research evidence for policy

October 2020

HOW MUCH SHOULD SAFELY MANAGED SANITATION COST?

Capital and Operational Costs of Different Sanitation Systems in Kampala

Meeting the sanitation-related sustainable development goals for all in Kampala

Uganda did not achieve the Millennium Development Goal related to sanitation for its rural or urban population. Available data indicate that the access to sanitation has decreased in urban areas, with a possible explanation being the concurrent increase in urban population living in informal settlements[1]. Kampala is expected to more than double in population size from today to 2035[2], which puts an enormous additional stress on the city's existing sanitation infrastructure and services. To meet the Sustainable Development Goal targets related to sanitation (Goal 6, target 6.2) for the Greater Kampala, will demand multiple innovative approaches and unlocking new investment opportunities for sanitation infrastructure and services in the coming decade. In preparation for such investments, an understanding of existing infrastructure and service delivery gaps coupled with associated costs and cross-cutting benefits is paramount.

Kampala has two distinct sanitation service systems: (i) the sewage system and (ii) the faecal sludge (FS) system. Both systems serve different customer types: households, industry, commercial entities and public bodies/institutions. In this study, we focused on costs for household services within the two systems.

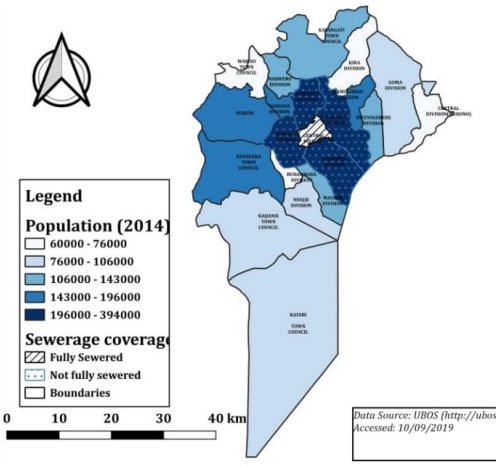
Results - Infrastructure performance

The system sizes are vastly different, with almost 99% of the population in Greater Kampala relying on on-site sanitation systems (also including 0.7% of "undefined" systems), hence belonging to the FS system. It is estimated that the implementation of the Kampala Sanitation Master Plan would bring 31% of Greater Kampala Metropolitan's population to centralized (sewage system) services in 2040, with connection to sewers and treatment plants. Even with a fluctuation between the systems based on influx to the city (which will increase the population using the centralized system during daytime) and even with a completion of the objectives of the Kampala Sanitation Master Plan[3], the FS system will continue to dominate Greater Metropolitan Kampala (GMK) for the foreseeable future.

Study highlights

* 56% of faecal matter in Greater Metropolitan Kampala is "safely managed".
* Annual capital and operating costs for the sewerage system are 13 times greater than for the FS system.
* NWSC's annualized costs for treatment in the FS system is 220 times lower than that for the sewage system.
* Strategies aiming at equitable and inclusive sanitation need to consider alternative sanitation systems and services in which users enjoy equal shares of public funding.

Study area – Greater Kampala



The "safely managed" efficiency from both systems is estimated to 56% of all fecal matter in Greater Kampala (Kampala city plus surrounding municipalities of Mukono, Entebbe, Makindye Sabagabo, Kira and Wakiso). It is estimated that the sewage system contributes to safely managing 1% of the total faecal flow. However, since only 1.3% of the faecal flow goes through that system, the safely managed efficiency for the sewage system can be estimated at 75%.

[1] http://www.worldbank.org/en/country/uganda/overview [2] https://www.brookings.edu/blog/africa-in-focus/2018/10/05/figure-of-the-week-africa-is-home-to-fastest-growing-cities-in-the-world/ [3] Government of Uganda/NWSC. 2015. Kampala Sanitation Master Plan Update. Volume 1: Report. Fichtner Water & Transportation / IGIP / M&E Project Office Kampala.

For the FS system, it is unclear what happens with the greywater from showers, kitchens and laundry. Less attention is normally given to the greywater flowstream, yet it poses potential environmental pollution and public health risks.

Study Description

Infrastructure Performance

This analysis aimed at determining to what degree the infrastructure in each of the systems safely manages human waste, by combining information regarding use of each technology type from the Kampala Sanitation Master Plan (Government of Uganda/NWSC, 2015) with assumed treatment efficiencies for each of the flowstreams, as estimated in the faecal flow analysis for Kampala (Schoebitz et al, 2016)*. "Safely managed" is defined as by WHO and UNICEF (2017)**.

Determination of Costs and Financial Flows

The financial flows considered in this study represent those of the key stakeholders in the system and the most significant components along the sanitation service chain. The annualized capital and operating costs per capita within each system were calculated with the following formula:

$$AC_0 = -C_0 \left(\frac{(1+i)^{n_0} \times i}{(1+i)^{n_0} - 1}\right) - F_0$$

where AC_0 is the annualized cost of the sanitation component (UGX per capita per year), C_0 is the capital cost of the component (UGX per capita), n_0 is the lifetime of the component (years), i is the real interest rate, and F_0 is the annual operating cost of the component (UGX per capita per year). A real interest rate of 5% was assumed based on values used by the World Bank. An exchange rate of UGX 3,673 to 1 US dollar was assumed based on the average daily exchange rate during the first five months of 2018.

*: Schoebitz, L., Niwagaba C. B., Strande, L., 2016. SFD Report Kampala, Uganda.

**: WHO and UNICEF. 2017. "Progress on Drinking Water, Sanitation and Hygiene." JMP Report. Geneva, Switzerland: World Health Organization.

Results - Annualized capital and operational costs

Combined annual capital and operating costs for the centralized system (UGX 683,725/capita/yr) are 13 times greater than the same figure for the on-site system (UGX 50,252/capita/yr). The substantial differences in annualized costs between the sewage and FS systems is primarily due to large capital costs for the sewer network and treatment plants.

As shown in Figure 2, the cost of the centralized system is mostly the responsibility of NWSC and the centralized system operates at a net loss. Revenues from sanitation fees and valorisation of end products cover about 57% of NWSC's total annualized costs. The loss could be even greater than shown in Figure 2. The Kampala Sanitation Master Plan[4] (2015) estimated that only 12 % of the revenue generated from sewerage services was used for payment of costs of the sewerage services (the rest of the revenues being used to subsidize services in other NWSC areas). It is therefore concluded in the Master Plan that the sewage system's operation is underfunded, with an extremely low service expansion rate and with preventive maintenance non-existent[5].

In the FS system, on the other hand, the households are bearing the majority of the costs. Capital costs for household on-site infrastructure represent 94% of annualized capital costs and the households pay 95% of total FS system costs. However, the FS system does not necessarily take into account the costs for collection and treatment of greywater. NWSC's annualized costs for treatment in the FS system (UGX 2,651/capita/yr) is 220 times lower than that for the sewage system (UGX 588,492/capita/yr).

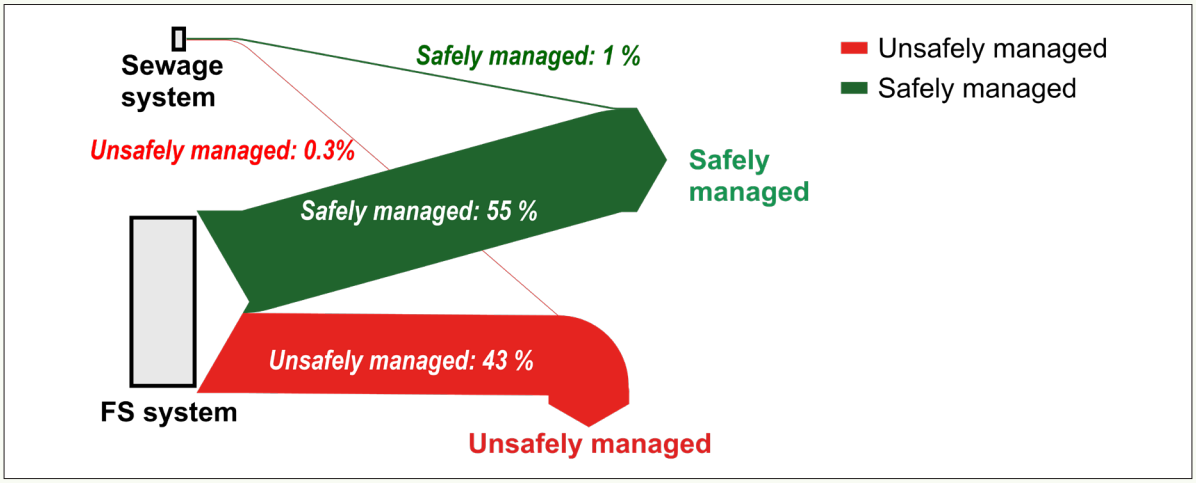


Figure 1: Simplified faecal-flow diagrams for the sewage and FS systems in GMK.

[4] Government of Uganda/NWSC (2015) [5] Government of Uganda/NWSC (2015)

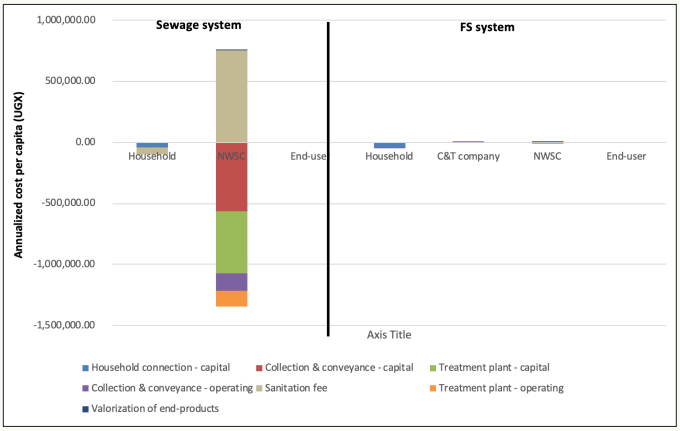


Figure 2: Annualized capital and operating costs for sewage and FS systems, when optimized, in GMK

What if the systems were optimized?

Neither of the systems are operating at an optimal level. The sewage system is under-utilized and the FS system is, in relative terms, able to safely manage less excreta compared to the sewage system. Therefore, it is interesting to do a sensitivity analysis of how the costs change if the systems were optimized. We have chosen to optimize one system at a time in the below calculations.

Annualized per capita costs for optimized sewage system

* UGX 354,222
* People served: 130,000 citizens (16% domestic customers)

Annualized per capita costs for optimized FS system

* UGX 62,441
* People served: 3,136,000 citizens

In the case of the sewage system, this optimization was calculated by increasing the population served by the system until the wastewater treatment plants were operated at full capacity, keeping the existing ratios of wastewater flows the same (i.e. 16% domestic). In this manner, 130,000 domestic customers could be served and the total capital and operating cost would be UGX 354,222 per capita per year or approximately half the cost of the existing situation (Figure 3), which shows the importance of incentives to increase connection rates to the sewage system. This cost is, however, still seven times greater than the FS system today and would serve only 4% of the population.

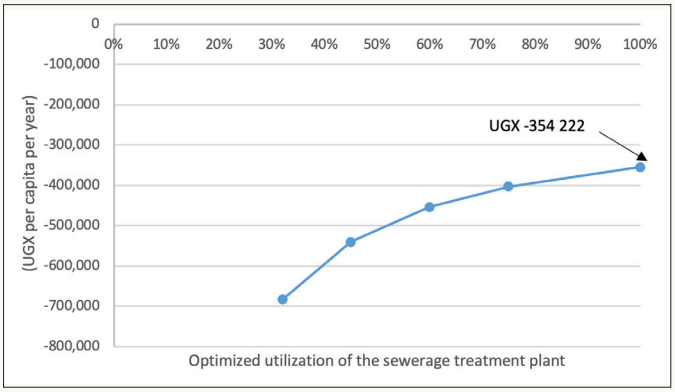


Figure 3: Changes in total annualized capital and operating costs in the sewage system based on increasing the number of people connected to the system up to a maximum capacity of the existing wastewater treatment plants.

For the FS system, the optimization analysis was calculated for a system, including collection and treatment, which would serve all people that are currently using on-site systems (3,136,000 people). We calculated this by determining the additional capital and operating costs for upgrading all on-site systems to a minimum of a VIP (lined) latrine, which would enable emptying, and the subsequent need for additional treatment capacity if 100% of faecal matter from on-site systems were to be collected and treated. Hence, the 56% of the population currently using traditional pit latrines are assumed to upgrade to VIPs, which would represent a capital investment of UGX 1,046 billion. In addition, additional collection services would be necessary: 91 small trucks and 74 large trucks for UGX 29.3 billion would be needed and two additional faecal sludge treatment plants the size of the plant at Lubigi (400 m3/day capacity) would be necessary to treat the collected faecal waste, representing a capital investment of UGX 209 billion. Annualized capital and operating costs for an on-site system that provides "safely managed" service to all within the FS system would be UGX 62,441 per capita per year. This value is still six times lower than the cost of the optimized sewage system.

Policy implications

Compliance with the Kampala Sanitation Master plan would bring 31% of the population of GMK under the sewage system by 2040. Hence, the majority of Kampala's citizens will continue to be served under the FS system for the foreseeable future. It is therefore of importance that policy and financial decisions in the coming decades within the sanitation sector reflect this reality, where a clear strategy, including technical, financial and regulatory frameworks and action plan with specific targets for improving on-site sanitation is one such an example.

Kampala Sanitation Master Plan (2015)

"…Important additional investments in the sewerage sector would translate into even higher costs for operation and maintenance and depreciation and higher tariffs, which would in turn defeat the objective of providing affordable water and sewerage services to the people."

The sewage system is estimated to have a higher, relative infrastructure performance than the FS system, although it handles only a fraction of the faecal flows going through Kampala. At the same time, the sewage system represents a considerably costlier service than the FS system. From an inclusive sanitation service delivery perspective, it would be expected that each sanitation system would enjoy equal shares of public funding, which is not the case today. Therefore public financing incentives and instruments that can significantly buffer the cost of service along the on-site sanitation service chain should be further explored, tested and scaled up.

The majority of the annualized costs for the on-site system in the FS system come from investment in household infrastructure. In the optimized scenario described above, households need to invest an additional UGX 1,046 billion or an annualized UGX 51,422 per capita per year to optimize the FS system's performance. The public funding that is spent on providing sanitation services in the sewage system (UGX 587,680/capita/yr) today is approximately ten times this figure. Therefore it is reasonable to consider increasing public financing to leverage increased access to improved sanitation at household level. This would reduce investment costs and quality of service inequalities between the sewered and non-sewered population segments.

The FS system holds many performance uncertainties, for example (i) estimations of how well simple storage can be considered "safely managed", (ii) estimations of how much "treatment" actually takes place in current septic tanks and VIPs, (iii) what happens to the greywater and (iv) strategic improvements to adequately manage greywater in the FS system. There is therefore a need for more knowledge on functionality within the existing FS system in Kampala. Furthermore, the current FS system in Kampala is highly dependent on the capacity to transport and treat FS, a capacity that needs to be expanded to meet the demand. Two faecal sludge treatment plants of the equal size of Lubigi are, indeed, already in the project implementation phase.

The Kampala Sanitation Master Plan (2015) makes reference to a tariff study from 2012, which concluded that the sewerage tariff should be double the current water tariff to cover the actual operating costs of the sewerage services. For full cost recovery, including investments, it should be seven times higher. It further states that additional investments would translate into the need for even higher tariffs within the centralized system. It would therefore seem that the way forward for NWSC is to start considering alternative, and cheaper, technological options. The Kampala Sanitation Master Plan mentions the plan to experiment with condominial sewerage systems to increase connectivity to waterborne sanitation in urban poor areas at lower costs. It is advisable that NWSC further explores condominial sewers within the sewage system, as well as, options for extending its service offers within the FS system, alongside with its expansion of conventional approaches. Decision-makers need to start considering alternative sanitation systems and services to be able to provide sanitation services to Kampala's citizens that are protecting health and environment while being both affordable and financially sustainable.

Research partners

SLU

RISE

Makerere University

Research funding

Vetenskapsrådet

Funding for the research was provided by The Swedish Research Council.

The policy brief is based on McConville, J.; Kvarnström, E.; Maiteki, J.; Niwagaba, C. 2019 Infrastructure investments and operating costs for fecal sludge and sewage treatment systems in Kampala, Uganda, Urban Water Journal, 16:8, 584-593, DOI: 10.1080/1573062X.2019.1700290

Research team

Jennifer McConville, PhD
Associate Professor
Department of Energy and Technology
Jennifer.mcconville@slu.se

Elisabeth Kvarnström, PhD
Researcher
RISE Research Institutes of Sweden
elisabeth.kvarnstrom@ri.se

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

Eng. James Miiro Maiteki
Senior Manager – Sewerage Services
National Water & Sewerage Corporation, Uganda
james.maiteki@nwsc.co.ug

Najib L. Bateganya, PhD
Deputy Director, Sanitation and Environment;
Kampala Capital City Authority (KCCA)
blnajib@gmail.com

Jude Z. Byansi
Manager, Waste and Sanitation
Kampala Capital City Authority
byansijude@gmail.com