecal sludge and wastewater treatment, disposal, and reuse facilities, and the decisions that they had to make. Such knowledge can inform the selection of treatment technologies that are appropriate for expected contextual realities.

The compilation presents nine case studies of selected faecal sludge and wastewater treatment technologies, and disposal and reuse options from eight countries across Africa and Asia. These include: conventional sludge drying beds, mechanical screw presses, rotating bio-contactors, and Anaerobic Baffled Reactors (ABR) in Indonesia; constructed wetlands and coco peat filters in Bangladesh; Black Soldier Flies (BSF) and briquettes in Kenya; biogas digesters in Zambia; and deep row entrenchments in India, Malaysia, South Africa, and Benin.

The compilation is intended to be illustrative and is not comprehensive across all available technologies. Each case study outlines a system, its treatment purpose, its regulatory context, and the process that led to its selection. In addition, the realities, challenges, and opportunities of operating and maintaining each technology are described. The studies complement existing technical, process-oriented documents by providing accounts of field-based experiences with the treatment technologies. It is not a manual for informed choice; rather, it is a resource that can be drawn upon during informed choice processes.

The target audience for this document are faecal sludge and wastewater treatment planners, decision-makers, and practitioners. This can include those working in government, non-governmental organisations (NGOs), research and learning institutions, or private sector. This compilation can be used at a broad level to get a sense of the different options described across the various technologies, or at a detailed level, to examine specific technologies.

The deliberate selection of case studies presents a mix of faecal sludge and wastewater handling technologies implemented at full scale over an extended time period. The operators and designers of each technology interviewed for this research were identified and accessed via the networks of the SNV Netherlands Development Organisation and the Institute for Sustainable Futures – University of Technology Sydney (ISF-UTS). The following sections of this document present the nine case studies in detail.


Khulna FSTP in Bangladesh (Photo: SNV)

Key insights emerging from the case studies

From these nine case studies, a number of key issues and considerations emerged that planners, decision-makers, and practitioners may consider when designing or operating faecal sludge and wastewater treatment technologies outlined in this document. These are presented below.

Matching intended capacity with demand realities is challenging. Designing treatment capacity to match unfolding demand for faecal sludge emptying and wastewater treatment can be a challenge. Several faecal sludge treatment plants were found to be operating below capacity. Low demand for regular desludging, or for connection to piped wastewater networks, were the primary reasons for this underutilisation. In all cases, to increase demand, promotion and communications campaigns were undertaken to inform households of the benefits of regular desludging or of joining piped networks. It is important to note that it takes time to develop demand as well as emptying service capacity. Until faecal sludge treatment plants are fully operational, safe disposal options are still needed. Options such as deep row entrenchment can offer interim solutions to the problem of faecal sludge disposal. In some cases, deep row entrenchment can provide a longer-term strategy, and in one case sludge was reused for agroforestry.

Sludge characteristics and variability of waste input are key but often omitted considerations. Sludge characteristics are important considerations when choosing a technology, and when making operational decisions; for instance, in the face of variable sludge quality. However, sludge characteristics are often poorly documented, or no analysis is done. This results in a lack of local data to make informed decisions. When sludge from septic tanks contains rough sand or trash, and/or when grease is thrown into latrines, sludge can block and damage screening equipment and delay the treatment process. Foreign objects mixed in the sludge can be an occupational health and safety issue for staff. For example, sharp metal items can injure workers when they are manually sorting organic matter. Strengthened early consideration of input characteristics would facilitate better choices and proactive mitigation efforts during operation.

Nearby communities need to be consulted on local impacts. Gaining community support for a treatment plant can be crucial for its long-term sustainability. Where possible, communities should be consulted and their concerns considered and addressed during the planning and design stages. Community concerns may include odour, leakage into groundwater wells, or disruptions to local traffic during the construction stage. Lack of community buy-in can threaten a plant's operation, as community members may refuse to use the service, leading to underutilisation and financial shortfalls.

Understanding all the input costs is critical to develop sound financial arrangements for reuse. Reuse options (e.g., briquettes, co-compost/fertilisers, and insect-based animal feed) are increasingly being trialled and used to ensure safe disposal in the last step of the chain *and* to recycle resources and generate income. However, the cost-effectiveness of these options is not always initially clear. High input and operational costs (such as energy) may in some cases mean that a scheme is not financially viable, or it may need external support.

Potential contamination of the surrounding environment may require mitigation measures. During site selection it is important to be aware of the risk of contaminating the surrounding land and groundwater resources. Strict controls are needed to ensure that treated effluent is responsibly managed to avoid local and downstream impacts. This was particularly noted for deep row entrenchments where it is not possible to use trenches in areas that experience flooding or inundation, or that have sandy soil. The risk of contamination should be considered for all types of treatment systems.

Power security and continuity can affect successful operation. Back-up or alternative sources to mains electricity may be needed to ensure continuity of operation, or alternative options that do not require power might be needed. Power outages and lack of back-up generators can interrupt faecal sludge *and* wastewater mechanical treatment. Technologies that rely on solar power may be unreliable due to their dependence on sunny weather.

Weather conditions should be factored in to selection choices and design. The chosen treatment technology should match local weather conditions. Rainy weather, for example, can affect the rate of drying in sludge drying beds and the drying of briquettes. This is particularly important in the context of climate change and potential increases in dry spells or extreme rainfall events in many locations.

The need for highly technical knowledge and a lack of locally available spare parts may make certain technologies undesirable. A lack of the technical skills needed to maintain some technologies, and an inability to obtain spare parts locally, can lead to stoppages, or they can mean that some technologies are out of operation for long periods. Appropriate recruitment and training are therefore important.

Overarching considerations

This case study compilation can help planners, practitioners, and decision-makers to improve contextualised choices of treatment technologies and address local operational challenges. They can consider the technologies presented in this compilation, or they can apply the informed choice considerations outlined here to evaluate other technologies beyond those presented here.

When selecting the most appropriate treatment options, technologies should be considered in short, medium, and long time frames. This includes how best to match the generation or input of waste with appropriate investment in viable treatment technologies. The quantity of waste will depend on community demand, desludging practices, and wastewater infrastructure. The viability of treatment technologies will depend on the availability of human resources and the context in which the technologies will be operating, as well as wider factors including climate, power supply, and environmental considerations.

Finally, it is important to reflect on how technologies work in practice in specific country contexts. Theoretical textbook instructions may seem straightforward, but this impression can be misleading. This case study compilation provides insight to the realities and challenges of operating and maintaining technologies on a daily basis, which can serve as a starting point for increased documentation and sharing of such knowledge across different countries and contexts.

Round-shaped carbonised briquettes in drying beds (Photo: SNV)

About the cover photo: Khulna City Corporation’s Faecal Sludge Treatment Plant in Bangladesh is one of the largest constructed wetlands in operation today. The plant sits on a passive landfill site with loose and spongy landfill contents. In order to transform this land area, embankments with compacted soil were introduced, and geotextiles and HDPE sheets were laid over the entire top surface to hold ponding settlement and to build resistance against slope failure. (Photo: Rajeev Munankami/SNV)