Chapter 4
Reframing the Challenges and Opportunities for Improved Sanitation Services in Eastern Africa Through Sustainability Science

Sara Gabrielsson, Angela Huston, and Susan Gaskin

4.1 Introduction

The need for access to sufficient, clean and reliable drinking water has long been recognized as a major development goal (WHO/UNICEF 2017). However the long-term public health benefits of clean water provision will only be sustained if hygienic sanitation conditions are present (Bartram and Cairncross 2010). The availability of water, sanitation and hygiene (WASH) services is essential for a healthy and dignified life, but these services are astonishingly still unavailable to a third of the global population (WHO/UNICEF 2017).

The main purpose of WASH programmes is to separate humans from contact with faeces (and associated pathogens) as a means of preventing disease transmission through faecal-oral pathways.[1] However, recent sanitation statistics indicate that out of the 962 million people living in Sub-Saharan Africa (SSA), as many as 220 million (23%) still practice open defecation, 300 million (31%) rely on

[1]WASH-related diarrhoea is the most widespread and dangerous of these diseases, estimated to have caused 842,000 deaths in 2012 alone (Pruss-Ustun et al. 2014).

S. Gabrielsson (✉)
Lund University Centre for Sustainability Studies, Lund, Sweden
e-mail: sara.gabrielsson@lucsus.lu.se

A. Huston
McGill University, Montreal, QC, Canada

IRC International Water and Sanitation Centre, The Hague, The Netherlands
e-mail: huston@ircwash.org

S. Gaskin
McGill University, Montreal, QC, Canada
e-mail: susan.gaskin@mcgill.ca

A. Gasparatos et al. (eds.), *Sustainability Challenges in Sub-Saharan Africa II*,
Science for Sustainable Societies, https://doi.org/10.1007/978-981-15-5358-5_4

unimproved sanitation facilities, 172 million have limited sanitation services (18%) and only 270 million (28%) have access to basic sanitation (e.g. an improved pit latrine not shared with other households) (WHO/UNICEF 2017). In addition to being a major health risk, inadequate sanitation has a high negative impact on earnings, with the national economic benefits of proper sanitation investments being well-documented (WSP 2012; UN-Water 2008). The World Bank Water and Sanitation Program has estimated that poor sanitation has major economic costs to 18 SSA countries (USD 5.5 billion per year), the greatest proportion of which is associated with premature death due to diarrheal diseases (WSP 2012).

While there are abundant approaches and frameworks for implementing sanitation services, there is still scarce evidence of the long-term success of sanitation interventions in SSA (Davis 2016). The international development community and national governments have not been able to meet the sanitation demands of the rapidly growing population across SSA, despite billions of dollars invested over the past decade (Davis 2016; WHO/UNICEF 2015, 2017) (Chaps. 1, 5 Vol. 1). Although the Gross Domestic Product (GDP) is increasing rapidly in many SSA countries, the continent is simultaneously coping with the negative impacts of climate change, high rates of population growth, massive migration into urban areas and the expansion of informal settlements (see Chap. 1, Vol. 1). This has resulted in increasing economic inequality that has left millions of people without the basic human right to sanitation (Cross and Coombes 2014; Oates et al. 2014).

Eastern Africa is a region of SSA that exemplifies the challenges and problems associated with the lack of successful implementation of WASH programmes. Despite large increases in the national GDP of Kenya, Tanzania and Uganda (eightfold, tenfold and six-fold, respectively, since 1990), the sanitation sector has not kept pace in terms of service delivery improvements and remains chronically underfunded (see Chaps. 1, 5, Vol. 1). In fact the fraction of the population with access to sanitation has only slightly increased from 25% to 30% in Kenya, from 7% to 16% in Tanzania and from 6% to 13% in Uganda between 2000 and 2015 (World Bank 2017). UN Water found that 80% of SSA countries report insufficient financing for the sanitation sector, which perpetuates the tendency to seek external *solutions* to the sanitation challenge, instead of developing new and robust local financing schemes and owner-operator-regulator relationships (UN Water 2014 cited by Davis 2016) (Chaps. 1, 5 Vol. 1). Although national-level policies widely recognize sanitation as the responsibility of the government (UN Water 2014), the international development and non-profit communities play a large role in both financing and implementing sanitation solutions in eastern Africa (WHO 2017). The extensive, but often inconsistent, investment from external support agencies has usurped the responsibility of the governments and has allowed national and local sanitation systems to remain weak (Ekane et al. 2014). Sanitation is often bundled with (but usually as a second priority to) drinking water and broader WASH sector activities, while donor investment remains fragmented, inconsistent and unsupported by national policy (Galli et al. 2014; Ekane et al. 2016) (Chap. 5 Vol. 1).

The above suggest that the proper implementation and wide-scale adoption of WASH activities are a major sustainability challenge in eastern Africa. Indeed,

between 2000 and 2015, the Millennium Development Goals (MDGs) were driving the international development agenda, with MDG 7c aiming to halve the number of people globally without access to an improved water source and to sanitation facilities (Hickling 2014). In 2015, it was evident that most SSA countries, including Kenya, Tanzania and Uganda, had failed to meet their WASH targets, with the largest gap being for basic sanitation (WHO/UNICEF 2017). While this failure is due in part to the chronic underfunding of the sanitation sector, it is also due to the lack of coordinated investment efforts, from both SSA governments and donors, and the lack of national policy frameworks (Galli et al. 2014; Ekane et al. 2016) (Chap. 5, Vol. 1). Even though, the commitment to improve sanitation coverage was an important step of MDG targets, the actual headline indicators focused on infrastructure construction without promoting sufficient investment in supporting systems promoting sanitation use and providing system maintenance (Davis 2015). The MDGs also limited their scope to the toilet itself and did not consider the entire *sanitation chain*,[2] which must also be addressed to achieve the desired long-term health benefits (Galli et al. 2014; Mulumba et al. 2014). Furthermore, the MDGs did not target household and community hygiene practices that must be understood and addressed at the same time as technological sanitation solutions are provided, in order to effectively break the faecal-oral disease pathway (Tilley et al. 2014).

The newly adopted Sustainable Development Goals (SDGs), through SDG 6, aim to overcome the shortcomings of MDG 7c by including targets for universal coverage, faecal sludge management and wastewater treatment (UNICEF 2017). These are ambitious targets that will motivate significant investment. However, even with the currently high levels of investments and good understanding of the challenges (Chap. 5, Vol. 1), these targets are unlikely to be met in most SSA countries (WHO/UNICEF 2017) without a radical paradigm shift in how we *view* and *do* sanitation.

Sustainability Science may help to reframe the sanitation challenge in SSA by offering insights about the requirements necessary to implement and maintain sustainable sanitation services. Sustainability Science is an emerging discipline with a vibrant research community that brings together scholarship and practice from different perspectives (e.g. global and local, north and south) and disciplines from the natural sciences, social sciences, engineering and medicine (Clark and Dickson 2003; Kates 2011; Ziegler and Ott 2011). Sustainability Science aims at finding solutions to complex problems, such as those characterized by numerous feedback loops and interactions with other sectors, which require behaviour change and have high damage potential, urgency and no obvious optimal solution (Rittel and Webber 1973; Wiek et al. 2011) (Chap. 1, Vol. 1). Solutions are sought by attempting to generate, integrate and link use-inspired knowledge and channel it into transformative action through participatory, deliberative and adaptive techniques

[2]The *sanitation chain* refers to the series of processes necessary in order to safely manage human waste. The steps are capture, containment, transport, treatment and disposal/reuse (Galli et al. 2014).

(Kates et al. 2001; Bäckstrand 2003; Clark and Dickson 2003; Komiyama and Takeuchi 2006; van Kerkhoff and Lebel 2006; Sarewitz et al. 2010; Jerneck et al. 2011; Wiek et al. 2011; Talwar et al. 2011) (Chap. 8 Vol. 2). The strength of this approach lies in redefining the functions, mandating and scoping of scientific inquiry and understanding human-environment systems as integrated (i.e. coupled) rather than separable or even separate (Clark 2007; Kates et al. 2001).

Sustainability Science adopts a systems thinking perspective. It is *problem-driven* and *solution-oriented*, making it conducive to understanding and responding to the complexity posed by poor sanitation in SSA (Huston and Moriarty 2018; Neely 2019; Andersson et al. 2016). Using this approach for the sanitation challenge first requires the identification and description of the entire sanitation chain in a particular geographic setting, i.e. how does the sanitation system function and how do related interventions perform, while considering the different value-laden goals and objectives (Schultz et al. 2008). For example, it could be possible to investigate the balancing and reinforcing feedback between the generation, removal, disposal and potential reuse of faeces and urine and the motivation for (and impacts of) different sanitation interventions on humans and ecosystems (Andersson et al. 2016). Such an inquiry would require extensive place-based knowledge and the use of theories, methods and tools from an array of disciplines (Jerneck et al. 2011). This would need to be produced in a *transdisciplinary* manner with the involvement of wider societal actors such as NGOs, the private sector, national/local government and local communities (Galli et al. 2014) (Chap. 8 Vol. 2).

Once the sanitation system is understood, practical solutions to the underlying sustainability challenges must be sought. Solution-oriented principles first require questioning the sustainability of existing solutions and then exploring alternative pathways through strategic and operational questions to identify which transition pathways are viable (Loorbach 2010; Jerneck et al. 2011). In the context of sanitation implementation in SSA, this step could include a critical analysis of the applicability and sustainability of water-based sanitation systems (also called wet sanitation),[3] considering their reliance on reliable piped water supply and sewer networks. Wet sanitation may not be appropriate considering the expected water scarcity due to climate change in much of SSA (see Chap. 1, Vol. 1). In addition, only 4.6% of the SSA population has access to sewers (Oates et al. 2014). This begs at least an investigation into alternative sanitation options as a means of meeting SDG6 (Clean Water and Sanitation), as well as other goals related to sanitation such SDG3 (Good Health and Wellbeing). Furthermore, Sustainability Science approaches could be used to explore the *synergistic effects* of turning human waste into valuable products (e.g. biogas, fertilizers, animal feeds) and how this could

[3]Wet sanitation refers to a system of capture and transport of excreta that uses water as a carrying medium. This is the Victorian era model used in western style flush toilets and sewer networks. Dry sanitation does not use water and hence does not require sewers but needs an alternative transport and treatment method for the more solid medium, composed primarily of faeces.

contribute to transformational change through the environmental and income generating benefits it could offer (Diener et al. 2014).

The aim of this chapter is twofold and is anchored in Sustainability Science thinking (Sect. 4.2). The first is to provide a heuristic analysis of how the sanitation problem (and its solutions) is commonly conceived and how this perpetuates cyclical failure in the SSA context (Sect. 4.3.1). The second is to offer empirical examples from eastern Africa of some practical solutions that are breaking out of this failure cycle in eastern Africa by adopting new and innovative approaches to improve and sustain sanitation service operation and maintenance (Sect. 4.3.2). We then discuss the governance implications of reframing the sanitation challenge in the region and make policy recommendations for the future (Sect. 4.4).

4.2 Methodology

The lack of priority for (and the competitive nature of) funding for sanitation in SSA reduces the opportunity to talk openly about failure and explains why so few failed projects have been reported and properly documented (Davis 2016). Not only does this diminish the potential learning from failure, but it also encourages stakeholders to understate and oversimplify its causes. Our methodological approach is anchored in Sustainability Science, and in particular the principle of systems thinking and is twofold: critical and exploratory. It is critical in its attempt to understand the drivers of systemic failure from a sector perspective (Sect. 4.3.1) and exploratory as it outlines how specific characteristics can allow sanitation systems to break out of this failure cycle (Sect. 4.3.2).

Our initial analysis of the drivers of systemic failure in the sanitation sector (Sect. 4.3.1) incorporates information from academic and grey literature, as well as the authors' own experience from practical sanitation work and research in the region during the last 5 years (2013–2018). Rather than doing detailed analyses of 'failed' sanitation projects and programmes across eastern Africa, our focus is to identify and discuss crosscutting aspects of the cyclic failure in the sector that persist across rural and urban contexts across the region.

An overview of the sanitation context in each of the three study countries (i.e. Kenya, Tanzania, Uganda) was obtained through seven transect walks combined with informal interviews with different actors (Table 4.1). These walks took place in one rural village (Lumuli, Tanzania), two peri-urban settings (Naivasha, Kenya and Chuka, Kenya), and four informal urban settlements (Keko in Dar es Salaam, Tanzania; Kibera in Nairobi, Kenya; Kiwanja Ndege in Naivasha, Kenya and Kabalagala in Kampala, Uganda) (Fig. 4.1).

We then analyze data from six implemented WASH schemes in the three countries (Box 4.1), to identify the characteristics conducive to breaking out of the failure cycle (Sect. 4.3.2). A snowball sampling method was used to identify the study schemes that are a representative sample of a specific type of projects (see below) rather than an exhaustive list of sanitation schemes in the region. In

Table 4.1 Characteristics of key informant interviews and focus group discussions

Respondent	Organization	Location	Data collection method
Research officer	Umande Trust	Kibera, Nairobi, Kenya	Key informant interview
Project manager	Umande Trust	Kibera, Nairobi, Kenya	Key informant interview
Deputy director	Umande Trust	Kibera, Nairobi, Kenya	Key informant interview
Soweto high-rise savings group	Umande Trust	Kibera, Nairobi, Kenya	Focus group discussion
Teacher, St. Christina School	Umande Trust	Kibera, Nairobi, Kenya	Informal interview
MUVI self-help group members	Umande Trust	Kibera, Nairobi, Kenya	Focus group discussion
Government relations specialist, Management team member	Sanergy	Makuru, Nairobi, Kenya	Key informant interview
Engineer	Sanergy	Makuru, Nairobi, Kenya	Key informant interview
Director	Centre for Community Initiatives	Keko, Dar es Salaam, TZ	Key informant interview
Sanitation engineer	Centre for Community Initiatives	Keko, Dar es Salaam, TZ	Key informant interview
Tumaini Letu group	Centre for Community Initiatives	Keko, Dar es Salaam, TZ	Focus group discussion
Co-founder	Sanivation	Naivasha, Kenya	Key informant interview
Energy production, team member	Sanivation	Naivasha, Kenya	Key informant interview
Programme assistant, decent living project	Environment Alert	Kabalagala, Uganda	Key informant interview

particular, the sanitation schemes were selected from communities that are currently underserved by sanitation services, which had adopted an innovative on-site technology in either a rural or an urban setting. They are self-financed (i.e. not through charity) and are either based on profit-making business models or are community-owned and managed schemes. We identify (a) the characteristics that make them different to the current business-as-usual sanitation approaches, (b) how their adaptive systems incorporate ‘soft’ elements and (c) how broader systems strengthening can build and support an environment conducive to sustainability.

Fig. 4.1 Study sites in Kenya, Tanzania and Uganda

Box 4.1 Study Sanitation Schemes

Umande Trust is a rights-based agency that works in informal settlements ('slum' communities) in and around Nairobi, Kenya. Umande uses a multi-level approach that focuses on delivering a 'product'(e.g. access to urban water, bio-sanitation, solid waste management services) by creating a raft of community-led processes to support it. Such processes are, for example,

(continued)

Box 4.1 (continued)
partnerships for change, integrated urban environmental planning, sanitation governance, human rights and urban services financing. The Umande Trust team is comprised of community organizers, academics, geospatial analysts, urban planners, human rights advocates, civil engineers, social scientists, environmental scientists as well as gender, youth and enterprise development resource persons. For more information refer to www.umande.org.

Centre for Community Initiatives (CCI) is a national support NGO formed in Tanzania. Its aim is to provide technical and financial assistance to local communities in informal settlements. CCI focuses on building resilient communities and supporting them to meet their needs. Their work could entail the provision of direct help to local communities by installing sanitation infrastructure or providing complementary support from the community such as establishing savings schemes, community resource mobilization and organization, enumeration and mapping support, exchange visits, partnership support, technical assistance, capacity building, leadership and management support, outreach, advocacy, action-oriented research and documentation. For more information refer to www.ccitanzania.org.

Sanergy is a social enterprise that provides low-cost hygienic sanitation facilities that are rapidly installed and designed to function in dense informal settlements in Nairobi, Kenya. Sanergy employs a franchise business model that provides business training and microcredit loan opportunities to small-scale sanitation engineers, who then maintain, operate and expand access to toilets in high-demand areas. Sanergy toilets are urine-diverting dry toilets, capturing the waste for reuse in agriculture and energy production. For more information refer to www.sanergy.com.

Sanivation is a social enterprise that instals container-based toilets in homes in local communities near Naivasha, Kenya. The toilets are installed for free and Sanivation charges a small monthly fee to empty them, transforming the waste into a clean burning alternative to charcoal. The enterprise focuses strongly on providing a *service* rather than simply a toilet or charcoal alternative. Thus they focus on the wants and needs of local communities, while at the same time addressing the entire sanitation chain in an effort to reduce faecal contamination hazards in urbanizing communities. For more information refer to www.sanivation.com.

The Decent Living Project in Kampala, Uganda, aims to improve the lives of residents in informal settlements through the development of WASH services for local needs. The project takes a three-pronged approach combining (a) advocacy for WASH needs and services, (b) construction of facilities with local artisans, and (c) the development of business enterprise to support a range of sanitation and water-related business models. Environment Alert, the implementing NGO, works with local entrepreneurs and youth groups to

(continued)

Box 4.1 (continued)
identify and understand local needs. It then supports the development of business models to fill these gaps in an equitable manner (e.g. brickmaking for improving facilities, waste treatment for use in urban agriculture). For more information refer to http://envalert.org/phase-2%E2%80%B2-decent-living-dl/.

These selected sanitation projects share three similarities: (a) they are deeply embedded in the local context; (b) they have a balanced approach to meeting human needs and assuring environmental sustainability, thereby taking a *service delivery approach*; and (c) they recognize the need to move away from aid-based approaches and towards financially viable sanitation solutions. By using these three aspects, we demonstrate how these organizations start from a complex and dynamic understanding of the current situation, which allows them to consider alternative future scenarios, rather than being limited to the business-as-usual approach.

The sanitation schemes were analyzed using qualitative data collected from in-person key informant interviews with staff, project site visits and focus group discussions with community members participating in the sanitation schemes (Table 4.1). The empirical data was collected during fieldwork in Tanzania (January to March 2015 and July of 2016), Kenya (June of 2015 and 2016) and Uganda (June of 2016). Additionally we conducted a desk review of the available documentation about each organization's approach and on published peer-reviewed articles about their progress (e.g. O'Keefe et al. 2015; Otsuki 2016).

The empirical data was analyzed and synthesized using a Sustainability Science approach, which is founded in an iterative learning process, to identify systemic properties that improve or inhibit sustainability. We should note that this analysis focuses on the qualitative aspects of sanitation provision in eastern Africa, rather than on providing a comprehensive technical and financial analysis of the different approaches. Through this rapid assessment approach, we identify key aspects that affect the technical and financial viability of the study sanitation schemes. In a sense, we seek to identify how novel ideas are implemented in innovative ways, exhibit institutional learning and adaptive capacity and have the potential for long-term sustainability. Rather than using a formal definition of *success*, we describe *promising* approaches based on their transformational change potential, in-built flexibility and suitability for scaling up.

Lastly, it must be recognized that the authors were born, raised and educated in the lobal North. Therefore, despite our profound recognition of the western bias as a contributing factor for systemic failure (Sect. 4.3.1.2), it is not removed from our research and perspectives, despite having spent a significant amount of time living and working in SSA (periodic stays of several months since 2006). We seek to mitigate the influence of this bias by undertaking a context-laden and systemic approach to this analysis.

4.3 Results and Discussion

4.3.1 Factors of Cyclic Failure

Through a critical analysis of the business-as-usual approach to sanitation using a sustainability thinking lens, we identify persistent shortcomings and trends associated with inadequate solutions (Sects. 4.3.1.1, 4.3.1.2, 4.3.1.3 and 4.3.1.4). Figure 4.2 outlines the relationship between the main factors and challenges described in Sect. 4.3.1 and demonstrates how they create a reinforcing cycle of failure for the business-as-usual sanitation sector in eastern Africa.

4.3.1.1 Lack of Systems-Based Thinking

When linear or single-issue thinking is applied, only one possible outcome is considered for a given intervention. A sanitation chain that recognizes the interlinkages between different processes from the capture to the safe disposal remains inadequate if the people, hygiene behaviours and capacities at each step of the chain are not considered. The construction, maintenance and sustained use of latrines are separate but related issues that must all be addressed in order to achieve the positive health outcomes associated with improving WASH access. Often the focus is on either technology or behaviour change, without adequate consideration of

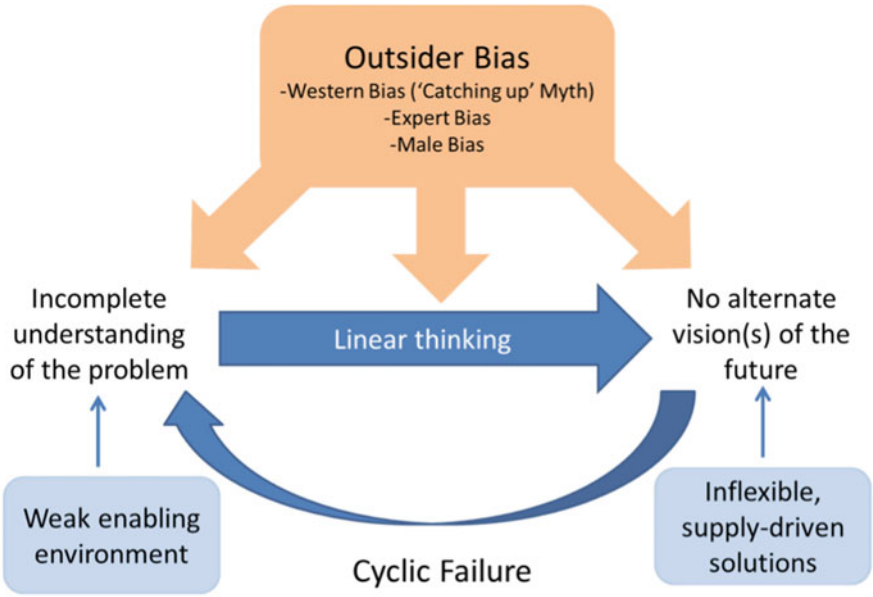

Fig. 4.2 Cyclic failure of the business-as-usual model for sanitation solutions in eastern Africa

what types of technology and what social conditions can jointly promote the sustained use of sanitation facilities. In other cases, facilities are developed without an adequate consideration of the land tenure, environmental conditions or legal and regulatory constraints that will affect the success of the intervention (Sepalla 2002; Huston and Moriarty 2018).

A *systems approach* acknowledges that the overall functioning of systems is more than just the sum of their parts (Stroh 2015). Such an approach demands a good understanding of the complex interactions within a system prior to developing interventions that aim to shift its dynamics (Stroh 2015). Systems-based solutions are holistic rather than symptom-based, they are achieved more slowly and their endpoint is more variable than conventional (single-issue) solutions (Galli et al. 2014). However, they are also more flexible because the dynamic and unpredictable nature of the system is recognized. In the context of sanitation, the sustainability of sanitation service provision depends on the interrelated factors of robustness of the economic conditions, effective governance, supportive social systems and sufficient natural resources (Galli et al. 2014).

4.3.1.2 Outsider Biases

The problems caused by short-term thinking (Sect. 4.3.1.1) are exacerbated when solutions are designed by outsiders having little or no long-term experience in the implementing context and who are unaware of (and unable to predict) the possible outcomes of a given intervention.

An example from the sanitation sector is community-led total sanitation (CLTS), which seeks to change sanitation habits by triggering shame in communities that practice open defecation and thus catalyze the construction and sustained use of latrines (Chambers and Myers 2016). This method was developed in Asia and has been applied broadly across much of SSA with little consideration of the different but related needs (Davis 2016). While CLTS will produce a peak in toilet construction and use, inadequate consideration of the specific needs for expertise, spare parts, environmentally appropriate technologies and context-specific public health behaviour training will limit its sustainability over the longer term and hinder the achievement of the desired health impacts over time (Davis 2016).

Sustainability Science calls for an increased understanding of the perspectives of the many stakeholders and their capacity to fulfil their roles and responsibilities (Jerneck et al. 2011). In western societies, where sanitation systems are well established, sanitation is usually the responsibility of the state (municipality) with its highly trained functionaries. Its operation and maintenance is financed through taxes or user fees, while capital projects are financed through loans and partnerships with upper levels of government. The in-house user interface with the sanitation system, the toilet, is bought by homeowners but mandated and regulated by public building codes and health standards. These multiple stakeholders (and their interactive roles for developing and maintaining a sanitation system) suggest that deep knowledge of the context, social behaviours and political economy is necessary in

order to understand and remove the multiple barriers to sanitation success. In this sense, path dependence refers to the constraint that the identified set of options/solutions for any given sustainability challenge is limited by past decisions and that visions of success can emerge from other contexts and under different conditions (Rip and Kemp 1998).

Below we discuss three outsider biases, which can be a key cause of the cyclic failure of sanitation systems, contributing to the lack of sustainable sanitation services in SSA: (a) western bias, (b) expert bias and (c) male bias.

W*estern bias* is the 'myth of catching up development' (Mies 1998), which assumes that the development of all countries will evolve along the same path to reach the same endpoint. For sanitation, the progression is to advance up the 'sanitation ladder' from open defecation, via pit latrines and pour flush toilets connected to septic tanks to toilets connected to a sewerage system (WHO/UNICEF 2015). Many large-scale projects are locked into the bias of water-based sewerage (Tilley 2008) and a financial and technological dependency that may not be appropriate or relevant in the eastern African context. Currently only 20% of the population in eastern Africa use sewers (WHO/UNICEF 2017),[4] and current strategic plans and legislative frameworks do not account for the remaining 80% who depend on non-sewered sanitation infrastructure (Ekane et al. 2016). The bias towards the western standard of a water-based sanitation system fails to recognize the unsustainability of this technology for water-stressed regions, such as eastern Africa (Penner 2010). The pursuit of this ideal hampers the organic development of locally appropriate sanitation systems, and instils a sense of inferiority or 'backwardness' when a country fails to advance up the linear sanitation ladder (Penner 2010). Questioning the environmental sustainability and financial viability of the top rungs of the ladder, some scholars are now calling for a revision of the concept of the sanitation ladder to add alternative benchmarks for improved WASH services, which recognize other more sustainable and/or appropriate sanitation technologies for countries of the Global South (Kvarnström et al. 2011).

Expert bias is due to outside 'experts' from the Global North or South (often sanitation engineers), who advise local communities on the construction of a predetermined sanitation technology. Challenges may arise when the outside experts fail to understand the local cultural context and behaviour or practices of the non-'-experts', particularly for local decision-making processes during the planning and execution of activities. In one example from Iringa, Tanzania, unnecessary conflicts arose when the sanitation engineer from India declared to the village leadership (exerting his power as an expert) that he knew the local needs better than the community who was to use the WASH system. This eroded the established trust between the outsiders and the community, further complicating the implementation of the system, which ultimately led to the abandonment of the project (Project Manager, personal communication, July 4, 2014).

[4]Data from WHO/UNICEF 2017 baseline. Mean estimate for Sub-Saharan Africa as a whole

Male bias reflects the domination of men in the sanitation sector across all levels of implementation (Seager 2010). This poses a major challenge for sanitation sustainability. While women and girls are disproportionately affected by inadequate WASH services due to their biological needs, roles as caretakers of domestic tasks and established societal taboos; they have the least power to change this situation (Taylor 2009; Gabrielsson and Ramasar 2013). Males hold the decision-making power in eastern Africa at all levels, ranging from the individual household to the sub-village, village, district, region and government levels (Gabrielsson and Ramasar 2013). Unless the men in power fully understand and prioritize the importance of sanitation at all these levels, the sustainable implementation of sanitation systems will be difficult to achieve (Seager 2010). A typical example of this lack of priority is the fact that the majority (63%) of school toilets in Tanzania lack facilities to dispose of menstrual hygiene care products, forcing schoolgirls to dump them inside the latrines (causing clogs and overfilling) or bring the soiled and smelly pads back home (NIMR 2016).

There are many specific consequences of these outsider biases, but the overall effect is the development of poorly designed, disjointed and misaligned sanitation strategies based on short-term goals (Davis 2016). In addition, many sanitation strategies disregard or neglect the needs, priorities, voices and participation of the most vulnerable community members in sanitation projects and related national policies (Tsinda et al. 2013). The pathways leading from sanitation-related problems to the identified solutions are either inadequate and/or inflexible (linear) and therefore cannot access alternate visions of the future (Galli et al. 2014).

Such inflexible approaches and outsider biases contribute to dire sustainability challenges for sanitation efforts in eastern Africa and may partly explain why current solutions to 'fix' the problem(s) are not working. Sections 4.3.1.3 and 4.3.1.4 explore using a sustainability science lens to more broadly assess the enabling environment (e.g. the political economy and governance framework), in which sanitation interventions take place.

4.3.1.3 Weak Governance and Inadequate Long-Term Financing

Sanitation interventions and services require the involvement of individuals, households, local communities (and/or schools), operators and multiple levels of government (Galli et al. 2014). Many actors must be engaged to coordinate between sectors, yet sanitation often remains a low priority even for actors legally responsible for it (Ekane et al. 2016). For example, in Tanzania, the responsibility for sanitation is divided between the Ministry of Health, Community Development, Gender, Elderly and Children, the Ministry of Water and Innovation and the Ministry of Education, Science and Technology. This contributes to fractured governance and financing, as sanitation implementation problems are often dismissed as 'somebody else's problem' (Kimwaga et al. 2013; Ekane et al. 2014).

As already discussed in Sect. 4.1, due to the fragmented financing landscape, many eastern African governments look externally for possible solutions and

support (Mulumba et al. 2014). However often such interventions are plagued with issues that reduce their long-term viability and sustainability. For example, the typical 3–5-year project funding cycles of NGOs, outside initiatives and even government programmes limits long-term planning for sustainability. In a survey of 48 US-funded WASH NGOs, 89% and 96% reported limited timeframes and lack of funding for long-term monitoring, respectively, as key hindrances to their ability to contribute to sustainable water and sanitation services (Davis 2015). Too often, we observe 'better-than-nothing' solutions that improve the situation for a short period and then fail, which are repeated and subsequently marked as successes (Jenkins and Sugden 2006). For example, continuing with the CLTS example (Sect. 4.3.1.1), communities were successfully triggered to build their own latrines; however, many were poorly constructed and could not withstand seasonal floods (Davis 2016). After as little as one season, many of the new latrines became open holes filled with human waste, presenting safety hazards to the community. Furthermore, without resources to rebuild (although some communities may be triggered to build better sanitation options) and the means to act, they develop a feeling of lesser dignity (Sanitation Engineer, CCI, personal communication, March 30, 2016). Inability to recognize the systemic inadequacy of linear and piecemeal solutions can lead to cyclic failure and prevent the development of alternative and more sustainable sanitation solutions (Waterkeyn and Waterkeyn 2013; Strande and Brdjanovic 2014).

Measuring performance accurately and beyond the initial project period is critical for a data-driven learning cycle to increase sustainability (Sparkman 2012). All-or-nothing indicators that report only on the presence of infrastructure and the progression of service provision (linearly) up the sanitation ladder neglect the complexities of sanitation provision. Building on lessons learned from CLTS, we observe that merely counting the number of activities or events triggered is insufficient to track and understand actual improvement (Sparkman 2012). For sustained success, it is important to monitor if (and how) actual sanitation practices are implemented over time. For example, many sanitation schemes that have used CLTS to trigger change in sanitation behaviour rarely provide dedicated funding and time for monitoring and reporting (Davis 2016). This makes it difficult to assess the overall impacts and performance of such schemes.

Monitoring can also lead to perverse incentives. For example, the strong focus towards meeting the MDG targets drove sector initiatives aimed at improving their national statistics in the fastest way possible, instead of working holistically to reach the most vulnerable and achieving sustained progress (Fukuda-Parr et al. 2014). For example, in peri-urban areas of Nairobi, Kenya, we witnessed how subsidies were used to replace existing latrines with 'improved latrines' in order to improve MDG statistics. However, a local staff member of an involved NGO suggested that these funds may have been better used to address the currently inadequate waste transportation and treatment options.

4.3.1.4 Focus on Supply-Driven Solutions

Sustainability science and systems thinking provide a lens to investigate not only the challenges of the broader enabling environment but also those of the sanitation interventions themselves. Strategies that aim to *solve* sanitation sustainability challenges in Kenya, Tanzania and Uganda continue to be dominated by supply-driven solutions (Nyonyintono and Musembi 2011). This is reinforced by the outsider biases (Sect. 4.3.1.2), where funding, expertise and technology from donor countries might drive incoming *solutions*, rather than by the local needs. Such *solutions*, developed with an incomplete understanding of the sanitation system and local context, share certain characteristics that may help explain the limited success of sanitation interventions in the past.

Supply-driven sanitation solutions are typically biased towards the use of hardware. They tend to focus more on the design and construction of sanitation technologies (e.g. toilets), rather than their adoption, sustained use and contribution towards change in hygiene behaviour (Strande and Brdjanovic 2014; Andersson et al. 2016). Generally, a bias towards hardware solutions also implies that the proposed sanitation technology is imposed by the implementing organization, rather than selected at the local level. For example, a study in Rwanda found, when revisiting households who had received advanced sanitation technologies in their homes (urine diversion dry toilets), that many were not in use or were used improperly, thus negating any potential benefits (Ekane et al. 2016). Large investments in technology can also lock the users into a specific technology pathway, limiting their avenues for adopting alternative and new sanitation technologies and behaviours. It may also reduce options to use locally available and more affordable construction materials (Rip and Kemp 1998; Kvarnström et al. 2011).

This bias was present in the implementation of an integrated water and sanitation scheme by an Indian-based NGO in rural Iringa, Tanzania. The organization insisted on using porcelain-made squatting slabs for their pour flush toilets, to replicate the system they implement in India. However, as Tanzania lacks a porcelain factory, porcelain sanitation ware had to be imported and transported by trucks to the interior of the country. Furthermore, good quality PVC pipes to distribute water or sewage were also imported. As a result, the costs for this seemingly low-cost sanitation scheme were higher in eastern Africa than in South Asia, where such construction materials are locally produced. This extra cost in Tanzania had to be borne by either the organization or the users. If there is no financial mechanism and strategy to enable users to save for this investment or pay for it incrementally over time, it becomes impossible for users to pay. In the Iringa case, the Indian organization did not account for these high material costs at the start of the project, nor did it make any attempts to enable villagers to pay for the porcelain ware. Costs therefore outgrew the project budget, and funds had to be diverted from other planned activities, such as masonry assistance, which had to be paid for by the villagers. Ultimately, this was one of the main reasons why many members of the local community opted not to participate in the scheme.

In addition to potentially limiting the availability of (and accessibility to) affordable construction materials, a hardware bias also runs the risk of being culturally inappropriate. A typical example would be to insist on building dry toilets in Muslim communities where anal cleansing using water is the norm (Nawab et al. 2006). Another example would be to build only communal toilets in areas where female mobility is constrained and their safety may be at risk, thus limiting their access to (and use of) WASH facilities (Nallari 2015).

Many supply-driven solutions are also market-based and hence managed by private sector stakeholders. Private sector investments offer some promising opportunities, but a disadvantage of such solutions is that both the responsibility for their management and their costs are borne by individuals, rather than the broader community (Ekane et al. 2014). For example, during the implementation of Eco-San (ecological sanitation) toilets in Uganda, households were asked to purchase on-site treatment technologies. While this is promising for waste containment, marketing to households shifts the responsibility to the individual and allows the state to neglect its role in developing services for its citizens (Huston et al. 2019). Market-based sanitation initiatives, therefore, allow the government to neglect its responsibility in the sanitation service chain. In Tanzania, as in much of eastern Africa, the regulatory environment is under-resourced and thus market-driven solutions run the risk of "enabling" the private sector to exploit the citizens and neglect those most marginalized (Ekane et al. 2014). Omitting the most vulnerable segments of society may not only limit the potential reach of the sanitation services to the unserved but also fail to reach the adopted SDG 6 target of ensuring sanitation for all by 2030.

4.3.2 Breaking the Cycle of Sanitation Failure

Sections 4.3.2.1, 4.3.2.2, 4.3.2.3 and 4.3.2.4 outline the characteristics of a small selection of examples of *promising* approaches, which are not yet defined as sanitation *successes*. These interventions holistically address several different aspects that cause cyclic failure within the sector; nothing however is fail-proof. Their iterative learning-based approach makes them robust and resilient. Particularly successful aspects of their model demonstrate the use of critical Sustainability Science thinking to overcome the challenges described in the previous section.

4.3.2.1 Promote Place-Based Solutions

A key aspect of breaking the cycle of failure is to develop sanitation solutions that are appropriate for the physical, socio-economic and cultural context within which they will be deployed (Tilley et al. 2014). While this is common sense, experience on the ground suggests that sanitation solutions rarely fully fit the characteristics of the

area, unless local communities and experts are closely involved in the implementation process (Mbaria 2014).

CCI in Tanzania now involves local communities and experts in identifying and developing interventions after initial failures to scale up the use of specific and favoured technologies. They acknowledge that when entering a new context, a problem that may initially look similar to a previous one, is in fact likely to be unique and may require a different approach. There is no 'one-size-fits-all' solution. This strategy seeks to avoid falling into the trap of promoting sanitation solutions that are eventually abandoned or fall into disrepair shortly after deployment (Davis 2015). At the start of each intervention, CCI spends a considerable amount of time to understand the community in which they are planning to work and then engages directly with individuals and groups within the community to develop the most appropriate solutions. For example, in Keko in Dar es Salaam, the groundwater table is very high, so a water-based system or even an improved pit latrine is not appropriate. With the local community participating in close consultation, CCI designed and constructed a urine diversion toilet with three holes that accommodates both the physical constraints of the area (i.e. the high water table), as well as the cultural issues (e.g. provision for anal cleansing). Another local community wanted to explore ways to reduce the need for costly pit emptying for household latrines. Families unable to afford emptying services often experience seasonal overflow that causes environmental pollution and possibly contaminates surface/groundwater sources (Strande and Brdjanovic 2014). Working with CCI, they adapted a version of a tiger toilet, an on-site system using worms to process faeces (Furlong 2016), as a means of reducing the volume of waste, with the added benefit of reducing smell and being able to reuse the vermicompost for local horticultural production. The combination of demand for the service and the involvement of the community in adapting the technology led to its appreciation, sustained adoption and use.

Sanivation and Sanergy also have built-in flexibility in their place-based sanitation solutions in Kenya. In their case, this flexibility lies in the use of local materials for the construction and manufacturing of their services and products. Sanivation relies on simple and locally available machinery to manufacture bio-charcoal derived from human waste, making it possible to hire local operators without the need for intensive training. This makes the technology scalable and reduces the overall production expenditures, keeping the price of the bio-charcoal lower than its wood-based alternative. This provides consumers with a significant incentive to switch their domestic fuel use (usually fuelwood or charcoal) to bio-charcoal with the added benefit of reducing deforestation and reducing related greenhouse gas emissions (Felix 2015) (see also Chap. 5, Vol. 2).

Sanergy also uses local materials to construct their Fresh Life Toilets. These are prefabricated at the Sanergy headquarters in Nairobi and are then assembled on-site in 2 days. The urine diversion dry toilets can also be disassembled into their cement block components. As a result there is flexibility in determining deployment location, as they are easy to transport to otherwise difficult to reach areas, characterized by high population density, erratic house planning and lack of access for cars and trucks. The quick assembly time also reduces costs and the risk of theft of the

materials during the construction process. Moreover, the design of the collection buckets (for both urine and faeces) inside the toilets and the meticulously planned daily collection of the waste keeps the toilets from overflowing. This improves cleanliness and facilitates maintenance for the franchise operators. A few specific components must still be imported; however, Sanergy is working to achieve sufficient scale so that it is feasible to establish manufacturing of all parts locally in the Nairobi area (Engineer, Sanergy, personal communication, May 10, 2016).

4.3.2.2 Situate Sanitation Within Broader Governance Systems

Sanitation intervention implementers must not only focus on the infrastructure but also on the social and cultural context of the targeted communities. This means that, in addition to completing the targeted intervention, support is provided to local systems for monitoring, regulation and maintenance, as well as for developing service demand (Moriarty et al. 2013). This dual focus can better situate sanitation interventions within the larger system, within which the targeted local communities work, live and thrive. Sanitation interventions can be perceived as entry point activities (or stepping-stones), to achieve broader sustainable development goals. Several of the organizations whose approach towards sanitation delivery is more successful are also involved in issues beyond sanitation. They usually link sanitation delivery to other important sustainability issues related to agriculture, energy, gender empowerment and livelihood/income diversification (CCI, year; Umande Trust, year; Floret 2017).

For example, the bio-centres of Umande Trust provide both public access to pour flush toilets and facilities for hand-washing and showering, as well as spaces for cooking, banking, community meetings, housing and the development of local business enterprises. The bio-centres, therefore, offer local communities a place to access affordable sanitation, hygiene services and cooking facilities fueled from the biogas generated from the human waste. The local community is responsible for managing and maintaining the bio-centre and in the process has an opportunity to develop financial literacy, engage in leadership training and have alternative income sources. These co-benefits enhance the feeling of ownership, increase capacity building and, in particular, build trust among diverse stakeholders. The integration of these communal activities helps overcome community conflicts and is a powerful tool for gender equality, as it can enhance the voices and decision-making power of women (Floret 2017).

Similarly, the Community WASH Centres in Kampala initiated by Environment Alert (in partnership with WaterAid) are closely managed by a caretaker from within the local community. As a result, users gain access to not only a toilet but also a clean shower and a reliable service for refilling drinking water containers.

4.3.2.3 Foster Multi-Stakeholder Collaboration and Coordination

As discussed in Sect. 4.3.1, in order to enhance the effectiveness of sanitation interventions, it is important to engage with many different stakeholders on different levels. Sanitation provision in urban slums, in particular, exemplifies the need for creative collaboration between different actors, who interact in the geographically and financially constrained environment of informal settlements (Galli et al. 2014).

The Umande Trust developed its first community water and sanitation biogas centre in Kibera slum (Nairobi) in 2004, during a period when the Kenyan government did not recognize such community facilities as safe or viable sanitation options. Umande realized that the sanitation technology options outlined in policies at that time (e.g. household latrines and septic tanks) were not feasible options for residents of Kibera. It immediately began advocating for both improved sanitation from a rights-based approach, as well as to gain legitimacy for their technological solution as a sanitation option that could meet the needs of the most vulnerable residents of the slum.

Umande simultaneously built up the business skills of the groups operating the toilets and advocated to be recognized as a formal stakeholder for urban sanitation in Nairobi in order to increase their voice and influence within the sector. This was essential to ensure recognition of their community sanitation centres as safe and viable options both to prevent any future conflict with the government and to prepare the ground for possible future collaborations with the government.

Sanergy followed an entirely different approach to sanitation in informal settlements, prioritizing change at the policy level. They employed more than six full-time staff members to build a relationship with different levels of government through involvement in ministry working groups and municipal planning teams. These staff members are advocates for policy change, who promote the harmonization of Sanergy's activities and targets with those of the government. They also work to support the development of capacity in the government for the regulation of their services, as a step towards a more sustainable and scalable model of service provision (Government Relations Specialist, Sanergy, personal communication, May 10, 2016).

CCI, in addition to working closely with community members and local organizations, works in partnership with Dar es Salaam's public water and sewerage utility company DAWASA on several projects. CCI is also a member and avid participant in activities and conferences organized by Slum Dwellers International.[5]

Ultimately, to effectively develop and sustain sanitation services, there is a need to engage individuals from different backgrounds to use systems thinking for long-term planning, identify the core issues and implement transformative change (Sect. 4.3.1). In this sense, while institutional development is important, human capacity to

[5] Slum Dwellers International is a network of community-based organizations that advocates for the human right to land and to basic services in informal settlements by sharing lessons from other organizations working in similar contexts.

fill and use even the most effective institutional, governance and financial structures is also crucial. When capacity and resources are continuously supplied from outside the local/national context, then outsider bias persists (Sect. 4.3.1.2), and there is insufficient investment in building local human capacity, where it is ultimately needed to sustain positive change. For example, a study on the human resource needs to meet Tanzanian water and sanitation MDG targets found a shortage of 4501 water supply and sanitation engineers, 447 social development professionals and 7589 operations and management professionals (Kimwaga et al. 2013). The development of the first local PhD programme in sanitation (in 2016) is a promising start but demonstrates the lack of priority of the government for capacity building in the sector. It also highlights the monumental challenges ahead to meet future sanitation demands in the country.

4.3.2.4 Identify and Leverage Alternative Funding Mechanisms

The public financing gap for sanitation in eastern Africa, combined with the unpredictability of donation-based finance models, suggests the need for innovative funding mechanisms to increase the financial viability of sanitation service delivery models (Abeysuriya et al. 2015). The western model for sanitation is defined by government laws and regulations and is financed by a robust taxation and public financing system to operate and maintain the infrastructure (and its management) for the transport and treatment of waste, while the user invests directly in toilets in the home (Sect. 4.3.1.2). In the long term, it is the responsibility of the government to provide basic water and sanitation services. However, the severe limitation of government budgets and capacity in eastern Africa (due in part to the high rate of population growth and urbanization) means that, in the interim, demand for the service is met by a market of sanitation service providers, who are independent organizations, private businesses and social enterprises (McFarlane et al. 2014).

Sanergy's approach is robust, in the sense that its innovative resource recovery technology establishes a value chain that integrates the demand for toilets, need for employment, development of business opportunities, production of organic fertilizers and provision of a source of low-cost energy. By using a franchise model of individually owned public pay-per-use toilets, Sanergy remains scalable and adaptable to the diverse and changing needs in densely populated urban settlements. Microcredit loans are available for new franchise owners, who are supported with training in business management and accounting. Toilet owners pay a monthly fee to Sanergy, who in return hires individuals to clean and empty the urine diversion dry toilets on a daily basis and makes a profit by converting the 'waste' into fertilizer and bioenergy. Thus, both the business model and the technology are suitable for dense informal settlements and are flexible and adaptable to the changing urban landscape. Sanergy has received extensive financial support from donors, and this initial investment was important for overcoming the hurdles of developing an innovative start-up business. Its social enterprise model aims to achieve financial independence for both the company and the franchise owners. Rather than only providing the

sanitation infrastructure, the *service delivery* model considers the complex system of the operating environment and can become an established private service provider for unplanned settlements that cannot be served by municipal governments.

Both CCI and Umande Trust, much like Sanergy, have developed pay-per-use systems for shared toilets that generate revenues to meet operational and maintenance costs. The concept of paying to use a toilet is not new, but there are many aspects to be considered to increase the sustainability and financial viability of this model (Arimah 1996). Umande Trust also recognizes the dangers of walking outside at night carrying cash to use a toilet. To reduce this disincentive to use the toilet, payment can be made with a personalized no-cash punch card that reduces the risk of robbery. In addition, they choose only to work with pre-existing community groups as managers for new facilities to reduce the potential conflicts between group members jointly managing the community WASH business.

These three organizations have adopted an innovative financial model to support sanitation service delivery. In addition, they invest in the people needed to operate them. Rather than (or parallel to) direct financial support, they facilitate skills training, entrepreneurial coaching, leadership development and business management. As the deputy director of Umande stated 'We don't build toilets we build communities' (Deputy Director, Umande, Personal communication, July 10, 2015).

4.3.2.5 Enhance Value-Addition and Co-benefits

One common thread in the holistic approaches to sanitation discussed above is the recognition that human faeces can potentially be a valuable resource rather than merely a waste flow whose environmental impacts have to be mitigated. Human waste can be transformed into organic fertilizer, animal feed or an energy source (Drechsel et al. 2011).

For example, CCI and Sanergy convert human urine and faecal waste into fertilizers to be used for agricultural purposes. Such fertilizers are in high demand in eastern Africa, because soil fertility is low and chemical fertilizers are expensive (Diener et al. 2014; Andersson 2015). Sanivation develops bio-charcoal and Umande biogas derived from human waste, both of which can be used as a domestic fuel for cooking. As co-products of the sanitation service, such fuels can provide an added income stream and also reduce the demand for conventional cooking fuels such as charcoal and fuelwood which are linked to ecosystem degradation and reduction of time availability for women and girls (Drechsel et al. 2011, Diener et al. 2014; Semiyaga et al. 2015) (see also Chaps. 2, 7 Vol. 1; Chap. 5 Vol. 2).

The above are good examples of Sustainability Science thinking, where the adoption of a systems thinking, problem-focused and solution-oriented mindset can provide solutions to persistent social and environmental sustainability challenges. These *solutions* are deeply embedded in the needs of the local communities and recognize that the sanitation service provision system is comprised of many different actors and users. Flexibility and adaptability are key elements of these operational models as they invest both in people and in infrastructure. Such resource

recovery systems can contribute to the vision of a future where human waste becomes part of a larger resource recovery value chain and coordinated action between multiple actors can drive behaviour change (Tilley et al. 2014).

4.4 Policy and Practice Implications and Recommendations

This chapter is situated at the interface of multiple SDDs such SDG6 (Clean Water and Sanitation), SDG3 (Good Health and Wellbeing), SDG8 (Decent Work and Economic Growth) and SDG9 (Industry, Innovation, and Infrastructure), among others. Given the complexity and heterogeneous nature of sanitation challenges in eastern Africa, and its growing population, urbanization and environmental concerns, we suggest several recommendations including to:

- Embrace a diverse set of sanitation approaches to fit the broad spectrum of contexts
- Engage and include stakeholders from the outset of sanitation interventions
- Develop and invest in sector coordination and learning platforms
- Experiment with and promote successful sanitation options
- Build capacity among sanitation users and decision-makers
- Develop innovative funding mechanisms
- Improve and invest in proper monitoring and evaluation processes

A diverse set of approaches is required to fit the broad spectrum of sanitation contexts in SSA, which would need to be supported by a comprehensive policy framework. The examples discussed in Sect. 4.3.2 show how the awareness and use of place-based knowledge, flexible financial mechanisms, systems thinking and value addition in the sanitation chain are all important factors that can enhance the sustained adoption and overall sustainability of relevant interventions. There is no one-size-fits-all approach. New technology policies should encourage customized designs that are appropriate to the diverse urban and rural landscapes, rather than favour one sanitation technology over another. Appropriate policies can guide private sector investment, and effective regulatory mechanisms should be in place for these actors at both the national and local level. The policy framework for sanitation interventions needs to be integrated properly into the broader set of other relevant policies and reflect the diverse needs and contexts of individual countries and/or cities.

Stakeholder engagement and inclusivity in the development and implementation of sanitation interventions will support the development of interventions, which fits the context and will be adopted by the community. Stakeholder inclusion should not only be a consultative process but can take the form of equal partnerships and/or involvement in leadership positions. By including diverse voices that counterbalance the three types of outside bias (i.e. expert, male, western) (Sect. 4.3.1.2), it could become possible to better understand how infrastructure, management and

awareness-raising approaches can be integrated to fit local needs. Civil society organizations (CSOs) can document the realities and current inadequacies in the sanitation sector, as well as comment on (and advocate for) sanitation options that are more suited to local needs. As many CSOs face severe resource limitations, partnerships with research institutions, private enterprises and other parties can support such grassroots advocacy.

Development and investment in sector coordination and learning platforms can address the fragmented nature of sanitation-related governance at the national level. This can be achieved by strengthening cooperation and coordination between national agencies and ministries responsible for (or with synergies to) sanitation and by developing sector learning platforms and reviewing existing mechanisms to facilitate joint discussions and planning of critical sanitation issues. These same mechanisms can offer opportunities not only to identify common challenges and inadequacies in current sanitation practices but also to highlight successes and share learning from promising examples, such as the case studies outlined in Sect. 4.3.2. This would require the documentation of successes, failures and lessons learnt from current initiatives. Certainly, this can only happen when multiple actors can recognize the limitations of the existing sanitation service delivery models, particularly in informal settlements in growing urban areas. Such findings can then be used to inform and update national policies. In addition, sector learning platforms such as sanitation working groups and learning teams can encourage collaborative partnerships between research institutions, NGOs, government and private companies to explore and finance new innovative sanitation pathways. Financial support for convening learning platforms can be built in or annexed to donor-financed projects.

Experimentation and promotion of successful sanitation options can enable the development of various sanitation interventions that are or can be adapted to the broad spectrum of sanitation contexts in SSA. A critical policy recommendation in this regard is the implementation of small-scale trials for a range of different sanitation interventions, followed by a comprehensive analysis of the context in which they are implemented, their overall performance and the factors contributing to success/failure. The examples in this chapter show promise for sustainability and for scaling up. However, this will require an enabling environment to achieve scaling up and long-term sustainability in the form of government recognition/oversight and creative mechanisms for long-term financing.

Building local capacity is particularly important in the context of sanitation in SSA. A key recommendation for donors and international actors would be to couple all of their sanitation projects and programmes with genuine efforts to integrate them within (and support) local systems and government initiatives. Local expertise within Kenya, Tanzania and Uganda need to be better recognized and expanded in order to channel resources more effectively and support the scaling up of locally appropriate solutions. The current resource gap should be targeted not only with solution-oriented projects that treat the 'symptoms' of the inadequate sanitation system but also with long-term investments to foster local knowledge and build capacity within the sector. These areas include, but are not limited to integrated sanitation management, environmental engineering, hygiene education, menstrual

hygiene management, community leadership and facilitation, faecal sludge management, resource recovery technology development, sanitation financing, sanitation marketing and sanitation business development.

Innovative funding mechanisms would be required to bridge the funding gap. Despite the continued and significant support of external agencies for sanitation in eastern Africa (Sect. 4.1), the constraints associated with short-term funding cycles (e.g. the need to show immediate and measurable results) will most certainly persist even for the most well-intentioned donors. However, by adopting a creative, flexible and adaptive approach can help pair shorter-term interventions with sustainable local systems building through the combination of different types of investments. The promising sanitation examples presented in Sect. 4.3.2 have all identified ways to overcome serious economic constraints by establishing sustainable business models. However, all of the studied projects still required (and received) seed funding or even long-term donor support during their development phase. In a sense, it was once the economic constraint was removed that innovation became possible. Thus, donors and investors should consider offering financing in the form of start-up grants to promising projects and loans to more diverse implementers. In order to promote innovation in the sector, this early funding can be supplemented with financial training for small- and medium-sized private companies interested in starting a sanitation enterprise. To ensure their financial viability, sanitation service schemes must consider different mechanisms for revenue generation, including user contributions or service payments for the building and maintenance of the actual sanitation services.

Improvements and investments in proper monitoring and evaluation processes will, in the longer term, contribute to meeting the SDG headline indicators. Holistic monitoring approaches are required that reflect the messy nature of progress and implementation in complex environments and the multiple factors needed to catalyze positive change and increase the likelihood of sustainability. Various 'sustainability indicators' are currently available for evaluating the likelihood of whether an intervention or a single part of broader infrastructure will last over time (Schweitzer et al. 2014). For example, some donors, such as the Netherlands Ministry of Foreign Affairs (DGIS), have been enforcing a clause that requires all of their funding contract implementers to perform a sustainability assessment using appropriate indicators to guarantee that funded projects will remain functional for a minimum of 10 years after initial completion (Ward 2017).

4.5 Conclusions

By using Sustainability Science as a guiding lens, this chapter attempted to reframe the sanitation challenge in eastern Africa. The focus was not only on the factors that perpetuate sanitation failure but also on the characteristics and competencies conducive to the development of sustainable sanitation systems in the region. In a nutshell, sanitation *solutions* that start from an incomplete understanding of the

problem and the broader context tend to rely on path-dependant and often supply-driven strategies. Such solutions are unable to break out of a cycle of failure to succeed in the complex environment within which they are implemented. The development of more holistic and sustainable approaches is often curtailed due to the lack of learning from failure and the inadequate space for iteration and adaptation based on inclusive perspectives, which perpetuates the outsider bias. This, in turn, curtails the development of an enabling environment and makes it difficult to seek support and operate within existing governance structures.

However, through the analysis of six promising sanitation projects, we have shown how various actors in the WASH sector in eastern Africa have managed to break this cycle of failure and develop alternate sanitation pathways that fit the geographical, cultural and financial realities of each project context. These sanitation approaches, although different, all demonstrate context adaptability and compatibility, mechanisms that ensure financial viability, technologies that are culturally appropriate and an emphasis on environmental sustainability through resource recovery and closed-loop thinking.

These examples illustrate that breaking the cycle of failure is possible if there is a proper enabling environment. This enabling environment can foster the key competencies needed to respond to complex sustainability challenges and must be (a) *descriptive* in how specific needs and linkages to other systems are identified; (b) *critical* of universally accepted sanitation solutions; (c) *cooperative* in the design, implementation, management and monitoring of activities, and (d) *visionary* through the inclusion of new ways of handling waste and turning it into value for the benefit of people as well as the environment.

While the six study projects show promise for scalability, they are still small-scale relative to the scope of the sanitation challenge in the region. However, they show that alternatives to the business-as-usual approaches to sanitation service delivery are both feasible and desirable. We can learn from both their strengths and their limitations when investing in new ideas and alternative sanitation futures.

That said, the scale of the sanitation challenge is enormous in SSA, and it must be tackled by (1) embracing a diverse set of approaches to fit the broad spectrum of contexts, (2) engaging and including stakeholders from the outset, (3) developing and investing in sector coordination and learning platforms, (4) experimenting with and promoting successful options, (5) building capacity, (6) developing innovative funding mechanisms and (7) improving and investing in proper monitoring/evaluation processes. This recognizes that challenges are transdisciplinary and multiscale, affected by governance, finance and sector coordination.

As a final note, by demonstrating the multiple benefits of improved sanitation on health, dignity, livelihood/income diversification and gender empowerment, we have shown that sanitation interventions can contribute to numerous SDGs. If the systemic linkages and mutual benefits discussed throughout this chapter are recognized beyond the community level to become anchored in government policies and funding priorities, then they could create the right enabling environment at the regional, national and subnational level. However, in order to achieve universal sanitation coverage, a radical paradigm shift anchored on Sustainability Science

principles would be required in how we *think about* and *do* sanitation. Only then will we be able to learn from past failures and build local capacity to enable investments in futures that we have not yet imagined.

Acknowledgements The authors would like to extend their deepest gratitude to the community members and sanitation organizations who voluntarily contributed precious time to share valuable insights about their lives and sanitation activities in their respective communities. Thanks also goes to the Swedish research council for sustainable development, *FORMAS*, who enabled this research through Dr. Gabrielsson's PostDoc project, 'Water for life and dignity: A study on the sustainability and scalability of community-based water supply and sanitation systems in Tanzania'.

References

Abeysuriya K, Kome A, Willetts J (2015) Enabling investment in urban sanitation services through the sustainable full cost recovery principle. In: 38th WEDC international conference. WEDC

Andersson E (2015) Turning waste into value: using human urine to enrich soils for sustainable food production in Uganda. J Clean Prod 96:290–298

Andersson K, Rosemarin A, Lamizana B, Kvarnström E, McConville J, Seidu R, Dickin S, Trimmer C (2016) Sanitation, wastewater management and sustainability: from waste disposal to resource recovery. United Nations Environment Programme and Stockholm Environment Institute, Nairobi/Stockholm

Arimah BC (1996) Willingness to pay for improved environmental sanitation in a Nigerian City. J Environ Manag 48(2):127–138

Bäckstrand K (2003) Civic science for sustainability: reframing the role of experts, policy-makers and citizens in environmental governance. Glob Environ Polit 3(4):24–41

Bartram J, Cairncross S (2010) Hygiene, sanitation, and water: forgotten foundations of health. PLoS Med 7(11):e1000367

Chambers R, Myers J (2016) Norms, knowledge and usage. Frontiers of CLTS: innovations and insights issue 7. IDS, Brighton

Clark WC (2007) Sustainability science: a room of its own. PNAS 104(6):1737

Clark WC, Dickson NM (2003) Sustainability science: the emerging research program. Proc Natl Acad Sci 100(14):8059–8061

Cross P, Coombes Y (eds) (2014) Sanitation and hygiene in Africa where do we stand? Analysis from the AfricaSan conference, Kigali, Rwanda. IWA Publishing, London

Davis S (2015) Do donor restrictions affect sustainability of water and sanitation interventions? Results from a Pilot Survey. Improve International

Davis S (2016) Seeking sanitation success: phase I. report. Published by catholic relief services

Diener S, Semiyaga S, Niwagaba CB, Muspratt AM, Gning JB, Mbéguéré M et al (2014) A value proposition: resource recovery from faecal sludge – can it be the driver for improved sanitation? Resour Conserv Recycl 88:32–38

Drechsel P et al (2011) Recovery and reuse of resources: enhancing urban resilience in low-income countries. Urban Agriculture Magazine no. 25. RUAF 10 years

Ekane N, Nykvist B, Kjellén M, Noel S, Weitz N (2014) Multi-level sanitation governance: understanding and overcoming challenges in the sanitation sector in sub-Saharan Africa. Waterlines 33(3):242–256

Ekane N, Weitz N, Nykvist B, Nordqvist P, Noel S (2016) Comparative assessment of sanitation and hygiene policies and institutional frameworks in Rwanda, Uganda and Tanzania. Stockholm Environment Institute (SEI) Working Paper, 5

Felix M (2015) Future prospect and sustainability of wood fuel resources in Tanzania. Renew Sust Energ Rev 51:856–862

Floret M (2017) Building capacity of urban poor CBOs in Dar es Salaam to set up ecological sanitation business, final evaluation report, Dar es Salaam, Tanzania
Fukuda-Parr S, Yamin AE, Greenstein J (2014) The power of numbers: a critical review of millennium development goal targets for human development and human rights. J Human Dev Capab 15:2–3, 105–117. https://doi.org/10.1080/19452829.2013.864622
Furlong C (2016) Tiger worms: a win-win solution. In: Chambers R, Myers J (eds) Norms, knowledge and usage. Frontiers of CLTS: innovations and insights issue 7. IDS, Brighton
Gabrielsson S, Ramasar V (2013) Widows: agents of change in a climate of water uncertainty. J Clean Prod 60:34–42
Galli, G., Nothomb, C., and Baetings, E. (2014) Towards systemic change in urban sanitation. IRC, The Hague
Hickling A (2014) Status of sanitation and hygiene in Africa. In: Cross P, Coombes Y (eds) Sanitation and hygiene in Africa where do we stand? Analysis from the AfricaSan conference, Kigali, Rwanda. IWA Publishing, London
Huston A, Moriarty P (2018) Understanding the WASH system and its building blocks, Working paper series building strong WASH systems for the SDGs. IRC, The Hague
Huston A, Moriarty P, Lockwood H (2019) All systems go! Background note for the WASH systems symposium. IRC, The Hague
Jenkins MW, Sugden S (2006) Rethinking sanitation: lessons and innovation for sustainability and success in the new millennium. UNDP
Jerneck A, Olsson L, Ness B, Anderberg S, Baier M, Clark E et al (2011) Structuring sustainability science. Sustain Sci 6(1):69–82
Kates RW (2011) What kind of a science is sustainability science? PNAS 108:19449–19450
Kates R, Clark W, Corell R, Hall J, Jaeger C, Lowe I, McCarthy J, Schellnhuber H, Bolin B, Dickson N, Faucheux S, Gallopin G, Grubler A, Huntley B, Jager J, Jodha N, Kasperson R, Mabogunje A, Matson P, Mooney H, Moore B III, O'Riordan T, Svedlin U (2001) Sustainability science. Science 292(5517):641–642
Kimwaga R, Nobert J, Kongo V, Ngwisa M (2013) Meeting the water and sanitation MDGs: a study of human resource development requirements in Tanzania. Water Policy 15(S2):61–78
Komiyama H, Takeuchi K (2006) Sustainability science: building a new discipline. Sustain Sci 1:1–6
Kvarnström E, McConville J, Bracken P et al (2011) The sanitation ladder – a need for a revamp? J Water Sanit Hygiene Dev 1(1):3–12
Loorbach D (2010) Transition management for sustainable development: a prescriptive, complexity-based governance framework. Governance 23(1):161–183
Mbaria J (2014) Engendering positive change in slums – role of biocentres in the supply for affordable and sustainable water and sanitation services in informal settlements. Umande Trust, Nairobi
McFarlane C, Desai R, Graham S (2014) Informal urban sanitation: everyday life, poverty, and comparison. Ann Assoc Am Geogr 104(5):989–1011
Mies M (1998) Patriarchy and accumulation on a world scale: women in the international division of labour. Palgrave Macmillan, London
Moriarty P, Smits S, Butterworth J, Franceys R (2013) Trends in rural water supply: towards a service delivery approach. Water Altern 6(3):329
Mulumba J, Nothomb C, Potter A, Snel M (2014) Striking the balance: what is the role of the public sector in sanitation as a service and as a business? Waterlines 33(3):195–210
Nallari A (2015) "All we want are toilets inside our homes!" The critical role of sanitation in the lives of urban poor adolescent girls in Bengaluru, India. Environ Urban 27(1):73–88
Nawab B, Nyborg IL, Esser KB, Jenssen PD (2006) Cultural preferences in designing ecological sanitation systems in North West Frontier Province, Pakistan. J Environ Psychol 26(3):236–246
Neely K (2019) Systems thinking and transdisciplinarity in WASH. Systems thinking and WASH: tools and case studies for a sustainable water supply, 17

NIMR (2016) Baseline of school wash facilities in Tanzania. National Institute of Medical Research, Dar es Salaam
Nyonyintono Lubaale G, Musembi Musyoki S (2011) Pro-poor sanitation and hygiene in East Africa. Background paper presented at the East Africa practitioners workshop on pro poor urban sanitation and hygiene, LAICO Umubano Hotel, Kigali, Rwanda, March 2011
O'Keefe M, Lüthi C, Tumwebaze IK, Tobias R (2015) Opportunities and limits to market-driven sanitation services: evidence from urban informal settlements in East Africa. Environ Urban 27 (2):421–440
Oates N, Ross I, Calow R, Carter RT, Doczi J (2014) Adaptation to climate change in water, sanitation and hygiene – assessing risks and appraising options in Africa. Overseas Development Institute, London
Otsuki K (2016) Infrastructure in informal settlements: co-production of public services for inclusive governance. Local Environ 21(12):1557–1572
Penner B (2010) Flush with inequality: sanitation in South Africa. Places J. Available : https://placesjournal.org/article/flush-with-inequality-sanitation-in-south-africa/
Prüss-Ustün A, Bartram J, Clasen T, Colford JM, Cumming O, Curtis V et al (2014) Burden of disease from inadequate water, sanitation and hygiene in low-and middle-income settings: a retrospective analysis of data from 145 countries. Tropical Med Int Health 19(8):894–905
Rip A, Kemp R (1998) Technological change. Battelle Press, Columbus, pp 327–399
Rittel HWJ, Webber MM (1973) Dilemmas in a General theory of planning. Policy Sci 4:155–169. https://doi.org/10.1007/bf01405730
Sarewitz D, Kriebel D, Clapp R, Crumbley C, Hoppin P, Jacobs M (2010) The sustainable solutions agenda: the consortium for science, policy and outcomes. Lowell Center for Sustainable Production
Schultz J, Brand F, Kopfmuller J, Ott K (2008) Building a 'theory of sustainable development': two salient conceptions within the German discourse. Int J Environ Sustain Dev 7(4):465–482
Schweitzer R, Grayson C, Lockwood H (2014) Mapping of water, sanitation, and hygiene sustainability tools. Working paper 10, IRC/Aguaconsult/Triple-S
Seager J (2010) Gender and water: good rhetoric, but it doesn't "count". Geoforum 41(1):1–3
Semiyaga S et al (2015) Decentralised options for faecal sludge management in urban slum areas of sub-Saharan Africa: a review of technologies, practices, and end-uses. Resour Conserv Recycl 104:109–119
Seppälä OT (2002) Effective water and sanitation policy reform implementation: need for systemic approach and stakeholder participation. Water Policy 4(4):367–388
Sparkman D (2012) More than just counting toilets: the complexities of monitoring for sustainability in sanitation. Waterlines 31(4):260–271
Strande L, Brdjanovic D (eds) (2014) Faecal sludge management: systems approach for implementation and operation. IWA Publishing, London
Stroh D (2015) Systems thinking for social change: a practical guide to solving complex problems, avoiding unintended consequences, and achieving lasting results. Chelsea Green Publishing, Hartford
Talwar S, Wiek A, Robinson J (2011) User engagement in sustainability research. Sci Public Policy 38(5):379–390
Taylor B (2009) Addressing the sustainability crisis: lessons from research on managing rural water projects. WaterAid Tanzania [online] Available at: http://www.wateraid.org/~/media/Publications/sustainabilitycrisis-rural-water-management-tanzania.pdf
Tilley E (2008) Compendium of sanitation systems and technologies. Eawag
Tilley E, Strande L, Lüthi C, Mosler HJ, Udert KM, Gebauer H, Hering JG (2014) Looking beyond technology: an integrated approach to water, sanitation and hygiene in low income countries. Environ Sci Technol 48:9965–9970
Tsinda A, Abbott P, Pedley S, Charles K, Adogo J, Okurut K, Chenoweth J (2013) Challenges to achieving sustainable sanitation in informal settlements of Kigali, Rwanda. Int J Environ Res Public Health 10(12):6939–6954

UN Water (2008) Sanitation is an investment with high economic returns. Factsheet. http://www.gwopa.org/index.php/resource-library/3166-sanitation-is-an-investment-with-high-economic-returns

UN Water (2014) Investing in water and sanitation: increasing access, reducing inequalities. Special report for the SWA high-level meeting

UNICEF (2017) The 2030 agenda for sustainable development. www.unicef.org/agenda2030/

Van Kerkhoff L, Lebel L (2006) Linking knowledge and action for sustainable development. Ann Rev Environ Resour 31:445–477

Ward, R (2017) Sustainability clause, check and compact primer for programming and long term management. Prepared for WASH Alliance International. Available: https://wash-alliance.org/wp-content/uploads/sites/36/2017/03/201701_SCCC_Guide_V.9_FINAL.pdf

Waterkeyn JA, Waterkeyn AJ (2013) Creating a culture of health: hygiene behaviour change in community health clubs through knowledge and positive peer pressure. J Water Sanit Hygiene Dev 3(2):144–155

WHO (2017) UN-Water global analysis and assessment of sanitation and drinking-water (GLAAS) 2017 report: financing universal water, sanitation and hygiene under the sustainable development goals. World Health Organization, Geneva. Licence: CC BY-NC-SA 3.0 IGO

WHO/UNICEF (2015) Progress on sanitation and drinking water â 2015 update and MDG assessment

WHO/UNICEF (2017) Progress on drinking water, sanitation and hygiene: 2017 update and SDG baselines. World Health Organization and the United Nations Children's Fund, Geneva

Wiek A, Withycombe L, Redman CL (2011) Key competencies in sustainability: a reference framework for academic program development. Sustain Sci 6(2):203–218

World Bank (2017) GDP growth annual. http://data.worldbank.org/indicator

WSP (2012) Economic impacts of sanitation, world bank water and sanitation program. www.wsp.org/content/economic-impacts-sanitation

Ziegler R, Ott K (2011) The quality of sustainability science: a philosophical perspective. Sustain Sci Pract Policy 7(1):31–44