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Commentary

Challenges of Governing Off-Grid "Productive" Sanitation in Peri-Urban Areas: Comparison of Case Studies in Bolivia and South Africa

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Abstract: Globally, peri-urban areas are experiencing rapid urbanization. Conventional infrastructure development is generally slow to catch up and the lack of basic sanitation in peri-urban areas is a constantly growing—and often overlooked—problem. There are examples where these challenges have been addressed by off-grid "productive" sanitation systems that provide opportunities for recovery and reuse of valuable waste stream resources. However, governing such systems and ensuring effective municipal policies can be challenging since the socio-economic contexts in many peri-urban areas are transforming rapidly. A comparison of two initiatives in Bolivia and South Africa offers valuable insights for introducing functional off-grid "productive" sanitation systems relying on urine-diverting dry toilets (UDDTs) in peri-urban settlements. Findings suggest that acceptance of the UDDTs by households largely rely on consistent awareness raising and capacity building, in addition to adaptation to the local needs and creating a sense of ownership over the toilet system. Changing perceptions of what constitutes an aspirational toilet, and developing services for waste management collection, seem to be crucial components for ensuring long-term use and functionality of the UDDTs. Investments and further innovations for upscaling of resource recovery systems are needed to make these systems cost-effective and logistically viable. To attract these additional investments, it will be crucial to assess the societal economic benefits of off-grid "productive" sanitation compared to centralized wastewater systems. The comparison also highlights that off-grid sanitation requires a clear division and coordination of roles and responsibilities among different authorities, in order to transcend political difficulties that emerge where these boundaries overlap. Thus, integrating clear boundaries into urban planning policies, and including informal processes in communities, play an important role in improving governance of basic services in peri-urban areas.

Keywords: governance; urban transformations; formal and informal; policies and planning practices; sustainable sanitation; reuse

1. Introduction

An estimated 700 million people in urban areas lack access to basic sanitation today, and most are poor and living in informal settlements or peri-urban areas in low- and middle-income countries [1]. Without basic sanitation they can become trapped in cycles of disadvantage, exposing already poor households and communities to disease and degraded environments, which in turn impacts their health, livelihoods, education, and other opportunities. Filling the urban sanitation gap and doing so in a way that supports broader sustainability efforts has been identified as a critical task for sustainable development [2].

Many of the cities where major sanitation gaps exist today are projected to expand rapidly in the coming decades. People moving to urban areas commonly move into peri-urban areas—areas

that are geographically and institutionally on the margins of formal urban settlements. These may be long-established rural villages that are gradually being absorbed into a growing city, or an expansion of informal settlements of new migrants [3]. Land-ownership may be unclear, leading to tenure issues, and unwillingness to invest in services, both from households and local authorities [4].

Development challenges are often overlooked for peri-urban areas. Infrastructure and services are often slow to catch up with the changing density and character of these communities, and one key reason for this is that peri-urban areas are often subject to multiple, at times overlapping, or even contradictory, governance systems—particularly where municipal and traditional authorities coexist [5,6].

This study compares how two different sanitation programs in peri-urban areas have tried to tackle the governance challenges of introducing functional off-grid "productive" sanitation systems on a large scale. The comparison builds on our sanitation governance research through two separate field case studies in El Alto, Bolivia and Durban, South Africa, carried out in collaboration with Stockholm Environment Institute (SEI) and local research partners and practitioners in the two countries [7,8]. The two programs were selected due to their unique large-scale urban implementation of off-grid "productive" sanitation in peri-urban areas. In the two study cases, mixed methods were applied, including semi-structured interviews, participatory observation, and analysis of existing survey results. Furthermore, this comparative study discusses how actors have interpreted, responded to, and enforced sanitation policies in the peri-urban areas of these two cities. The study reflects on the outcomes of the two sanitation programs, considering their intervention approaches, and their governance and contextual conditions, with the aim of sharing and learning from south-to-south experiences.

2. Off-Grid Sanitation with Potential Reuse

For many people the ideal for sanitation provision is still flush toilets connected to underground sewerage grids that carry waterborne excreta away from households to a centralized treatment plant [9]. But these systems require major infrastructure investments, particularly to ensure the sewage receives adequate treatment. They consume large amounts of water—usually treated potable water—which may be in short supply; an increasing problem in the light of climate change. Plus, typically, these systems do not allow easy recovery and safe reuse of potentially valuable resources in the waste streams.

Off-grid sanitation systems take many forms. The processing of sanitation waste streams may be entirely or partly managed on-site. Excreta from off-grid sanitation systems is commonly collected and treated in relatively small-scale, local "decentralized" or on-site management systems. Many are "dry" systems requiring little or no water input to function, and are; thus, suited to areas where water supply services are limited. Some are designed specifically for efficient recovery of resources found in the sanitation streams: water, nutrients, organic matter, and energy. Examples of systems are urine-diverting dry toilets (UDDTs) that separate nutrient-rich urine from organic matter-rich feces, or decentralized anaerobic digesters that produce biogas from decomposing organic waste [10,11]. The terms productive sanitation or ecological sanitation (ecosan) are sometimes used to describe systems designed for this kind of recovery and reuse. The location of peri-urban areas in the urban-rural divide creates good opportunities to reuse nutrient and organic matter in adjacent agricultural lands in need of fertilizers [12].

Off-grid sanitation systems with low water and energy consumption, and that are designed to allow recovery and safe, productive reuse of resources, offer a promising path towards "sustainable sanitation" [13], which is reflected in the high number of research groups working on this topic [14].

3. From National Policy to Peri-Urban Reality: Two Case Studies

In both Bolivia and South Africa, water and sanitation policies are deliberately trying to address the legacies of socially unequal development and the current challenges of rapid urbanization. In South Africa, policy documents such as the 2001 White Paper on Basic Household Sanitation and the 2003 national strategic framework for water services, "Water is life, Sanitation is dignity", have called for more inclusive and equitable sanitation provision [15,16]; while the 2009 Constitution of Bolivia

declares that all residents have the right to universal and equitable access to basic services such as potable water and sanitation in their households. Both these national policies are well aligned to the Sustainable Development Goal (SDG) 6 on "Clean Water and Sanitation" that aims to achieving access to adequate and equitable sanitation and hygiene for all (target 6.2).

Meeting these ambitions by expanding and maintaining sewer sanitation infrastructure would require high investments, and in water-scarce municipalities, such as eThekwini in South Africa and El Alto in Bolivia, it would be neither environmentally nor economically sustainable. Thus, both municipalities have looked to off-grid, low-water sanitation to fill the sanitation gaps in their peri-urban communities. A comparison of two case studies in Bolivia and South Africa offers valuable insights [7,8].

3.1. Case 1: District 7, El Alto

In Bolivia, only 64% of the urban population has access to improved sanitation, while access in rural areas is much lower [1]. In recent years, El Alto has grown from a peri-urban area of La Paz into a major satellite city, and continues to expand into the surrounding countryside. The population grew from 650,000 in 2001 to 850,000 in 2012 [17].

Since 2008, the Swedish International Development Cooperation Agency (Sida) has supported an ecological sanitation project in District 7 of El Alto. The project has been managed by the local Bolivian non-governmental organization, Fundación Sumaj Huasi (FSH). The overall aim of the project is to develop a model for providing sustainable sanitation access through decentralized solutions that are not dependent on large external funding for infrastructure.

District 7 is mainly populated by poor migrants from rural Bolivia. Households have electricity and receive only limited potable water supplies through the household distribution network from EPSAS (the public water and sanitation company), but lack good access to other basic services such as sewer-linked sanitation. During the major drought in 2016, the habitants in El Alto and a large part of Bolivia suffered from major water shortage. Water supply has become a major challenge due to increasing demands from a growing population combined with global warming and disappearing glaciers, which has been a major water source for El Alto.

Prior to the intervention, residents mainly practiced open defecation or used unimproved pit latrines. Given the absence of a centralized sewer network and lack of toilets in most households, along with the limited water supply, the project sought to promote on-site sanitation systems, based on UDDTs and local management of household graywater.

More than 1200 toilets have been constructed under the initiative, benefiting approximately 6000 people [18]. Sumaj Huasi and a local microenterprise named ABONA collect feces and urine from the households and transport it to decentralized treatment facilities in El Alto, where they are processed into safe solid and liquid fertilizers. Feces are treated through composting with worms (which takes about six months) to convert it to humus, while urine is treated by storage.

The treated fertilizers are used locally, for instance in potato cultivation, or delivered to the municipality for afforestation. A part of the humus is also sold as fertilizer on the local market. However, with increasing volumes, this stage (especially the urine handling) has become one of the main challenges of the program and the involved organizations are working on different strategies, such as exploring ways to reduce volumes and to commercialize the fertilizers for sale on a larger scale [19].

The initiative in El Alto goes beyond SDG Target 6.2 by contributing to reduced pollution and recycling of the different sanitation waste streams (target 6.3). In 2016, a new national plan for basic sanitation was launched in Bolivia, promoting off-grid sanitation technologies (e.g., UDDTs) for peri-urban areas [20], which may support upscaling in the country.

3.2. Case 2: Mzinyathi, eThekwini Municipality

South Africa is one of the most unequal countries in the world, and this is also reflected in access to improved sanitation. To a large extent the inequalities also run along urban-rural lines.

eThekwini Municipality administers an area that includes South Africa's third largest city, Durban, along with surrounding towns and rural areas. eThekwini Water and Sanitation (EWS), a unit of the municipal government, has implemented a range of sanitation systems in settlements that previously lacked access to water and basic sanitation.

Its overall strategy for water and sanitation centers on providing two different sets of services: One for urban areas, including a sewer network with wastewater treatment plant; and one large-scale program for (nominally) rural and peri-urban areas. Initiated in 2002, the latter program offers households a free package with limited water services through a potable groundwater tank system (200–300 liters) with yard taps along with a UDDT and training in operation and maintenance (O&M). One of the main rationales behind the program's design and the choice of UDDTs was the need to minimize pressure on water resources. The hilly topography also increases the costs and the complexity for centralized waterborne solutions. Over 80,000 UDDTs have been installed under the program [9].

The municipality provides households with UDDTs at no cost, on the condition that they maintain the toilet and manage the excreta themselves. Urine is directly infiltrated in soil, while it is recommended that users dehydrate the feces and then bury the waste. The initiative contributes to the achievement of SDG target 6.2, but only limited to 6.3, as reuse was not initially pursued.

Mzinyathi is a formerly rural area in the municipality on the outskirts of Durban. Water and sanitation services in Mzinyathi are provided by the municipality unit eThekwini Water and Sanitation (EWS). Mzinyathi is; however, also governed by a chief from the Qadi Traditional Authorities. Mzinyathi is owned by a body called the Ingonyama Trust and administered through a Board, with the current Zulu king as the sole trustee of all land.

The UDDT program faces several challenges, partly because of how households relate to the use and maintenance of the UDDTs, particularly the direct handling of excreta. Acceptance is also low, due to low status of the system and the common perception that the UDDT is a temporary measure [21]. Overlapping political governance structures and rapid informal urbanization also affect the sustainability of the program by making it more difficult to implement and follow up (for more details see [8]).

4. Challenges and Lessons

In this section, some of the key challenges and lessons are discussed and compared between the two sanitation programs, in Bolivia and South Africa.

4.1. Changing Contexts

Both District 7 and Mzinyathi have changed significantly since the respective sanitation programs started, beginning as largely rural and transitioning to increasingly urban areas. While urbanization was a factor in the planning of both programs, it has nevertheless brought implementation challenges. The policy of differentiated "urban" and "rural" services offered by EWS for instance has become difficult to follow-up under conditions of rapid urbanization. There is a socio-economic transition taking place, with some wealthier migrants strengthening the local economies and purchasing power of households. Residents' expectations for living standards and service provision are shifting; among other things residents are less willing to accept the off-grid "dry" sanitation solutions. If water-based toilets are installed to replace the UDDTs, it may significantly challenge the sustainability of the sanitation system by increasing the consumption of water and the discharge of inadequately treated wastewater.

4.2. Overlapping Authorities

A crucial challenge for the off-grid sanitation programs is the overlapping roles of traditional authorities and formal municipal authorities. The boundaries between the mandates of the two authorities are not always settled or clear, as responsibilities overlap. This affects both case study areas, but is more pronounced in Mzinyathi, where the compositions and practices of the two governance systems are very different.

While EWS is restricted to formal institutions and processes, the traditional authorities in Mzinyathi have more informal processes. Land allocations for new residents are made by the Qadi chief while building regulations are virtually non-existent, and the municipality does not have a leading role in the urban development of the area.

In Mzinyathi, EWS is obliged to provide water and sanitation services to the residents, but has no authority to establish or enforce control over these systems. Alternative systems instead of or alongside UDDTs are; therefore, now being installed, including flush toilets. However, these alternative systems are mostly not connected to any treatment facility, posing risks to health and ecosystems. EWS is having difficulties finding efficient means of cooperating with the traditional authorities to solve the service provision.

In El Alto, the sanitation work has been implemented by an NGO (FSH), while the municipality has prioritized the development of the centralized sewage system, which does not serve the peri-urban parts of the city. The city of El Alto with its peri-urban areas are under municipal authority and there is no traditional authority with formal powers. However, in El Alto there is a Federation of Neighborhood Councils-El Alto (FEJUVE in Spanish), a strong force in the social development debate, which also, at times, assumes responsibility for basic services. To enable larger upscaling of off-grid systems, it is important that they are endorsed and supported by both the municipal authorities and the traditional authorities. The overlapping authorities have not been as problematic in El Alto as in eThekwini, as their competences do not conflict in the same ways. In Bolivia, support for off-grid solutions such as UDDTs has also reached national level: In 2015, the Ministry of Environment and Water launched a national program for "dry ecological toilets" [22].

4.3. Behaviour Change and Adaptation to Local Needs

Developing new hygiene and sanitation habits can be more difficult than developing new regulations [9]. This can be particularly true when the norm before intervention is open defecation, which has been common practice among the beneficiaries in both cases. However, there is a significant difference in social acceptance between the two programs, with a general high acceptance in El Alto and low in eThekwini, where the aspiration for flushing toilets is more widespread [7,9].

The two programs have both invested in capacity building and in changing behaviors and attitudes to off-grid sanitation, but to markedly different degrees. The El Alto program has strongly prioritized the social component and there have been continuous efforts to promote education about toilet use, a sense of ownership and behavior change to end open defecation. With its demand-driven approach, The El Alto program has been able to generate a sense of ownership over the toilets among the recipient families, which has resulted in a better level of sustained use and maintenance of the toilets. Key strategies have been households' in-kind contributions (e.g., part of material cost and labor) to the sanitation facility, as well as flexible design options, so the toilets can be individually adapted to the needs and desires of each family. This has probably contributed to fewer issues linked to the social status of having dry toilets in El Alto. Providing collection service has also proved to be a key factor for higher acceptance among the beneficiaries. A health follow-up study revealed that there is a significant, measurable, and sustained reduction in incidence of diarrheal disease among households that had installed UDDTs [23].

While EWS considers its off-grid system as an appropriate and fair sanitation technology, many users do not. The program has provided training on hygiene and O&M, but has put less emphasis on the long-term support and continuously enforcing these social components. Many households use, but are dissatisfied with, the UDDT system; they dislike the close contact with the excreta and report wanting to move to a more "developed" and "dignified" system [8,24]. The case study in Mzinyathi also found that households generally had a weak sense of ownership of the sanitation facility and managed the waste poorly or not at all [8]. One possible factor for the low sense of ownership is the fact that the toilets are provided free of cost. At the same time, there are no services offered for waste management, meaning it must be done entirely by the users. Thus, the potential benefits of reuse

are not being realized. Mzinyathi has seen a clear drop-off in use of the UDDTs over the long-term. Households tend to abandon the UDDTs for other types of flushable sanitation systems, even though the required infrastructure for those kinds of technologies is missing.

4.4. Ensuring Functionality and Resource Sustainability

Inadequate maintenance of on-site sanitation models has been identified as a key risk factor, which can result in users abandoning the toilets [24]. For instance, when toilets get too dirty, people tend to go back to old sanitation habits. The functionality of decentralized sanitation systems requires that technical components and actors along the entire sanitation value chain (user-interface, collection, transport, treatment, and reuse) work well together, especially when resource recovery is the aim.

The Bolivian program established a system for excreta collection service, and also developed a decentralized treatment. The microenterprise in charge of the collection service also provides support with system maintenance and repairs, which contributes to long-term functioning. Agricultural trials with demonstration of reuse in different scales have also been used to show how effective the treated sanitation waste is as fertilizer. These demonstration initiatives have also helped increase acceptance among both farmers and residents; a strategy that has shown to be effective in other urban sanitation projects [25]. However, managing the increasing volume of waste that builds up with higher participation as well as long-term use, and finding consistent demand for the fertilizer products, are major challenges to address.

Apart from the O&M training, the eThekwini program did not offer collection or other maintenance services. Users expressed that the UDDTs were difficult to maintain in several aspects (e.g., challenging acquiring dry sawdust, demanding maintenance of the toilet building, and difficulty emptying the vaults receiving fecal matter) [8]. Many users also complained about bad odors and flies. The program has not yet taken advantage of the reuse potential of collected waste. However, EWS is exploring solutions; including a collection service and options for reusing excreta safely on a large scale. Given the limited uptake of the UDDTs, and the fact that Mzinyathi is becoming more urban and local residents are interested in flush toilets, questions remain as to how to build user demand for UDDTs.

5. Concluding Remarks

Off-grid sanitation systems with decentralized management are a cost-effective, sustainable way to provide high-quality sanitation services to peri-urban communities, which often include the most disadvantaged and poor populations. In planning decentralized (or any other) sanitation systems, it is important to take into account the many essential aspects that contribute to sustainability—technical, financial, social, institutional, environmental, health protection—as well as to consider the whole system and value chain together [26]. Thus, it is of the highest priority to continue sharing lessons and knowledge on implementation and up-scaling. Drawing on experiences in District 7 and Mzinyathi, we highlight the following policy messages and lessons.

- Off-grid sanitation needs a clear division of roles and responsibilities—as well as coordination—between governance institutions, both formal and informal. However politically difficult it may be, informal systems need to be incorporated into the governance arrangements to avoid overlaps—or gaps—between competences and management functions of different actors in a sanitation system. This should be recognized in national policies, as well as municipal-level planning and implementation.
- Decentralized sanitation systems in a peri-urban setting based on UDDTs require investment in safe excreta storage, system maintenance, emptying and recycling services for managing the excreta, as well as in "soft" aspects, such as building ownership of the sanitation system and changing attitudes and behaviors by the users. To enable a sustainable uptake and use of off-grid sanitation, the provision of education has proved to be crucial to support raising awareness and to train users in how to properly operate and manage their new sanitation systems.

- It is important to counter perceptions of decentralized sanitation as a "rural" or "poor man's" alternative to flush toilets. Successful strategies include ensuring that the systems offered are of high quality and comfortable; offering users a range of toilet products and options; and requiring some financial input from the user to create a sense of ownership. Reliable, efficient, and safe excreta collection services are also essential for ensuring sustained use and the attractiveness of on-site systems in an urban context [7,8]. Engagement of traditional authorities, where they exist, can also avoid conflicting messages about the systems.
- Decentralized sanitation system development needs to be integrated into mainstream urban development, for example in strategic urban planning policies, property regulations, building codes, and municipal services. Given the reality of rapid urbanization in many parts of the world, it is also critically important to determine early on whether off-grid sanitation systems are to be a temporary bridge to centralized systems within a clear timeframe, or a permanent solution for more densely populated peri-urban areas even as they evolve into suburbs.
- From a financial perspective, there are still challenges in highlighting the societal economic benefits of investing in "productive" sanitation systems. Improving the functionality of sanitation and wastewater management results in a large pay-off in terms of reduced expenditures on public health [27]. There is evidence showing that reuse can contribute even more to cost-efficient and long-term waste management, producing benefits in sectors beyond water and sanitation (e.g., energy and agriculture) [28].
- Scaling up reuse will require innovation, not only on the technical side, but also in governance and finance. Issues linked to the enabling environment for the reuse market needs to be addressed, such as developing new policies, governance models, and financing mechanisms (e.g., adequate regulations, tax incentives, and public-private partnerships) [14].

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