Mineral fertilizer · No fertilizer · Urine fertilizer

WHAT WOULD IT TAKE TO IMPLEMENT RESOURCE RECOVERY FROM ON-SITE SANITATION SYSTEMS?

Suggestions for policy, educational and organisational changes in Kampala's sanitation sector

Pressure for new sanitation systems

Rapid urbanization has led to serious health and environmental impacts that can be linked to poor sanitation. Yet, the critical resource shortages and ecosystem collapse from poor sanitation can be resolved by recycling nutrients in human excreta. Recognition of this has led to global targets of providing "sanitation for all" and calls for resource recovery from our sanitation systems.

Rapid urbanization makes it difficult to extend public services like sanitation fast enough. However, rapidly changing urban areas also offer opportunities for rethinking traditional structures for sanitation management. This is true for the Greater Kampala Metropolitan area (GKMA), where less than 2% of the population are connected to conventional wastewater treatment. Based on volume and proportion of people serviced, the opportunities for improving services and upscaling resource recovery in GKMA are greatest for the on-site sanitation services since 98% of the population use these systems.

There are a number of innovations being developed for resource recovery from on-site sanitation. Many of these technologies separate faeces from urine for easier

Study highlights

* Significant amounts of fertilizing nutrient from human excreta are currently lost to the environment.

* On-site sanitation technologies exist that can recover nutrients.

* The centralized sewage system dominates in education and sector documents, making it difficult for innovations in on-site sanitation to emerge.

* Sector values focus on implementing physical infrastructure and less on maintaining them or recovering resources.

* Policies supporting resource recovery exist, but are currently too general to drive increased reuse.

* Policy guidance is technology prescriptive, making it difficult for new technologies to enter the market; instead it should be performance-based to support innovations.

treatment, either on-site or at a treatment plant. Others, like container-based toilets offer innovative management schemes for service and resource recovery. This study explores the opportunities for increasing use of these services.
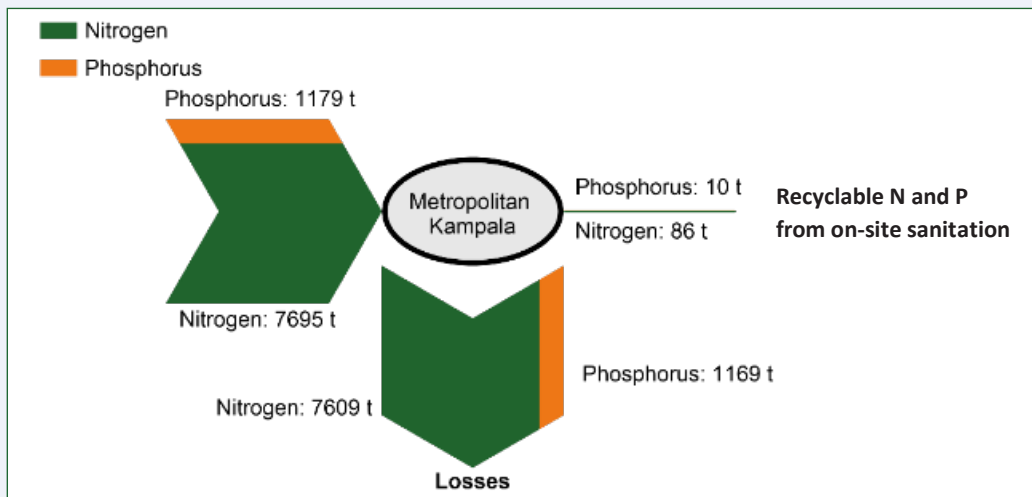
Figure 1: Recoverable nitrogen and phosphorus flows from the excreta of people currently connected to on-site sanitation in GKMA, reported in metric tons per year.

Nutrient Recovery potential

Fertilizing nutrients found in human excreta come from the food that we eat. Based on a study of 10 African countries, nutrients from excreta could replace between 50-100% of the nutrients currently applied in the form of subsidized fertilizers[1].

In GKMA, an estimated 55% of the faecal sludge (FS) produced in on-site sanitation systems is safely managed. However, nutrient recovery from these systems is low. Current management practices result in nearly a 99% loss of both nitrogen (N) and phosphorus (P) to the environment (Figure 1). A large portion of the FS is contained in un-emptied pits where nutrients leak into the groundwater or else contents are emptied into the environment before reaching the treatment plant. Even if all FS were collected, it would result in a marginal improvement due to the high losses of N and P in on-site sanitation containment and treatment.

Sanitation solutions that apply urine-diversion and treatment can capture over 80% of the nitrogen in excreta and nearly 100% of the phosphorus. Systems such as urine-diverting toilets or container-based system in which urine and faeces are transformed into fertilisers exist and would be possible to implement in Uganda.

Knowledge Available

The project reviewed curricula from five Ugandan universities offering engineering programs related to sanitation, including both Bachelor and Master programs. In half of the programs, more knowledge is provided about centralized wastewater systems than on-site sanitation. Other programs contain equal information regarding centralized and on-site systems, but no program contains more information related to the on-site sanitation. Considering that 99% of the Ugandan population is connected to on-site sanitation there seems to be a contradiction between knowledge provided and the existing situation.

Study description

This study recognizes that implementation of sanitation services is more than just application of technology. It is connected with social norms, management structures and access to knowledge and resources. The study uses a sustainability transitions framework to understand opportunities for change in Kampala's on-site sanitation sector. Specifically, the study analysed the existing context in order to identify stress points where innovation may have key advantages and potential barriers for changing to resource recovery systems.

Aspects investigated in the current system:

* Degree of nutrient recovery
* Knowledge available
* Sector values
* Existing policies
* Organisational structures
* Financing structures
  (results presented in separate policy brief)

Information to evaluate each dimension was collected from national statistics, national policy documents, published literature, and semi-structured interviews with experts. The initial results were validated with local stakeholders in 2018, including representatives from the municipalities, utility, university, NGOs and aid organisations.

1   Lohman, H. A., Trimmer, J. T., Katende, D., Mubasira, M., Nagirinya, M., Nsereko, F., ... & Guest, J. S. (2020). Advancing sustainable sanitation and agriculture through investments in human-derived nutrient systems. Environmental science & technology, 54(15), 9217-9227.

The concept of resource recovery is included in nearly all of the twelve programs studied. Yet, information on what resources can be recovered varies. Only two of the programs include recovery of energy, water and nutrients from sanitation systems. Recovery of water is least common in the curricula (5 programs), followed by energy recovery (6 programs) and most commonly nutrient recovery, often in relationship to ecological on-site sanitation (9 programs). While resource recovery is included in curricula, it is covered in less than 10% of the total courses offered.

Sector Values

A review of the Sector Performance Reports (SPR) found that the most common values in the Ugandan sanitation sector are about achieving access to sanitation services and regulatory compliance (Figure 2). There is a strong dominance of values related to implementing physical infrastructure in the sector, as well as assuring good governance.

Health and environmental protection are less often explicitly stated in the SPRs. However, the strong focus on regulatory compliance is likely connected to meeting these objectives.
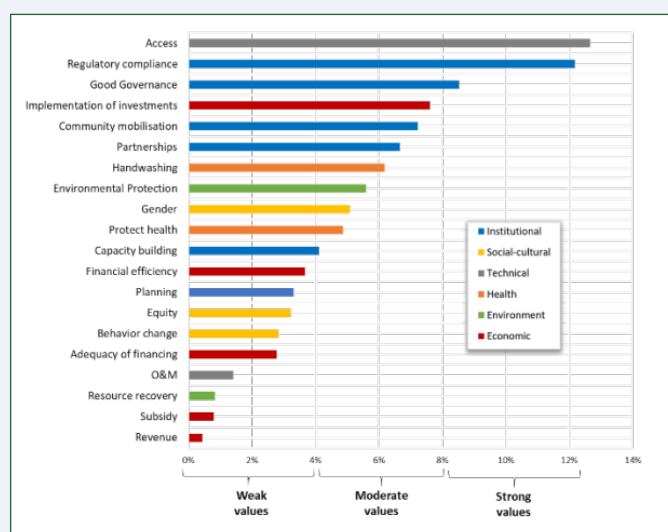

Figure 2: Sanitation sector values identified in SPRs from 2005-2019. The figure shows the average coding density for each value, reported as percentage of all coded text.

Issues that receive less attention are related to adequate financing and revenues (including subsidies), operation and maintenance and resource recovery. Achieving long-term sustainability of sanitation services will require a focus on how to maintain them in the long-term, including how to finance them. Resource recovery can play a part in this, but it is currently not highly valued in the sector.

Existing Policy

Policies, acts, regulations, standards and plans relevant for on-site sanitation were analysed in this study (Figure 3). The documents were categorized according to their relevance for each part of the sanitation service chain: (i) planning/construction/containment, (ii) emptying and transport, (iii) treatment and (iv) reuse.

There are large gaps in policy guidance and only the first step in the service chain is fully covered within relevant documents. Specifically, there is a lack of guidance for treatment of FS from on-site sanitation systems, in spite of the new KCCA ordinance. A key challenge for on-site sanitation systems is the focus on centralized wastewater management in policies and plans.

There are also few policy documents covering reuse. The ones that exist cover the concept of circular economy (The National Environment Act) and an expressed need for local production of fertilizers (The Uganda Fertilizer Policy). Yet, these are currently too general to provide the much needed support for resource recovery innovations at this point.

In addition, the guiding documents generally provide a list of approved technologies rather than stipulating functions to be achieved by the technologies. A technology-focused policy and regulation environment is generally inhibiting to innovation since new technologies will not be listed in existing policies and regulation[2].

Organisational capacity

Assessment of the organisational structures within the on-site sanitation service chain found unclear roles and responsibilities of specific actors and weak coordination between actors, particularly in end-use. Introducing resource recovery systems will likely increase demands on organisational capacity in the service chain, including developing new skills and capacities. Thus, from an organisational perspective, resource recovery systems do not currently have a competitive advantage. However, there may be opportunities for new systems to design their approach in ways that will simplify coordination within the service chain. Developers of innovative on-site sanitation systems should look for ways to simplify organisational structures when they develop their approaches.
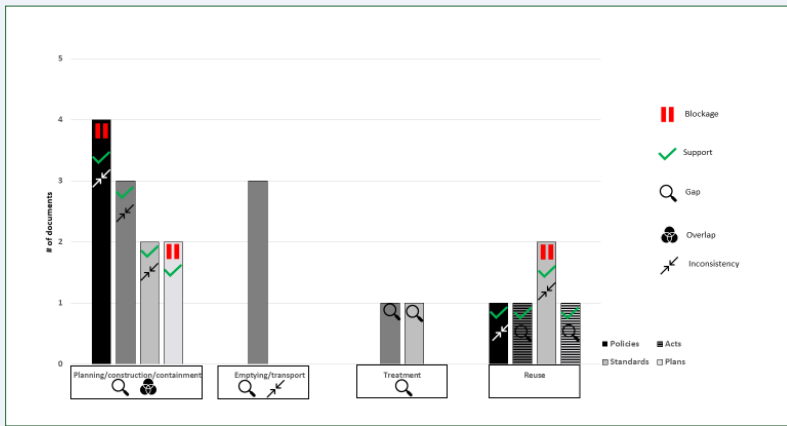
2   Kvarn ström, E, J Mcconville, P Bracken, M Johansson, and M Fogde. 2011. "The Sanitation Ladder - a Need for a Revamp?" *Journal of Water, Sanitation and Hygiene for Development* 1 (1): 3–12. https://doi.org/10.2166/washdev.2010.01

Policy implications

It will be difficult for resource-recovery innovations in on-site sanitation to break into a sector in which educational practice, organisational structures and policy are heavily dominated by centralised sewage systems. Current higher education programs related to sanitation in Uganda are still focused on centralised sewers, which is not helpful for solving challenges related to on-site sanitation. Globally, there is an increasing focus on non-sewered sanitation, but current educational practice is lagging behind. Similar to the knowledge lock-in related to choice of technology, there seems to be a "policy lock-in" regarding which technologies are approved for use. Reframing existing sanitation policy guidelines from technology-prescriptive to performance-based may open up for more innovation. It will require action on behalf of multiple actors to increase knowledge exchange, try new organisation models and push for policy change. Stakeholder specific suggestions for action based on results of this study include:

* Utilities should pilot innovative solutions in order to demonstrate their advantages and build knowledge.

* Universities should adapt curricula to break the dominance of sewage systems, including more on-site solutions and Best Available Technology (BAT) approach.

* Researchers should disseminate knowledge regarding technical advantages of the innovations.

* Policy makers should adapt policy to reflect actual and planned reality of sanitation services, including making public funding available for on-site sanitation and resource recovery.

* On-site sanitation innovations should focus on possibilities for simplifying organisational structures, streamlining and clarifying roles and responsibilities.

Research partners

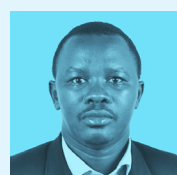

Research funding

Research team

Jennifer McConville, PhD
Associate Professor;
Department of Energy & Technology;
Swedish University of Agricultural Sciences
Jennifer.mcconville@slu.se

Elisabeth Kvarnström, PhD
Researcher; Ecoloop, Stockholm Sweden
(formerly with RISE);
elisabeth.kvarnstrom@ecoloop.se

Charles Niwagaba, PhD
Associate Professor;
Department of Civil & Environmental
Engineering; Makerere University (MAK)
charles.niwagaba@mak.ac.ug