Review Paper

‘Top-down’ planning for scalable sustainable sanitation in high-density low-income urban areas: is it more appropriate than ‘bottom-up’ planning?

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ABSTRACT

We argue that, if the sanitation target of the Sustainable Development Goals (universal access to ‘safely-managed’ sanitation by 2030) is to have any chance of success, then a community-sensitive top-down planning approach has to be adopted for sanitation provision in high-density low-income urban areas in developing countries, as ‘bottom-up’ planning is much more time-consuming and not yet successfully proven at scale. In high-density low-income urban areas, there is only a limited choice for safely-managed sanitation: (i) simplified/condominial sewerage (which becomes cheaper than on-site sanitation systems at the relatively low population densities of 160–200 people per ha), (ii) low-cost combined sewerage (if it is cheaper than separate simplified sewerage and stormwater drainage), (iii) community-managed sanitation blocks, and (iv) container-based sanitation (the last two of which are suitable, especially in slums, when neither simplified sewerage nor low-cost combined sewerage is affordable or technically feasible). These four sustainable sanitation options are as scalable in developing countries as conventional sewerage has been in industrialized countries.

Key words | community-managed sanitation blocks, low-cost combined sewerage, low-income urban areas, planning, simplified sewerage, slums

INTRODUCTION

This paper starts with the premise that, if conventional sewerage were affordable in poor urban areas in low- and middle-income countries, there would be little planning that involved the community – other than, to ensure a good rate of connection, to inform community members what was going to happen, what their responsibilities were (especially in relation to operation and maintenance), how much their monthly water bill would increase, and to offer low-cost loans (to be repaid through the monthly water bill) to install an in-house pour-flush or low-volume cistern-flush toilet, and the house connection to the street sewer.

An enlightened water and sewerage utility would not charge a high upfront connection fee (often the local equivalent of US$100 or more per household) as connection fees are too anti-poor (Kayaga & Franceys 2007), and the utility can straightforwardly recover its costs by a small surcharge to the sewerage tariff (Frauendorfer 2008). Enlightened utilities would also adhere to the fourth IWA Bonn Principle that ‘the price of water should be set so that price does not prevent consumers from obtaining water of sufficient quantity and quality to meet fundamental domestic needs’ (Speers 2007) – but modified to include sewerage (or other sanitation) charges.
Should this ‘planning process’ be any different if the sanitation technology selected were not conventional sewerage? Many sanitation engineers and planners would reply that it has to be different to ensure that the beneficiary households would accept and correctly use and maintain the technology selected. Indeed, many planners would argue that the beneficiary households should be involved in the sanitation planning process ab initio and to the extent that they, and they alone, would choose which sanitation solution they wanted from a range of solutions that were socially, economically, financially, physically, hydrologically, and institutionally feasible in their local context (see, for example, Kalbermatten et al. 1983; Hall et al. 2016). We question this ‘bottom-up’ approach and argue that, providing the local water and sanitation provider interacts meaningfully with its low-income customers, ‘top-down’ planning is more appropriate in high-density urban/periurban areas. Such a top-down planning approach is especially important if the sanitation target of the Sustainable Development Goals (SDG) is to be attained by 2030.

SANITATION TARGET OF THE SUSTAINABLE DEVELOPMENT GOALS

Target #6.2 of the SDGs, adopted by the United Nations General Assembly (2015a) in its Resolution of 23 September 2015, is:

‘By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.’

One descriptor missing in this target is affordability. However, the United Nations General Assembly (2015b), in its Resolution of 18 November 2015 on sanitation as a separate human right (separate, that is, from the human right to water), stated that:

‘The human right to sanitation entitles everyone, without discrimination, to have physical and affordable access to sanitation [emphasis added], in all spheres of life, that is safe, hygienic, secure, socially and culturally acceptable and that provides privacy and ensures dignity.’

The Joint Monitoring Programme (JMP) for Water Supply and Sanitation of the World Health Organization and UNICEF has provided ‘normative interpretations’ of the descriptors in the SDG sanitation target (JMP 2015). Importantly, it interprets ‘adequate’ sanitation as ‘safely-managed’ sanitation, which is defined as basic (formerly ‘improved’) sanitation facilities which are not shared between households and from which the excreta and non-toilet domestic wastewater are either safely disposed of in situ or safely collected and transported to a well operated-and-maintained faecal-sludge or wastewater treatment works.

Progress in the provision of urban sanitation during the final quinquennium of the Millenium Development Goal era was very slow, almost to the point of non-existence, mainly due to the twin phenomena of rapid population growth and accelerating urbanization in developing countries (UN-Habitat 2016). In mid-2010, 684 million people in urban areas in developing countries were without basic sanitation, equal to 27% of the urban population (57% in sub-Saharan Africa, 36% in South Asia) (WHO/UNICEF 2012), and in mid-2015, the corresponding figure was essentially the same, 680 million (25%, but 60% in sub-Saharan Africa and 33% in South Asia) (WHO/UNICEF 2015).

There is as yet very little information on how well the SDG target of safely-managed sanitation for all is progressing. WHO/UNICEF (2017) reported that 43% of the global urban population was served with safely-managed sanitation in 2015, and 83% with ‘at least basic’ sanitation; for Latin America and the Caribbean, for example, these figures were 27% and 90%, respectively; but no information was given on safely-managed sanitation in, for example, sub-Saharan Africa or Central Asia and Southern Asia, only that 41% and 69%, respectively, had ‘at least basic’ sanitation. (The 2017 WHO/UNICEF report departed from earlier practice by using SDG regions (IIISD 2017), rather than more precise geographcal regions; thus, sanitation-access data given above for Central Asia and Southern Asia are less helpful than data given separately for the two sub-regions as they differ greatly in their sanitation access and use: in Central Asia 98% of the population had ‘improved’ (now ‘basic’) sanitation in 2015, whereas only 47% were so served in Southern Asia (United Nations Economic & Social Council 2017).)
SUSTAINABLE SANITATION PLANNING FOR HIGH-DENSITY LOW-INCOME URBAN AREAS

Urban sanitation planning is very different from sanitation planning in rural areas where many agencies (e.g., UNICEF, WaterAid) have most of their experience. Some of the key factors that make urban areas more challenging than rural areas are (Lüthi et al. 2010):

- Heterogeneous populations: people from different origins, ethnic backgrounds, [and] social norms make for heterogeneous nature of urban settlements.
- Land tenure: a key issue that needs to be addressed as it is much more difficult to achieve sustainable infrastructure solutions with tenants or absentee landlords in a commoditized urban land market.
- Sanitation chain: urban sanitation presents great challenges in the development of integrated solutions for managing a variety of waste streams that go beyond achieving defecation-free environments (e.g., proper disposal of household wastewater; faecal sludge management).
- Technology choice: dense urban settlements limit the feasible technology options available [see below].
- Institutional fragmentation: whereas rural institutional responsibilities are mostly straightforward, a multitude of different stakeholders have a claim in urban areas: local authorities, health departments, utilities, communities, local non-governmental organizations (NGOs), etc.

Further detail on urban sanitation planning is given by Tayler et al. (2003), McConville (2008), Lüthi et al. (2011), Parkinson et al. (2014) and Reymond et al. (2016).

On-site or off-site sanitation systems?

The key difference in sustainable sanitation systems for high-density low-income urban areas is whether they are on-site or off-site systems, as follows.

On-site sanitation systems

For on-site sanitation systems in periurban areas the role of the community in the planning process is clearly important to ensure that the most feasible and acceptable technology is chosen. However, the choice is really quite limited – for example, alternating twin-pit ventilated improved pit (VIP) latrines (Mara 1984), alternating twin-pit pour-flush toilets (Roy et al. 1984; Mara 1985), and eThekwini latrines (i.e., urine-diverting alternating twin-vault ventilated improved vault latrines (WIN-SA 2008); these are wholly above ground, so facilitating desludging, and they can easily be operated as ecological-sanitation units if the users so wish). The role of the community in the planning process is often overstated – basically, a good ‘rule of thumb’ is that if it goes much beyond that in the Kalbermatten model (Kalbermatten et al. 1983; Kennedy-Walker et al. 2014; see the note at the end of this article for outline details of the model), then it is probably being overplayed.

The main problem with on-site systems in high-density low-income urban areas is that they require more land (which is often unavailable), and they are generally more expensive than simplified sewerage (see (a) below).

Off-site sanitation systems

There are four low-cost off-site sustainable and scalable sanitation systems suitable for use in high-density low-income urban areas: (a) simplified (also termed ‘condominial’) sewerage, (b) low-cost combined sewerage, (c) community-managed sanitation blocks, and (d) container-based sanitation. These are now discussed, together with treatment options for them.

(a) Simplified/condominial sewerage: There is much experience, mainly in Brazil but also in a few other countries in Latin America, Africa and South Asia, with simplified/condominial sewerage (de Andrade Neto 1985; Melo 1985, 1994, 2005, 2008; Sinnatamby et al. 1985; Komives 1999; Luduvice et al. 1999). A simplified-sewer network can discharge either into a conventional sewer if one is locally available, or into its own treatment plant (often waste stabilization ponds with or without pretreatment in, for example, an upflow anaerobic sludge blanket, UASB). With this sewerage technology, a 100-mm diameter sewer laid at a gradient of 1 in 200 (5‰) can satisfactorily serve ~1,200 people with a water consumption of 100 litres per person per day (or ~2,400 people with a water consumption of 50 lpd)
(Mara et al. 2001). In northeast Brazil it was found that simplified sewerage became cheaper than on-site sanitation systems (pour-flush toilets + leach pits) at population densities above the relatively low value of ~160 persons per ha (Sinnatamby et al. 1983); in Soweto, Johannesburg this value was ~200 persons per ha (Manga 2011). Thus, except in areas subject to regular flooding (see (b) below), simplified sewerage is almost always likely to be the sustainable sanitation technology of first choice in high-density urban areas.

In Brazil it currently serves over 5 million people (Melo 2008). Rigorous epidemiological studies on the health effects of city-wide simplified sewerage in Salvador in northeast Brazil (where ~1 million people are served by this sanitation system) have shown that: (i) the longitudinal diarrhoea prevalence in children less than 3 years of age fell by 22% in the population of the city as a whole, and 43% in the areas where the baseline prevalence of diarrhoea was highest (i.e., in poor areas); and (ii) the prevalence of Ascaris lumbricoides infection in children aged 1–4 was reduced from 24% before simplified sewerage was installed to 12% afterwards, Trichuris trichiura fell from 18% to 5%, and Giardia intestinalis from 14% to 5% (Barreto et al. 2007, 2010; Genser et al. 2008).

(b) Low-cost combined sewerage: This is suitable in areas subject to regular flooding as it is generally cheaper than the separate provision of simplified sewerage and stormwater drainage. It has been successfully used in coastal areas of Rio de Janeiro state in Brazil, where the sewer is designed to carry the stormwater from a 10-year storm in commercial and industrial areas and from a 5-year storm in residential areas, subject to a minimum sewer diameter of 400 mm; the minimum sewer gradient is determined from the dry-weather (i.e., wastewater) flow (Guimarães & de Souza 2004). The system has also been successfully used in India (Sundaravadivel et al. 1999) and Viet Nam (Beausejour & Nguyen 2007).

(c) Community-managed sanitation blocks: These are suitable in very poor (often slum) areas where both simplified sewerage and low-cost combined sewerage are unaffordable and/or technically infeasible (Burra & Patel 2002; Burra et al. 2003; Peal & Evans 2010; Norman 2011; Meredith et al. 2014). Particular attention has to be given to the needs of women and girls so that they feel safe using the facility, especially at night (Lenton et al. 2005; Drabble et al. 2014; Gosling et al. 2015). As these sanitation blocks have a water connection, they are in fact community-managed sanitation-and-water blocks where water can be purchased in 20- and 10-litre, or for children 5-litre, volumes.

(d) Container-based sanitation: CBS is a recent development: in each participating slum household there is a stand-alone pedestal-seat urine-diverting toilet, below the seat of which there is a plastic bag to contain faeces; this bag is regularly removed (after sealing) and replaced with a fresh bag by a local third-party contractor; the used bag is taken to a faecal-sludge treatment plant (where it is commonly composted and the resulting compost sold for agricultural or local horticultural use); the diverted urine is either infiltrated into the soil or diluted with water and used for local horticultural irrigation (Russel et al. 2015; Auerbach 2016; Hawkins 2016; EY & WSUP 2017). CBS is a low-cost safely-managed sanitation system: Sklar & Faustin (2017) estimated that its cost, including the container-toilet unit and the collection and disposal of the faecal sludge, in Port-au-Prince and Cap Haïtien in Haïti was HTG 188 (GBP 2.30, USD 2.83) per household per month. CBS has the advantage of providing local employment for the distribution and collection of the container bags and for the operation of the faecal-sludge treatment plant. Furthermore, its in-house space requirements are minimal, and it is thus a potentially scalable solution to excreta management in high-density slums, although more work at greater scale is required to confirm this.

(e) Discharge and treatment options: As noted above, JMP (2015) interprets SDG target #6.2 as ‘safely-managed sanitation for all by 2030’, with safely-managed sanitation including safe collection, transport and treatment of the faecal sludge and wastewater. Simplified sewers can discharge into nearby conventional sewers or, if these are unavailable, into their own treatment works and thence into a receiving watercourse. Low-cost combined sewers discharge into their own treatment works which should be located near a river or stream which can receive stormwater overflows.
Treatment options for simplified sewerage and low-cost combined sewerage are those for domestic wastewater treatment (Parikh et al. 2002; Mara 2004; von Sperling & Chernicharo 2005; de Lemos Chernicharo 2007; von Sperling 2007; Dotro et al. 2017), including well-designed stormwater overflow weirs in the case of low-cost combined sewerage. Community-managed sanitation blocks should be located where they can easily discharge into a sewer (Peal & Evans 2010; Meredith et al. 2014). Alternatively, several such blocks could be linked by a sewer which discharges into its own small treatment plant.

Container-based sanitation, when well designed and well operated, follows good practice for faecal sludge management (Strande et al. 2014). As noted above, treatment is usually by composting the faecal sludge; co-composting with household refuse could be an alternative (Pereira-Neto et al. 2011). Both well-designed stormwater management and solid waste management. As the toilet unit used with container-based sanitation is urine-diverting, a soakaway for urine is needed; this could also be designed to receive the household’s relatively small quantities of greywater.

Some, perhaps all, of the above sanitation options may require national design codes to be modified or introduced in order for local planners and designers to be able to consider them as permissible options. This was done, for example, in Brazil in 1986 when the national sewerage design code was altered to permit the use of simplified sewerage (ABNT 1986).

‘TOP-DOWN’ VS ‘BOTTOM-UP’ PLANNING

‘Top-down’ planning is frequently criticized as it is commonly perceived to sidestep the beneficiary community and come up with inappropriate sanitation solutions. In order to avoid this, ‘bottom-up’ planning is generally advocated (for example, Fransen et al. 2002; EAWAG 2005; Satterthwaite et al. 2005; Fall et al. 2009; Lüthi et al. 2010, 2011; Mulenga 2011; McGranahan 2013, 2015; McGranahan & Mitlin 2016). However, good top-down planners do not sidestep the community and they can come up with appropriate sanitation solutions (for example, Tayler et al. 2003; Norström 2007; Parkinson et al. 2014). Five examples of successful community-sensitive top-down planning for urban sanitation are as follows.

Simplified/condominial sewerage

When simplified/condominial sewerage was first developed in northeast Brazil, it was introduced to the beneficiary communities as the only feasible technical option for sanitation in high-density low-income urban areas by Companhia de Águas e Esgotos do Rio Grande do Norte (CAERN, the water and sewerage company of the state of Rio Grande do Norte, where it was first installed in 1981). CAERN made huge efforts to engage with the community (Melo 1985, 1994, 2005, 2008; de Andrade Neto 1999); indeed, Melo (2008) stated that ‘social mobilization’ was the fundamental key to the success of condominial systems. The success of these efforts can be judged by the fact that these early CAERN systems were found to be functioning perfectly satisfactorily after 20 years (Sarmento 2001). However, when some state water and sewerage companies in Brazil did not engage effectively with their communities, their systems ran into major operational difficulties (Watson 1995). In 2017 in Rio Grande do Norte the monthly cost to households served with simplified/condominial sewerage was BRL 2.70 (GBP 0.68, USD 0.87) (CAERN 2017), equivalent to only ~0.3% of the Brazilian minimum wage (Salário Mínimo 2017), so it is clearly a financially very affordable system.

The Orangi Pilot Project

The Orangi Pilot Project (OPP) in Karachi, Pakistan (Khan 1998) was a successful project that brought sanitation to the ‘unplanned’ (that is, illegally developed) area of Orangi (actually it was planned in the sense that the developer had set out the settlement in regular plots on a grid system – all, it has to be said, on stolen government land). The sanitation technology adopted was simplified sewerage or something very close to it – in fact, OPP planners had visited the joint UN-Habitat–BCCI (Bank of Credit and Commerce International) Foundation pilot project in the nearby settlement of Kristy Nagar where strict Brazilian-style simplified sewerage was being installed (Sinnatamby et al. 1985).
Fortunately for OPP the ground slopes in Orangi were greater than the minimum sewer gradient required for simplified sewerage (5‰), so sewer self-cleansing was assured. The OPP has been a very successful project with its staff working very closely with the beneficiary communities (Khan 1998; Hasan 2002).

**eThekwini latrines**

The eThekwini water and sanitation programme in South Africa comprises, on the sanitation side, urine-diverting alternating twin-vault ventilated improved vault latrines which are wholly above ground and simple to empty; they were developed by eThekwini Water as the sanitation solution for communities outside the sewered areas of the municipality (WIN-SA 2008). The programme was severely criticized during discussions at the 2007 World Water Week in Stockholm simply because the beneficiaries were given no choice by eThekwini Water – i.e., because it was a top-down planning process (Mara, personal observation 2007). However, it has been a very successful sanitation project and eThekwini Water did work very hard and sensitively with the communities to explain the system, what their responsibilities would be for operation and maintenance, in particular regarding faecal-sludge removal from the vaults.

**Safely-managed shared sanitation**

In 2015, 357 million people worldwide used ‘shared’ sanitation (now termed ‘limited’ sanitation by WHO/UNICEF 2017) in urban areas – shared, that is, between two or more households, including 27% of the urban population in least-developed countries (as defined by UNCTAD 2016), and 32% in sub-Saharan Africa (WHO/UNICEF 2017). Many, if not most, of these shared facilities suffer from such an extreme lack of maintenance that they are in a high state of faecal disorder. However, this does not have to be the case: it is perfectly possible to have safely-managed and hygienic shared sanitation, as exemplified by the community-designed and managed sanitation-and-water blocks in India (Burra et al. 2005; Patel 2014; Banana et al. 2015). The maintenance of these blocks is the responsibility of caretakers (or, for large blocks, caretaker couples) who keep the facility clean as they know that their employment depends on this. Maintenance materials and the caretakers’ wages are covered by small user charges for sanitation and purchases of 5–20-litre volumes of water (Patel & SPARC 2013). These facilities in Indian cities were developed ‘bottom-up’ by a consortium of community-based organizations, including the National Slum Dwellers Federation, Mahila Milan (a federation of women’s savings groups) and SPARC (the Society for the Protection of Area Resource Centres, an Indian NGO), but in Kenya, where they were successfully replicated, they were a ‘top-down’ development promoted by UN-Habitat working with local NGOs (Meredith et al. 2014). The top-down planning and implementation of these community sanitation-and-water blocks in slums is likely to be the only way of providing a reliable and hygienic sanitation-and-water service to slum dwellers, who number over 881 million (the figure for 2014, UN-Habitat 2016) and who represent 30% of the urban population in developing countries (56% in sub-Saharan Africa), as there is insufficient land available in these high-density areas for conventional individual household latrines. Thus, safely-managed shared sanitation in urban slums needs to be much more widely promoted than at present (Rheinländer et al. 2015), and it also needs to be recognized by WHO/UNICEF as an acceptable/adequate solution to sanitation in urban slums (Mara 2016). If WHO/UNICEF do not accept safely-managed shared sanitation, then the SDG sanitation target can only be met by a truly massive increase in household-level container-based sanitation or an equivalent future development.

Mara & Alabaster (2008) recommended a condominial solution to sanitation (and water supply) in low-income urban areas: in slum areas the solution was to provide designated areas (‘condominia’) with safely-managed shared sanitation-and-water blocks, and in non-slum areas to provide the condominia with condominial sewerage and a condominial water supply (for these options, see Melo 2005). They recommended that monthly costs be based on a percentage of the local minimum wage (e.g., 1–2% in slum areas and 3–5% in non-slum areas); each household in each condominium would pay its condominial charge to a local resident of its condominium who thus acts as the condominium’s treasurer, and who would then pay the water and sewerage utility (this simplifies the utility’s billing process).
Conventional sewerage in industrialized countries

There was essentially no interaction with the beneficiaries of conventional sewerage in the mid/late-19th and early-20th centuries in the United Kingdom (Bazalgette 1865; Sellers 1997; Halliday 1999), with public finance mainly being used for implementation (Bisaga & Norman 2015). The situation in the United States was similar to that in the UK (Goldman 1931; Burian et al. 2000). In both countries, and indeed in most of Europe, conventional sewerage was readily accepted by its beneficiaries as it was a system that worked, was not expensive (in the UK its costs were included in local-government taxes known as ‘rates’ which were based on the estimated rent the household could charge a tenant on a year’s lease), and represented a major advantage over what it replaced (commonly overflowing cesspools and open drains, sometimes septic tanks).

Comment

When properly done, ‘top-down’ planning can be highly effective, as shown above. However, for this to happen urban planners and sanitation-service providers have to be very good at their job and be willing and able to interact in a meaningful way with the beneficiary communities. If they are not, then organizations like the Urban Resource Centre in Karachi are needed (Hasan 2007):

‘The Urban Resource Centre is a Karachi-based NGO […] set up in response to the recognition that the planning process for Karachi did not serve the interests of low- and lower-middle-income groups. […] The Urban Resource Centre […] has created a network of professionals and activists from civil society and government agencies who understand planning issues from the perspective of these communities. […] This network has successfully challenged many government plans that are ineffective, over-expensive and anti-poor, and has promoted alternatives. It shows how the questioning of government plans in an informed manner […] can force the government to listen and to make modifications to its plans, projects and investments.’

CONCLUDING REMARKS

1. Community-sensitive top-down planning has a greater chance in high-density low-income urban areas of achieving the sanitation target of the SDG than the much more time-consuming approach of bottom-up planning.
2. Simplified sewerage is especially suited to community-sensitive top-down planning and in most high-density areas it is the sustainable sanitation technology of first choice (and often the only choice) as it is cheaper than on-site systems at relatively low population densities (around 160–200 people per ha).
3. Simplified sewerage, low-cost combined sewerage, safely-managed community sanitation blocks, and perhaps also container-based sanitation, are as scalable in low-income high-density urban areas in developing countries as conventional sewerage has been in industrialized countries.
4. A final point is that community-sensitive top-down sanitation planners can see the whole urban picture and plan accordingly.

Note: The Kalbermatten sanitation-planning model

The Kalbermatten model for sanitation planning and sanitation-technology selection (Kalbermatten et al. 1985) comprises six steps undertaken by three types of professional—an economist/financial analyst, a sanitary engineer/public health specialist, and a sociologist/social anthropologist/behavioural scientist—all of whom work in conjunction with the beneficiary community. In Steps #1 and 2 the economist collects macroeconomic information; the engineer/health specialist examines local physical and environmental conditions and establishes the community health profile, and costs the technically feasible sanitation options; and the sociologist interacts with the community to determine their sanitation practices and preferences, and identifies the socially acceptable sanitation options. In Step #3 a short list of the economically, technically and socially feasible options is prepared, and the community advises its level of affordability and what in-kind contributions it could make. In Step #4 the community agrees on typical layouts for the economically, technically and socially feasible options, and the engineer prepares final
designs and preliminary cost estimates for them. In Step #5 the financial analyst prepares financial costs for these final options, and in Step #6 the community selects its preferred sanitation option.

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First received 8 August 2017; accepted in revised form 19 December 2017. Available online 16 January 2018