Governing the circular economy: Assessing the capacity to implement resource-oriented sanitation and waste management systems in low- and middle-income countries

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ABSTRACT

Transitioning to a circular economy requires strategic investments in infrastructure, but it also requires policy coherence, coordination and collaboration among stakeholders across sectors and governance levels. In this paper, we aimed to identify the factors that facilitate or impede governance capacity to adopt circularity in the form of resource recovery from urban organic waste streams. We conducted a literature review and semi-structured interviews using the 'Governance Capacity Framework' in a case study of Naivasha, Kenya. Our findings emphasize the importance of leadership from the public sector in co-developing visionary strategies for circularity and using their convening power to facilitate cross-sectoral collaboration. Moreover, we identify a need for bridging theoretical circular economy concepts to initiatives in local communities of practice. The insights in this paper are relevant for advancing the understanding of challenges for governance of the circular economy especially in low-and middle-income country contexts.

1. Introduction

1.1. Challenges and opportunities for circular economy transition in cities

The population in cities, especially in low- and middle-income countries, is expected to increase (UN DESA, 2019). This growth will intensify the demand for food, water and energy in urban areas. Increasing affluence in cities also leads to compounding amounts of waste annually. Urban residents generate over two billion tons of waste each year (Kaza et al., 2018) and over six billion liters of excreta per day, assuming a per capita excreta generation of 1.5 L/day (Rose et al., 2015) and excluding the water used to transport excreta in sewer systems. Due to poor urban waste collection and treatment systems, the excreta is seldom treated adequately or is not treated at all (Verbyla et al., 2013), leading to serious consequences for both public and ecosystem health.

Implementing a circular economy (CE) approach through resource-oriented sanitation and waste management systems can address multiple challenges and provide incentives to improve waste management infrastructure (Diener et al., 2014). Resource-oriented sanitation and waste management systems aim at recovering resources like water, energy and nutrients from organic waste streams like faecal sludge, wastewater and food waste, through products like biogas, compost and recycled water (Langergraber, 2013; Li et al., 2013). Details on such systems including technological aspects and case studies are provided in the literature e.g. Polprasert (2007), Strande et al. (2014) and Otoo and Drechsel (2018). Potential benefits of circular approaches include mitigating greenhouse gas emissions; securing water, food and energy resources; and providing

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employment opportunities in growing cities (Andersson et al., 2016).

Globally, governments and public agencies are developing strategies toward implementing circularity principles (Ghisellini et al., 2016; Prendeville et al., 2018), at regional, national and city levels. Cities are a fitting context within which circular solutions for waste and resource management can be implemented, as well as other solutions to environmental challenges (Prendeville et al., 2018). This is especially true for organic waste streams connected to food and sanitation systems. However, unlocking the benefits of resource-oriented sanitation and waste management systems requires innovation and making the right investments, not only in infrastructure and business models but also within governance domains. In particular, advances are needed in policy coherence, coordination and collaboration among stakeholders across various sectors and governance levels (van Leeuwen et al., 2018).

Understanding the governance factors that can emerge to facilitate or impede success is essential for implementing resource recovery and hence CE. The CE transcends administrative boundaries and requires thinking beyond traditional sectoral governance paths. To achieve this, adequate governance capacity is necessary to support coordination and collaboration, and to overcome impediments against adopting resource-oriented sanitation and waste management systems.

1.2. Governance capacity for the circular economy

Our understanding of the CE in this paper is informed by Kirchherr et al. (2017) who describe it as "*an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes … to accomplish sustainable development*". Implementing circularity for organic waste streams which form the "biological materials cycle" (Ellen MacArthur Foundation, 2017), involves recovering water, nutrients, energy and other materials which are typically managed within different resource management sectors. The conditions that enable success in the different domains of resource management are widely covered across the literature on environmental management and governance (e.g. Driessen et al., 2012; Newell et al., 2012; Ostrom, 1990; Rist et al., 2007). However, the variety of sectors, stakeholders and policies that are associated with these resources across governance levels creates new challenges for the CE, which need to be addressed through integrated approaches.

In the CE literature, governance in a multi-sectoral context is not well explored, especially from the perspective of the factors that can facilitate or impede CE implementation. This gap remains even though governance capacity is considered a challenge to making a business case for resource recovery (Velenturf and Jopson, 2019), and governance arrangements are critical to shaping the direction and pace of the transition to circularity (Flynn and Hacking, 2019). So far, the CE literature largely focuses on technology and business models (Abreu and Ceglia, 2018). Recent attempts to explore governance approaches for the CE focus on national and international supply chains and standards (Flynn and Hacking, 2019; Moya et al., 2019). This focus neglects the governance processes that can create enabling conditions for implementation at the local urban scale. Furthermore, the governance factors that can facilitate or impede CE implementation in the context of low- and middle-income countries are yet to be explored in the literature to the best of the authors' knowledge.

In this paper, we focus on the governance capacity of cities to implement resource-oriented sanitation and waste management systems that address resource scarcity and improve natural resource management. Through a case study of the town of Naivasha, Kenya, we aim to identify key factors that facilitate or impede the governance capacity to implement circular approaches to the management of organic waste streams in low-income and middle-income urban contexts, particularly in sub-Saharan Africa. In section 2 of the paper, we present the case study − Naivasha, Kenya. In section 3, we describe the methodology used and then describe the results from the case study in section 4. In section 5, we discuss the results, providing reflections on transferrable insights for other urban areas where there is interest in implementing circularity in the management of organic waste. We outline our main conclusions in section 6.

2. Case study description: Naivasha (Kenya)

The urban population in the East African country of Kenya is expected to grow from 13.8 million in 2018 to 44.2 million by 2050 (UN DESA, 2019). Studies have shown that between 59% and 79% of all excreta in major Kenyan urban areas is unsafely managed and is improperly disposed into the environment (e.g. Dewhurst, 2018; Furlong, 2015b, 2015a). Less than half of the solid waste generated in the cities is collected (Soezer, 2016) and that which is collected mostly ends up at dumpsites (Kaza et al., 2018). The solid waste generated in Kenya's urban areas is predominantly organic in nature, due to the country's expanding agro-industrial sector (NEMA, 2014). Kenya aspires to deal with its waste challenges by becoming a more sustainable and circular economy according to the draft waste management policy (Ministry of Environment and Forestry, 2019) and proposed climate change mitigation actions (Soezer, 2016). However, implementation has lagged policy aspirations both at national level and in localities like Naivasha.

Naivasha is within Nakuru County and is located about 90 km north-west of Nairobi, Kenya's capital. It is led by a sub-county administrator who is appointed by the county governor and approved by the county's legislative assembly (Republic of Kenya, 2012). Major areas of service, e.g. public health, water, environment and agriculture, have dedicated departments at county level, and representative offices at sub-county level. Naivasha's economy relies on the agricultural and tourism sectors, also key revenue sources for the county and the country generally. The Kenyan flower industry, mostly concentrated around the Lake Naivasha area, employs about 2.1 million people (Kenya Flower Council, 2019). The population of Naivasha is expected to grow from 224,141 people in 2009 to 667,916 in 2040 (Mott MacDonald, 2017).

The Naivasha Water and Sanitation Company, the water and sanitation utility in the sub-county, operates the single wastewater treatment plant in the town center, with a sewer network to which about 40% of households are connected. Other households use onsite sanitation and the collected faecal sludge is also discharged at the treatment plant which leads to overloading and ineffective treatment (Bohnert, 2017). Naivasha's solid waste is predominantly disposed at a dumpsite where capacity is almost being exceeded. There is interest from local stakeholders in mitigating these challenges through circularity and hence generating business opportunities that contribute to water, energy and food security (Duma, 2019). However, implementation has so far not gone beyond a few actors operating on a small scale. These factors make Naivasha an interesting case for understanding how resource recovery from organic waste can be implemented locally and perhaps in similar cities in sub-Saharan Africa and other low- and middle-income regions.

3. Methods

To assess governance capacity, we apply and adapt the Governance Capacity Framework (GCF) developed by Koop et al. (2017), an empirically-based diagnostic approach to assess factors that

facilitate or impede environmental governance in cities. The framework consists of 27 indicators across nine conditions and three dimensions (Table 1). The "knowing" dimension addresses the need to be aware, understand and learn about the risks and impacts of environmental challenges, policy and strategic choices. The "wanting" dimension examines the willingness of stakeholders to cooperate, express and act upon their ambitions and commit to using their capabilities to find solutions. The "enabling" dimension considers the network, resources and instruments that stakeholders have available to realize their ambitions (Koop et al., 2017).

The GCF approach was selected for two key reasons. First, the GCF is derived from an extensive knowledge base on how normative principles, enabling efforts and adaptive capacity can be used to overcome governance gaps and barriers that result from ineffective policy actions (Koop et al., 2017). Second, since this paper aims to provide insights that may apply beyond the case study itself, using the GCF's standardized triangulation approach provides the opportunity for reproducibility and comparability with other cases. This can serve as a basis for systematic research in the field of governance for the CE in urban areas of low-income and middle-income countries. Previous case studies that applied the framework focused on governance challenges relating to the water sector and were largely in cities outside Africa (e.g. Brockhoff et al., 2019; Feingold et al., 2018; Kim et al., 2018; Koop et al., 2018; Šteflová et al., 2018). In this study, the GCF is applied to the CE in a context that involves multiple sectors connected to resource recovery from organic waste streams.

For Naivasha, we followed the prescribed methodological approach by Koop et al. (2017) but modified the information about the indicators to reflect the multi-sectoral context. After developing pre-defined questions for the 27 indicators, we conducted a desk study with a focus on reviewing scientific and gray literature related to sanitation, waste management and resource recovery in Naivasha. Some literature came from online sources, while local stakeholders provided other documents. The desk study was guided by the pre-defined questions (provided in the Supplementary Material) and it resulted in preliminary information and scores on the indicators.

We then conducted a stakeholder identification exercise through a desk study and suggestions by local partners which resulted in a comprehensive list of potential stakeholders to involve in interviews. We categorized the stakeholders into various roles, types and stage of the sanitation and waste service chain such as waste generation, collection and transport, treatment and disposal/end-use, to allow selection of a diverse set of interviewees. Categories of stakeholder types included national public authorities, local public authorities, private sector, research & innovation institutions, non-governmental organizations (NGOs) & cluster organizations, citizens and user groups. Selection of interviewees focused on those primarily based in Naivasha. Since some of those requested were not able to participate in the interviews, the selection was done iteratively. Altogether, we conducted interviews with 21 stakeholders. The list of stakeholders represented among the interviewees and details about their categorization is provided in the Supplementary Material.

Each interviewee consented before participating and all interviews were recorded in audio except for two instances where the interviewees declined. The interviews typically occurred at the interviewee's place of work and lasted between 30 to 90 min. The interviews were of semi-structured format with the pre-defined questions guiding the discussion and follow-up questions posed to enable the interviewees to further substantiate their statements. Rather than responding to questions for all the indicators, each interview focused on the indicators most connected to the interviewee's expertise and experience. Afterwards, a summary of each interviewee's responses was made and sent to the interviewee so that they could provide feedback and necessary corrections as well as any further substantiation related to the indicators. Half of the interviewees provided feedback but half had not by the time of analysis. The feedback provided was integrated and then responses from all interviewees for each indicator were combined with the information from the desk study into a summary drawing out highlights for each indicator. From the summary, scores were

Table 1
The Governance Capacity Framework. Together the dimensions, conditions and indicators are considered to determine the overall governance capacity to address a resource challenge (Koop et al., 2017).

Dimensions	Conditions	Indicators
Knowing	1 Awareness	1.1 Community knowledge
		1.2 Local sense of urgency
		1.3 Behavioural internalization
	2 Useful knowledge	2.1 Information availability
		2.2 Information transparency
		2.3 Knowledge cohesion
	3 Continuous learning	3.1 Smart monitoring
		3.2 Evaluation
		3.3 Cross-stakeholder learning
Wanting	4 Stakeholder engagement process	4.1 Stakeholder inclusiveness
		4.2 Protection of core values
		4.3 Progress and variety of options
	5 Management ambition	5.1 Ambitious and realistic management
		5.2 Discourse embedding
		5.3 Management cohesion
	6 Agents of change	6.1 Entrepreneurial agents
		6.2 Collaborative agents
		6.3 Visionary agents
Enabling	7 Multi-level network potential	7.1 Room to manoeuvre
		7.2 Clear division of responsibilities
		7.3 Authority
	8 Financial viability	8.1 Affordability
		8.2 Consumer willingness-to-pay
		8.3 Financial continuation
	9 Implementing capacity	9.1 Policy instruments
		9.2 Statutory compliance
		9.3 Preparedness

assigned by the authors out of a five-point Likert-type scale, ranging from very encouraging (++) to very limiting (−−), to gauge the overall governance capacity with regards to each indicator. A scoring guide, exemplified in Table 2 for indicator 2.2, was used. The summary and scoring guides which are specific for each of the 27 indicators are provided in the Supplementary Material.

Resource-oriented sanitation and waste management systems are quite broad, covering aspects from waste containment, collection, and transport to treatment and end-use. An implication of this is that some indicators, such as indicator 8.1 − affordability, were quite difficult to interpret for some interviewees since they did not know which part of the waste management chain to refer to specifically. Nevertheless, responses regarding the affordability of various resource recovery options provided a comprehensive overview for the indicator. While the difficulties with interpretation resulted in some contradictions between interviewees, the triangulation approach of the methodology helped to identify substantiated information since interviewee responses were to some extent validated by the literature reviewed, and vice versa. The feedback from interviewees was also useful in clarifying any inconsistencies.

4. Results

The governance capacity profile of Naivasha is shown in Fig. 1. The scores illustrate the extent to which each indicator is limiting or encouraging for implementing resource-oriented sanitation and waste management systems in Naivasha. The results indicate that condition 6 − agents of change and condition 8 − financial viability, are particularly encouraging while condition 2 − useful knowledge, 3 − continuous learning and 9 − implementing capacity, generally impede Naivasha's overall governance capacity, as illustrated in Fig. 2. A narrative overview of the results is presented in sections 4.1 to 4.4, arranged according to the three dimensions of the GCF; knowing, wanting and enabling. To maintain the anonymity of the interviewees, a coding system is used whereby the codes SN01; SN02; SN03 and so on refer to the various interviewees.

4.1. Knowing

There is a moderate level of awareness about the CE and resource recovery from organic waste streams in Naivasha (indicator 1.1). The awareness is based on precedents including biogas toilets (Rieck and Onyango, 2010; SN05), making briquettes (Berner et al., 2015; Morrison et al., 2014; SN06; SN12), wastewater reuse for irrigation (SN05; SN20), composting (SN04; SN06) and combined heat and power from biogas (SN02; SN06). However, many stakeholders do not seem to fully acknowledge the environmental and economic benefits that could accrue from circularity (SN08; indicator 1.3). Public officials have not created incentives and strategies for implementing practices like source separation of solid waste which could facilitate resource recovery, and they instead hope that some private sector stakeholders or NGOs can kick-start the process (SN01; SN03; SN07, SN14). The stakeholders that seem to have a higher sense of urgency about resource recovery (indicator 1.2) are those that have recognized the potential economic opportunities therein (SN01; SN04; SN19).

Information is available about resource recovery from organic waste streams based on previous initiatives in Naivasha (indicator 2.1). However, it seems limited to those who have been involved in these initiatives like universities, utilities, NGOs and private companies (SN09; SN18) and it is not easily accessed (SN09; SN14; SN17). Most of the information is written in expert language (SN03; SN09; SN12) and often in English with no local translations although Kiswahili is the lingua franca (Athiemoolam and Kibui, 2013). Only a few resource recovery options have some information available in lay language, e.g., about making briquettes (SN18; indicator 2.2). Some of the concepts around resource recovery from organic waste streams may not yet have found equivalents in a local context, hence contributing to knowledge incoherence (indicator 2.3). This was demonstrated by one interviewee who mentioned that "The CE is a European model and it is their formal way of doing things, unlike us who do things differently" (SN11).

Monitoring systems in Naivasha, such as quality assurance laboratories, audits and certification systems, are fragmented among sectors and stakeholders, focusing on different aspects (indicator 3.1) with limited possibility to generate integrated insights (SN04; SN07). The evaluation of strategies and policies and their implementation for related areas like water, sanitation and agriculture (indicator 3.2) have historically been done on ad hoc basis (SN06; SN09; SN12; SN20), and sometimes only after prompting from the private sector as happened with the Kenya code of practice for the horticulture industry for example (SN06; Kenya Flower Council, 2017). There are several formal and informal platforms for

Table 2
Illustration of the GCF scoring methodology, with the predefined question and scoring guide for indicator 2.2 − information transparency.

| Predefined Question →	To what extent is information on resource-oriented sanitation and waste management systems accessible and understandable for interested stakeholders, including experts and non-experts?
Score	**Description**
++	**Easy access to cohesive knowledge**
	Information is easily accessible on open source information platforms. There are multiple ways of accessing and sharing information. Information is often provided by multiple sources and is understandable for non-experts
+	**Sharing of partly cohesive knowledge**
	All interested stakeholders can access information. Action has been taken to make knowledge increasingly understandable. Still, it is a time-consuming search through a maze of organizations, protocols and databases to abstract cohesive knowledge and insights
0	**Sharing of very technical knowledge**
	There are protocols for accessing information. However, it is not readily available. Although information is openly available, it is difficult to access and comprehend because it is very technical. Resource-oriented sanitation and waste management systems are reported about on local websites and reports
−	**Low sharing of fragmentized knowledge**
	Information is sometimes shared with other stakeholders. However, information is inaccessible for most stakeholders. Furthermore, knowledge is often technical and difficult to understand for non-experts. Resource-oriented sanitation and waste management systems may be addressed on local websites
−−	**Not transparent and inaccessible knowledge**
	Information is limitedly available, and sharing may be discouraged. The information that is available is difficult to understand. Resource-oriented sanitation and waste management systems are not addressed on local websites
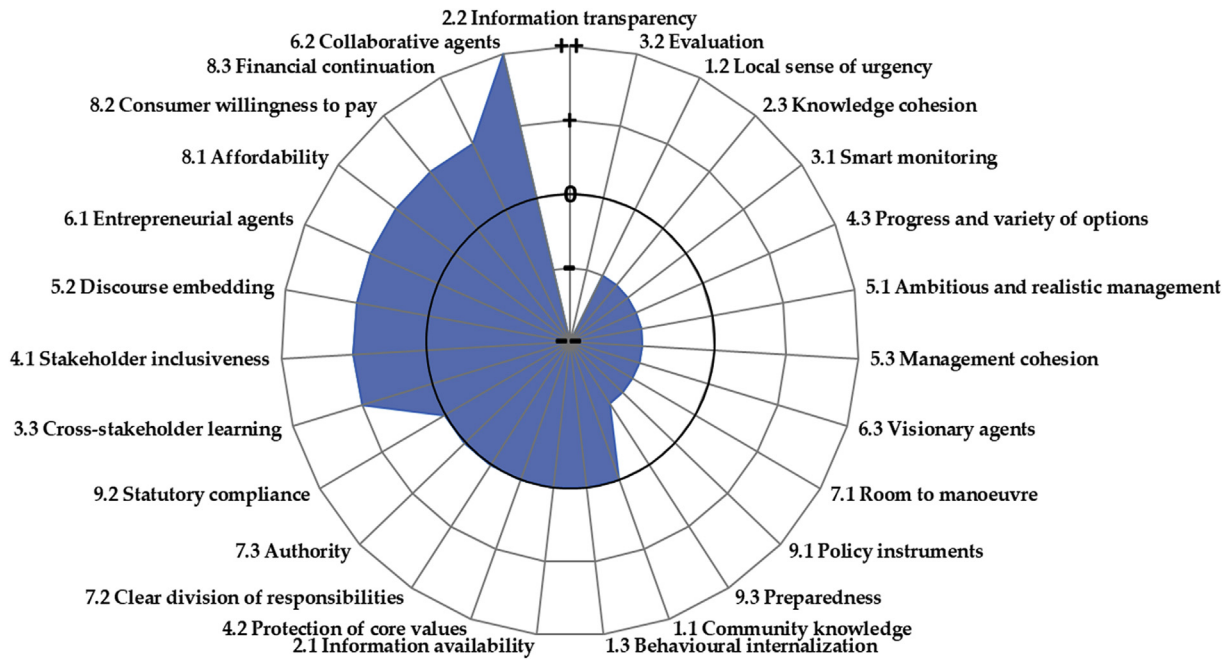
Fig. 1. GCF results from Naivasha with the 27 indicators arranged in clockwise manner according to scores from very limiting (−) to very encouraging (++).
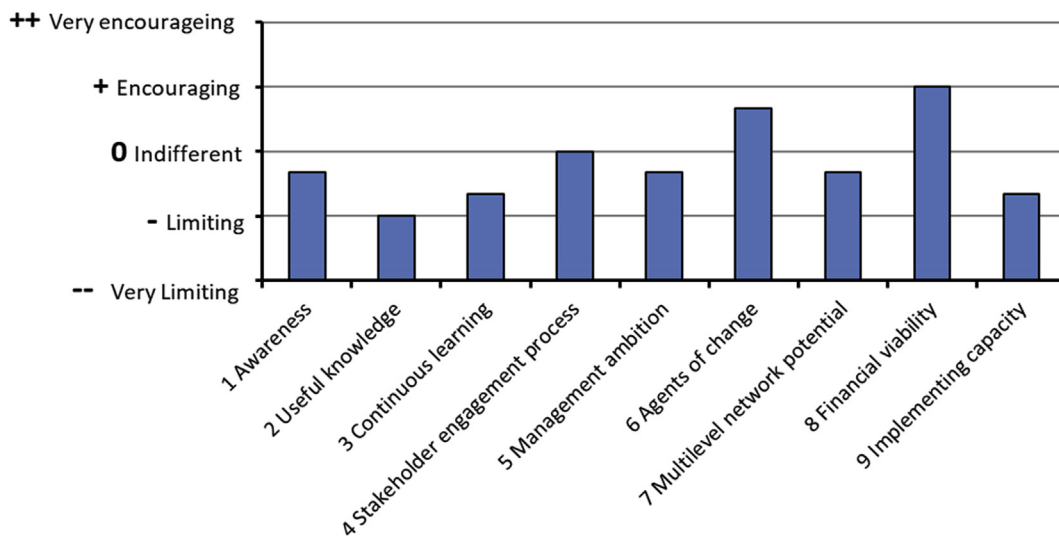

Fig. 2. Summary scores of Naivasha's governance capacity to implement resource-oriented sanitation and waste management systems. The bars represent the average scores for each governance condition.

interaction and learning for stakeholders (SN09) such as the Naivasha Green Grassroots Waste Management Association and the Imarisha Naivasha public-private partnership coordination program. However, they are mostly organized along sectoral lines (indicator 3.3) and platforms that transcend sectoral boundaries are yet to emerge (SN04; SN07; SN10; SN12; SN19; SN20).

4.2. Wanting

Kenya has legal provisions for public-private partnerships (CLGF, 2017) and public participation in processes across governance levels (CLGF, 2017; SN09; indicator 4.1). These provisions are

operationalized through involving various stakeholders in processes like the development of the Naivasha sub-county-wide sanitation plan (SN19; SN20) and the ongoing development of a waste management bill and policy (SN07; SN09; SN12). However, some processes are only open to conventional sanitation/waste management actors. This is exemplified by the absence of stakeholders connected to agriculture and energy in the Nakuru County Sanitation Steering Committee (SN10; NACOSTEC, 2018), despite their relevance for resource recovery. Moreover, some stakeholders' views may not be considered and their presence merely used to legitimatize participatory processes (indicator 4.2; SN09). Local citizens may also not be able to contribute effectively sometimes,

due to limited relevant knowledge and/or lack of preparation (SN09; SN18; indicator 4.3).

Across national and local levels of governance, the presence of terms like "resource recovery" and "recycling" in some policy and regulatory documents (SN10; SN19; Duma, 2019; Ministry of Environment and Forestry, 2019) illustrates awareness of the need for resource-oriented sanitation and waste management (indicator 5.2). However, there are no explicit targets for resource recovery (indicator 5.1), reducing the amount of waste at dumpsites (SN01; SN03; SN20) or even increasing energy recovery (SN02). Relevant policies and regulations are spread across various departments, including public health, water and sanitation, environment and natural resources, energy and agriculture (SN07; SN11; SN12; SN19) which inevitably leads to some incoherence (indicator 5.3). Moreover, resource recovery from organic waste is not adequately addressed in most waste-related policy documents (SN03; SN04; SN07) and even agricultural strategies, which have explicit targets and subsidies for increasing chemical fertilizer usage but not for waste-derived fertilizers (SN08; Moya et al., 2019). Private sector and civil society actors including Sanivation, Dudu-Tech, Taka Ventures, Tropical Power/BioJoule, Waste to Best, Kwa Muhia Environmental Group and other community-based organizations (CBOs) operate resource recovery initiatives in Naivasha (indicator 6.1). Their entrepreneurship led to the first grid-connected biogas plant in Africa (Kamadi, 2017; SN02), two excreta-to-solid-fuel enterprises within Nakuru County (SN19) and various composting projects (SN04; SN06; SN11). The culture of forming associations and self-help groups in Kenya has enabled the proliferation of associations for collaboration among stakeholders in resource-oriented sanitation and waste management (Duma, 2019; SN09; SN12; indicator 6.2). There are some visionary agents (indicator 6.3) who are enthusiastic about sanitation and waste management e.g. the current county governor who often goes by the moniker 'sanitation champion' (Duma, 2019; NACOSTEC, 2018; SN12). The five-year election cycles in Kenya however affects the implementation of strategies, often due to a high turnover of staff linked to new political leaders. This leads to limited institutional memory and continuity in technical capacity (SN12) and hampers the development and implementation of long-term strategies.

4.3. Enabling

Processes to streamline activities at the sub-county and county level have helped to clarify roles and responsibilities for sanitation and waste management among stakeholders from the public, private and civil society sectors (indicator 7.2) through the Nakuru County Sanitation Steering Committee (SN07; SN10; SN12; SN19). Within the public sector however, resource recovery from organic waste streams does not seem to have a clear "home" since none of the utilities and respective departments for water, public health and environment view it as part of their core mandate as described within the relevant laws (SN07; SN12; SN20; indicator 7.1). Resource recovery activities may also be limited due to regulatory vacuums or contradictions (indicator 7.3). This applies for example to generating solid fuels from faecal sludge (SN12; SN19).

People's ability and willingness to pay for resource-oriented sanitation and waste management services varies (indicator 8.1 and 8.2) and it is largely determined by household income levels (SN03; SN07). Household waste collection services cost anywhere between 100 to 2000 Kenyan shillings per household per month (US$ 1 to 20) with low-income households typically paying the lower amounts. This reflects some flexibility in charges, also present in water tariffs and faecal sludge pit emptying services (SN03; SN04; SN05; SN11; SN20). Resource recovery products like briquettes and compost are viewed as relatively affordable for many households, relative to alternative products (SN19). They have a significant market in Naivasha and Kenya in general and in some instances, the demand for products outstrips supply (SN01; SN19).

Both public and private sources of funding are accessible in Naivasha for implementing resource-oriented sanitation and waste management systems (SN01; SN05; Atello et al., 2016). Private sector funding is mostly availed to commercially viable initiatives (SN02), although financing is also needed to go from concept through feasibility studies to proven viability (indicator 8.3). Public funding and foundation grants could bridge that gap, but they sometimes have a short-term horizon (SN02) and/or limitations on what items can be financed (SN11). Some stakeholders have accessed grant funding from international sources (SN12; SN19; SN20), although this led to difficulties in some instances when funding was terminated (SN10; SN12).

Policy instruments, including licenses, permits and mandatory public participation are being used in connection to sanitation and waste management. However, implementation difficulties due to the limited capacity of the public sector have been reported (SN01; SN03; SN07; SN08; SN12; SN17; SN19). This implies that there is insufficient evaluation of policy instruments to generate insights about how they work and how to improve their implementation (indicator 9.1). Some regulations have achieved low levels of compliance among stakeholders (indicator 9.2). This is partly attributable to costs of compliance, especially when they are borne by low-income households (SN03; SN07; SN18); ignorance about applicable regulations (SN04; SN08); and the limited capacity of the public authorities to enforce regulations (SN01; SN07; SN12; SN18). Financing and infrastructure for sanitation and waste management has not kept up with the rising population in Naivasha (SN03; SN05; SN07; SN10; SN11; SN13; SN14; SN18). The public authorities do not seem to have enough capacity to meet the emerging challenges (indicator 9.3) but they have an interest in collaborating with other stakeholders on resource-oriented sanitation and waste management systems (SN03; SN12; SN07; SN19).

4.4. Synthesis of key factors for Naivasha

Overall, there is considerable need to improve Naivasha's governance capacity to create a favorable environment for the implementation of resource recovery from organic waste streams. Lack of an information-sharing culture among local stakeholders and availability of information incomprehensible to non-experts creates low levels of information transparency (indicator 2.2). Policies are evaluated on an ad hoc basis (indicator 3.2) and public sector stakeholders have limited resources to implement policy instruments (condition 9). Still, there is a significant market potential and access to various funding sources for resource recovery initiatives (condition 8). Naivasha already has many agents of change (condition 6) and the presence of many collaborative associations provides impetus for cross-sectoral cooperation centered around resource recovery to develop. Kenya has legal provisions for public participation and public-private partnerships (condition 4), a foundation for multiple actors to drive initiatives for resource-oriented sanitation and waste management. While the public sector could stimulate such initiatives, it might need to be in ways not requiring much effort, given the limitations on public sector capacity (condition 9).

5. Discussion

5.1. The mismatch between theory and practice

In Naivasha, the low level of useful knowledge (condition 2) could impede overall governance capacity. Knowledge is needed to

inform decision-making, prevent fragmented policy and implementation (Rowley, 2007; van Rijswick et al., 2014) and is an essential element of governance (Kooiman et al., 2008). At the same time however, there are several existing resource recovery initiatives in Naivasha driven by local stakeholders. This is similar to cities and towns in other low- and middle-income countries where resource recovery from organic waste has been practiced for a long time (Otoo and Drechsel, 2018) with no reference to the CE discourse. In fact, human and animal waste have been recycled in ancient societies (Lüthi et al., 2011) long before CE-related concepts were expressed by e.g. Boulding (1966).

The apparent disconnect between useful knowledge and ongoing practice on the ground could perhaps be explained by cultural evolution theory (Henrich and McElreath, 2003) whereby practices are transmitted by individuals through social learning processes that involve the copying and imitation of behaviors, strategies and techniques. Over long periods of time, sophisticated solutions to everyday challenges can be generated through cultural evolution even when the society does not have theoretical explanations for why those solutions actually work (Henrich, 2017). Therefore, implementation of CE approaches, especially in low- and middle-income countries, needs to take into account existing communities of practice (CoPs) and cultural norms connected to resource recovery from organic waste and seek to bridge the gaps between theoretical CE concepts and local knowledge. CoPs arrange for local stakeholders to engage and share different perspectives and needs, and ultimately to co-create knowledge through social learning (Fulgenzi et al., 2020).

The success of CE approaches depends on the availability of a market for resource recovery products, which is influenced significantly by public awareness (Danso et al., 2017; Otoo and Drechsel, 2018). Naivasha has some public awareness about resource recovery from organic waste based on previous initiatives and this is a good foundation to build on for further implementation of circularity. On the other hand, the sense of urgency in implementing initiatives for resource recovery from organic waste streams seems to be relatively low. This disconnect between awareness and urgency for action could perhaps be addressed within stakeholder engagement campaigns (Stephens and Graham, 2008).

Public perceptions about the reuse of wastewater and other organic waste streams are the subject of a growing body of literature covering issues that include cultural norms and practices, the "yuck factor", perceived resource scarcity, and pricing concerns (see e.g. Fielding et al., 2019; Polprasert, 2007; van Rensburg, 2016). Resource recovery from waste streams like excreta and wastewater is associated with both risks and benefits (Ekane et al., 2016) and implementation by stakeholders may depend on whether their risk perception outweighs their benefit judgement or vice versa. A low sense of urgency by stakeholders could perhaps imply a higher risk perception in relation to dealing with organic waste streams and hence makes it crucial to have strong monitoring systems (indicator 3.1) that can alleviate both perceived and real risks.

5.2. Cross-sectoral and multi-stakeholder collaboration

Relational resources are needed to operationalize CE concepts in such multi-sectoral contexts since collaboration is crucial (Abreu and Ceglia, 2018; Moreau et al., 2017). The importance of collaboration is also highlighted across the wider governance literature (e.g. Kooiman et al., 2008; Phelps and Tewdwr-Jones, 2000) and in relation to broader CE approaches like industrial symbiosis and collaborative consumption models of renting, sharing and bartering (Ghisellini et al., 2016). In cities, organic waste streams like food waste, faecal sludge and wastewater are often handled by different stakeholders (Velenturf, 2016) yet synergies can be created by managing them together through for example co-treatment and co-valorization (Cofie et al., 2009). This underscores the need for cross-stakeholder collaboration.

In Naivasha, the present fragmented nature of collaborations however implies that cross-stakeholder learning has not yet crossed sectoral boundaries. For example, stakeholders from the energy and agricultural sector are often not involved in the discussions around sanitation and waste management, yet they are crucial links in closing biomass material loops. The current set-up of collaborative arrangements could also create difficulties for new entrants into the resource recovery scene in Naivasha especially if they are not from the usual sectors already involved in existing networks. This highlights a role that could be played by public sector actors to foster cross-sectoral collaborations, also across governance levels (Abreu and Ceglia, 2018; Velenturf, 2016). Undertaking a social network analysis could more clearly characterize the interactions among different stakeholders and identify gaps as well as which important stakeholders are being left out of the conversation (Lienert et al., 2013).

Stakeholder engagement and public participation are important elements for enhancing governance capacity (Kooiman and Jentoft, 2009; Pahl-Wostl, 2009). The results indicate that participation and engagement are not always effective. This could be connected to the level of knowledge and how concepts are framed when presented to local stakeholders. Similar examples exist in the environmental governance literature where stakeholder participation has not achieved intended outcomes due to challenges related to levels of knowledge among stakeholders, power relations, the language of interaction in the engagement process, and the design of institutions and processes (Rydin and Pennington, 2000; Webler et al., 2001). Therefore, this indicates a need for mechanisms to ensure that local stakeholders have the capacity to effectively contribute to participatory processes regarding implementation of the CE.

5.3. The roles of the private sector & public sector

Existing resource recovery initiatives in Naivasha are mainly being led by private sector stakeholders with the public sector lagging behind. While this could be explained as a result of narrow definition and scope of stakeholder mandates, it is further exacerbated by the limited capacity of public sector to implement and enforce policy instruments. Further public sector involvement in resource recovery initiatives could further burden their overstretched capacity. Resource recovery initiatives are most challenged where the capacity of municipalities is constrained (Otoo and Drechsel, 2018). The lack of enthusiasm by public sector actors to be at the forefront of CE initiatives has been identified in other low- and middle-income countries (Preston et al., 2019) and is not unique to Naivasha. Importantly, the same can be said of local regions in Europe where private sector actors have been at the vanguard of processes like establishing standards for the CE (Flynn and Hacking, 2019) and leading initiatives for circularity in cities (Prendeville et al., 2018; Velenturf, 2016).

Private sector leadership in resource recovery initiatives is not a panacea, however and should not overshadow the crucial roles of the public sector (Flynn and Hacking, 2019; Kooiman and Jentoft, 2009). Public sector actors offloading the challenge of implementing CE approaches to the private sector could be seen as a breach of social contract (Velenturf and Jopson, 2019). Municipalities elsewhere have highlighted challenges with relying on the private sector for handling urban waste, given that the private sector is often less likely to deliver public benefits where circular approaches require making unprofitable transformations (Williams, 2019). Moreover, attention has been brought to the crucial role of

the public sector as an "entrepreneur" in creating innovation systems that deliver benefits to all of society and in investing where the private sector will not (Mazzucato, 2018). In the context of CE implementation, clear roles that public sector actors should fulfill include;

- creating knowledge and relational resources as well as mobilizing actors for implementation (Abreu and Ceglia, 2018)
- setting regulations and standards which are crucial for sustainability transitions (Flynn and Hacking, 2019).
- establishing systems for smart monitoring and evaluation of policy and implementation (Otoo and Drechsel, 2018)
- providing funding for research and development and capital for early-stage ventures (Mazzucato, 2018)
- convening, as local government actors usually have that power (Chaturvedi et al., 2015) and can create platforms for cross-sectoral stakeholder collaboration and attract investment into their region (Velenturf, 2016)

In Naivasha, there are examples of the public sector playing key roles in other areas that could be applied to the CE. For example, the Kenyan government does not manufacture chemical fertilizers, but they provide subsidies for fertilizer purchase to farmers (Moya et al., 2019). This is a strategy that not only caters for soil fertility objectives but also provides stimulus for stakeholders engaged in the supply chain of chemical fertilizers. Therefore, one way for the public sector to be involved in resource recovery initiatives could be through providing stimuli by extending these subsidies to cover waste-derived fertilizers as well. The public sector could also play a role in funding resource recovery initiatives that are at the early stage until they have reached a commercially viable level that attracts private capital. National level stakeholders like the National Environment Trust Fund are already providing seed funding for waste-related business ventures, and hence Naivasha-based initiatives can also access this funding.

5.4. Policy strategies for the circular economy

Globally, implementation of the CE is still in its infancy and the role of policies to steer the transition is crucial (Velenturf and Jopson, 2019). Besides acting as regulatory mechanisms, policies can provide a common vision describing societal level goals, which is a necessity for sustainability transitions (Frantzeskaki et al., 2012). In Naivasha, the relatively low level of policy and management ambition (condition 5) creates a vacuum whereby local stakeholders lack incentives to drive local action.

Development of policy and regulatory frameworks often trails behind innovation (Ladu and Quitzow, 2017). In the EU, private sector actors are at the fore of establishing standards for the CE, and this is seen by some as a way of providing public policy through private means (Flynn and Hacking, 2019). However, implementing the CE requires the articulation of a common vision as noted in the sustainability transitions literature and this can be provided through policy (Frantzeskaki et al., 2012; Köhler et al., 2019; Schot and Geels, 2008). A vision is a key element of governance (Kooiman et al., 2008) and the need for a common vision at a local context is highlighted by Velenturf (2016). It is even more crucial considering that CE can have different meanings for different stakeholders (Kirchherr et al., 2017).

At a national and regional level, policy packages established in the EU and China have been instrumental in catalyzing CE initiatives (McDowall et al., 2017). Even at local level, cities with explicit roadmaps and strategies for circular approaches have incentivized local action and provided inspiration for other cities (Prendeville et al., 2018). Other urban areas with ambitions for CE

implementation could also establish explicit policy strategies to guide and to stimulate local initiatives.

A common vision for the CE can consist of multiple strategies and does not have to be created by the public sector alone. As emphasized by Köhler et al. (2019) and Frantzeskaki et al. (2012), such visions can be the outcome of contestation and struggle between multiple visions and agendas from stakeholders across the public, private and civil society sectors and across governance levels, each enjoying accessibility and responsiveness. Indeed, a diversity of strategies towards CE implementation is needed and debate about these, involving various stakeholders, technology users, market actors, households and grassroots community groups, can lead to better outcomes in terms of social, environmental and economic terms (Beck et al., 2018). As discussed in section 5.2, an atmosphere of cross-sectoral and multi-stakeholder collaboration can enable this kind of engagement and co-development to occur.

5.5. Contributions and limitations

The GCF methodology was originally created for the water sector. In this study, it has been applied to CE implementation in a multi-sectoral context. This shows that the framework can be transferred to other contexts with a few modifications, hence allowing also for comparisons and learning between different sectors. The framework provided a structure for a comprehensive assessment and for identifying factors that facilitate or impede governance capacity to implement resource recovery from organic waste streams. The breadth of the framework could have been a drawback in the study since some of the indicators seem quite similar for example indicator 6.1 − entrepreneurial agents and 6.3 − visionary agents, as well as 7.1 − room to maneuver and 7.3 − authority. This implies that there was a risk that a score for one indicator could have been assigned based on justification that would ideally be more suited for a related indicator. However, the relation among the indicators provides a form of validation. For example, with indicators 6.1 and 7.1, if there is more room to maneuver, entrepreneurial agents have more opportunities; and with 6.3 and 7.3, visionary agents are more likely to leave their mark if they have relatively high levels of authority. Besides the similarities of a few indicators, it was challenging to describe some indicators to some of the interviewees. The GCF methodology was available in English, and some terms did not have accurate equivalents in Naivasha's local languages for some interviewees who may have had challenges conceptualizing some indicators.

6. Conclusions

In this study, we aimed to identify key factors that facilitate or impede the governance capacity to implement CE approaches that recover resources from organic waste streams. The governance capacity framework was applied to the CE in a multi-sectoral context in this study, demonstrating the broader usefulness of the framework. Our results show that there is a disconnect between public awareness about CE approaches and the urgency for action especially within the public sector. There is also a disconnect between theoretical CE concepts and ongoing practices by local stakeholders. Existing initiatives for resource recovery from organic waste streams are largely led by private sector and civil society actors and the public sector stakeholders do not seem to see a need to play a leading role. Moreover, existing platforms for collaboration are still arranged in silos and stakeholder participation is not always effective. To improve overall governance capacity in Naivasha, the public sector needs to use its convening power to foster cross-sectoral collaboration and build the capacity of local

stakeholders to effectively participate in governance processes for the CE. Examples could be drawn from public sector leadership in other areas to enable the co-development of strategies to drive CE implementation in Naivasha.

From an international perspective, concepts of CE are predominantly focused on Western societies that have full access to centralized sanitation and waste systems with typically high investment costs, and which can rely on a relatively well-established public sector to monitor risks. Low- and middle-income countries typically have localized systems relying merely on small and medium enterprises with limited risk monitoring mechanisms. A key step would therefore be to strengthen the public sector with adequate risk monitoring guidelines that facilitate safe local CE initiatives. Communities of practice consisting of multi-sector public, private and civil society local stakeholders plus international public-private partnerships and academia, may provide a fruitful breeding ground to overcome the mismatch between CE theory and local practices of CE in low- and middle-income countries. It is therefore necessary to map and align with existing resource recovery initiatives, norms and practices in local communities and co-create tailored knowledge that match with these contexts. The insights provided in this paper could be of value to other urban areas looking to implement CE approaches, both in Africa and elsewhere with circumstances akin to those in Naivasha.

CRediT authorship contribution statement

Daniel Ddiba: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Visualization, Writing - original draft, Writing - review & editing. **Kim Andersson:** Funding acquisition, Project administration, Writing - review & editing. **Steven H.A. Koop:** Formal analysis, Methodology, Validation, Visualization, Writing - review & editing. **Elisabeth Ekener:** Funding acquisition, Supervision, Writing - review & editing. **Göran Finnveden:** Funding acquisition, Supervision, Writing - review & editing. **Sarah Dickin:** Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Validation, Writing - review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.esg.2020.100063.

References

Abreu, M.C.S.d., Ceglia, D., 2018. On the implementation of a circular economy: the role of institutional capacity-building through industrial symbiosis. Resour. Conserv. Recycl. 138, 99–109. https://doi.org/10.1016/j.resconrec.2018.07.001.

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, first ed. United Nations Environment Programme and Stockholm Environment Institute, Nairobi and Stockholm.

Atello, N., Mulanga, M., Njoroge, H., Njeru, F., Omondi, J., 2016. Informal vs formal: the need for financial services to complement, not compete − financial Sector Deepening Kenya [WWW Document]. *FSD Kenya Blog.* https://fsdkenya.org/blog/informal-vs-formal-the-need-for-financial-services-to-complement-not-compete/. (Accessed 7 May 2019).

Athiemoolam, L., Kibui, A., 2013. An analysis of Kenyan learners' proficiency in English based on reading comprehension and vocabulary. J. NELTA 17, 1–13. https://doi.org/10.3126/nelta.v17i1-2.8088.

Beck, M.B., Thompson, M., Gyawali, D., Langan, S., Linnerooth-Bayer, J., 2018. Viewpoint - pouring money down the drain: can we break the habit by reconceiving wastes as resources? Water Altern. (WaA) 11, 260–283.

Berner, C., Woods, E., Foote, A., 2015. Waste transformation, not waste treatment: understanding the value of poop in sanivation's waste processing model for cities. In: Faecal Sludge Management (FSM4) 2015. FSM Alliance and Sustainable Sanitation Alliance, Chennai, India, pp. 3–5.

Bohnert, K., 2017. Shit Flow Diagram Report for Naivasha Sub-county, Kenya. SFD Promotion Initiative, Sanivation, Naivasha, Kenya.

Boulding, K.E., 1966. The economics of the coming spaceship earth. In: Jarrett, H. (Ed.), Environmental Quality Issues in a Growing Economy. Resources for the Future/Johns Hopkins University Press, Baltimore, MD, pp. 3–14.

Brockhoff, R.C., Koop, S.H.A., Snel, K.A.W., 2019. Pluvial flooding in utrecht: on its way to a flood-proof city. Water 11, 1501. https://doi.org/10.3390/w11071501.

Chaturvedi, A., Arora, R., Saluja, M.S., 2015. Private sector and waste management in Delhi: a political economy perspective. IDS Bull. 46, 7–16. https://doi.org/10.1111/1759-5436.12140.

CLGF, 2017. The Local Government System in Kenya (2017-2018), Country Profiles. Commonwealth Local Government Forum (CLGF).

Cofie, O., Kone, D., Rothenberger, S., Moser, D., Zubruegg, C., 2009. Co-composting of faecal sludge and organic solid waste for agriculture: process dynamics. Water Res. 43, 4665–4675. https://doi.org/10.1016/J.WATRES.2009.07.021.

Danso, G.K., Otoo, M., Ekere, W., Ddungu, S., Madurangi, G., 2017. Market feasibility of faecal sludge and municipal solid waste-based compost as measured by farmers' willingness-to-pay for product attributes: evidence from Kampala, Uganda. Resources 6, 31. https://doi.org/10.3390/resources6030031.

Dewhurst, R., 2018. SFD Thinking - SFD Creation Process and Impacts: Case of Nairobi, Kenya. SFD Promotion Initiative, Water Engineering and Development Centre (WEDC), Nairobi, Kenya.

Diener, S., Semiyaga, S., Niwagaba, C.B., Muspratt, A.M., Gning, J.B., Mbéguéré, M., Ennin, J.E., Zurbrugg, C., Strande, L., 2014. A value proposition: resource recovery from faecal sludge—can it be the driver for improved sanitation? Resour. Conserv. Recycl. 88, 32–38. https://doi.org/10.1016/J.RESCONREC.2014.04.005.

Driessen, P.P.J., Dieperink, C., van Laerhoven, F., Runhaar, H.A.C., Vermeulen, W.J.V., 2012. Towards a conceptual framework for the study of shifts in modes of environmental governance - experiences from The Netherlands. Environ. Pol. Govern. 22, 143–160. https://doi.org/10.1002/eet.1580.

Duma, L., 2019. The Naivasha Sub-county Vision: County-wide Inclusive Sanitation Plan for Naivasha Sub-county. Sanivation and BORDA, Naivasha, Kenya.

Ekane, N., Mertz, C.K., Slovic, P., Kjellén, M., Westlund, H., 2016. Risk and benefit judgment of excreta as fertilizer in agriculture: an exploratory investigation in Rwanda and Uganda. Hum. Ecol. Risk Assess. 22, 639–666. https://doi.org/10.1080/10807039.2015.1100515.

Ellen MacArthur Foundation, 2017. Urban Biocycles. Ellen MacArthur Foundation and the World Economic Forum, London, United Kingdom.

Feingold, D., Koop, S., van Leeuwen, K., 2018. The City Blueprint approach: urban water management and governance in cities in the US. Environ. Manag. 61 (1), 9–23. https://doi.org/10.1007/s00267-017-0952-y.

Fielding, K.S., Dolnicar, S., Schultz, T., 2019. Public acceptance of recycled water. Int. J. Water Resour. Dev. 35, 551–586. https://doi.org/10.1080/07900627.2017.1419125.

Flynn, A., Hacking, N., 2019. Setting standards for a circular economy: a challenge too far for neoliberal environmental governance? J. Clean. Prod. 212, 1256–1267. https://doi.org/10.1016/j.jclepro.2018.11.257.

Frantzeskaki, N., Loorbach, D., Meadowcroft, J., 2012. Governing societal transitions to sustainability. Int. J. Sustain. Dev. 15, 19. https://doi.org/10.1504/IJSD.2012.044032.

Fulgenzi, A., Brouwer, S., Baker, K., Frijns, J., 2020. Communities of practice at the center of circular water solutions. WIREs Water. https://doi.org/10.1002/wat2.1450.

Furlong, C., 2015a. Shit Flow Diagram Report for Nakuru, Kenya. SFD Promotion Initiative, Water, Engineering and Development Centre (WEDC) and Water & Sanitation for the Urban Poor (WSUP), Nakuru, Kenya.

Furlong, C., 2015b. Shit Flow Diagram Report for Kisumu, Kenya. SFD Promotion Initiative and the Water, Engineering and Development Centre (WEDC), Kisumu, Kenya.

Ghisellini, P., Cialani, C., Ulgiati, S., 2016. A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. J. Clean. Prod. 114, 11–32. https://doi.org/10.1016/j.jclepro.2015.09.007. Towards Post Fossil Carbon Societies: Regenerative and Preventative Eco-Industrial Development.

Henrich, J., 2017. The Secret of Our Success: How Culture Is Driving Human Evolution, Domesticating Our Species, and Making Us Smarter, first ed. Princeton University Press, Princeton, NJ, US.

Henrich, J., McElreath, R., 2003. The evolution of cultural evolution. Evol. Anthropol. Issues News Rev. 12, 123–135. https://doi.org/10.1002/evan.10110.

Kamadi, G., 2017. Africa's first grid-connected biogas plant powers up - Reuters [WWW Document]. Reuters. https://www.reuters.com/article/kenya-energy-biogas/africas-first-grid-connected-biogas-plant-powers-up-idUSL5N1EZ1KL. (Accessed 7 May 2019).

Kaza, S., Yao, L., Bhada-Tata, P., Van Woerden, F., 2018. What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. World Bank Group, Washington, D.C. https://doi.org/10.1596/978-1-4648 -1329-0.

Kenya Flower Council, 2019. Kenya flower council. Floriculture In Kenya [WWW Document]. http://kenyaflowercouncil.org/?page_id=92. (Accessed 6 November 2019).

Kenya Flower Council, 2017. Kenya flower council. Part two of the KS1758 for fruits and vegetables launched [WWW Document]. http://www.kenyaflowercouncil.org/blog/?p=6285. (Accessed 6 May 2019).

Kim, H., Son, J., Lee, S., Koop, S., van Leeuwen, K., Choi, Y., Park, J., 2018. Assessing urban water management sustainability of a megacity: case study of seoul, South Korea. Water 10, 682. https://doi.org/10.3390/w10060682.

Kirchherr, J., Reike, D., Hekkert, M., 2017. Conceptualizing the circular economy: an analysis of 114 definitions. Resour. Conserv. Recycl. 127, 221–232. https://doi.org/10.1016/j.resconrec.2017.09.005.

Köhler, J., Geels, F.W., Kern, F., Markard, J., Onsongo, E., Wieczorek, A., Alkemade, F., Avelino, F., Bergek, A., Boons, F., Fünfschilling, L., Hess, D., Holtz, G., Hyysalo, S., Jenkins, K., Kivimaa, P., Martiskainen, M., McMeekin, A., Mühlemeier, M.S., Nykvist, B., Pel, B., Raven, R., Rohracher, H., Sandén, B., Schot, J., Sovacool, B., Turnheim, B., Welch, D., Wells, P., 2019. An agenda for sustainability transitions research: state of the art and future directions. Environ. Innov. Soc. Transit. 31, 1–32. https://doi.org/10.1016/j.eist.2019.01.004.

Kooiman, J., Bavinck, M., Chuenpagdee, R., Mahon, R., Pullin, R., 2008. Interactive governance and governability: an introduction. J. Transdiscipl. Environ. Stud. 7 (1), 1–11.

Kooiman, J., Jentoft, S., 2009. Meta-governance: values, norms and principles, and the making of hard choices. Publ. Adm. 87, 818–836. https://doi.org/10.1111/j.1467-9299.2009.01780.x.

Koop, S., Gomes, F.M., Schoot, L., Dieperink, C., Driessen, P., Van Leeuwen, K., 2018. Assessing the capacity to govern flood risk in cities and the role of contextual factors. Sustainability 10, 1–21. https://doi.org/10.3390/su10082869.

Koop, S.H.A., Koetsier, L., Doornhof, A., Reinstra, O., Van Leeuwen, C.J., Brouwer, S., Dieperink, C., Driessen, P.P.J., 2017. Assessing the governance capacity of cities to address challenges of water, waste, and climate change. Water Resour. Manag. 31, 3427–3443. https://doi.org/10.1007/s11269-017-1677-7.

Ladu, L., Quitzow, R., 2017. Bio-based economy: policy framework and foresight thinking. In: Food Waste Reduction and Valorisation. Springer International Publishing, pp. 167–195. https://doi.org/10.1007/978-3-319-50088-1_9. Cham.

Langergraber, G., 2013. Are constructed treatment wetlands sustainable sanitation solutions? Water Sci. Technol. 67, 2133–2140. https://doi.org/10.2166/wst.2013.122.

Li, P., Wu, H.J., Chen, B., 2013. RSW-MCFP: a resource-oriented solid waste management system for a mixed rural-urban area through Monte Carlo simulation-based fuzzy programming. Math. Probl Eng. https://doi.org/10.1155/2013/780354, 2013.

Lienert, J., Schnetzer, F., Ingold, K., 2013. Stakeholder analysis combined with social network analysis provides fine-grained insights into water infrastructure planning processes. J. Environ. Manag. 125, 134–148. https://doi.org/10.1016/j.jenvman.2013.03.052.

Lüthi, C., Panesar, A., Schütze, T., Norström, A., McConville, J., Parkinson, J., Saywell, D., Ingle, R., 2011. Sustainable Sanitation in Cities: A Framework for Action. In: Sustainable Sanitation Alliance (SuSanA) & International Forum on Urbanism (IFoU), first ed. Papiroz Publishing House, Rijswijk, The Netherlands.

Mazzucato, M., 2018. The Entrepreneurial State: Debunking Public vs. Private Sector Myths, Revised. Penguin, London, UK.

McDowall, W., Geng, Y., Huang, B., Barteková, E., Bleischwitz, R., Türkeli, S., Kemp, R., Doménech, T., 2017. Circular economy policies in China and Europe. J. Ind. Ecol. 21, 651–661. https://doi.org/10.1111/jiec.12597.

Ministry of Environment and Forestry, 2019. National Sustainable Waste Management Policy. Ministry of Environment and Forestry, Republic of Kenya, Nairobi, Kenya.

Moreau, V., Sahakian, M., van Griethuysen, P., Vuille, F., 2017. Coming full circle: why social and institutional dimensions matter for the circular economy. J. Ind. Ecol. 21, 497–506. https://doi.org/10.1111/jiec.12598.

Morrison, E.H.J., Banzaert, A., Upton, C., Pacini, N., Pokorný, J., Harper, D.M., 2014. Biomass briquettes: a novel incentive for managing papyrus wetlands sustainably? Wetl. Ecol. Manag. 22, 129–141. https://doi.org/10.1007/s11273-013-9310-x.

MacDonald, Mott, 2017. Nakuru Integrated Solid Waste Management PPP: Project Feasibility Study Report and PPP Implementation Plan. Prepared by Mott MacDonald for the World Bank Group and County Government of Nakuru, Nakuru, Kenya.

Moya, B., Sakrabani, R., Parker, A., Moya, B., Sakrabani, R., Parker, A., 2019. Realizing the circular economy for sanitation: assessing enabling conditions and barriers to the commercialization of human excreta derived fertilizer in Haiti and Kenya. Sustainability 11, 3154. https://doi.org/10.3390/su11113154.

NACOSTEC, 2018. Nakuru Countywide Inclusive Sanitation Strategy. Nakuru County Sanitation Steering Committee (NACOSTEC). Nakuru County Government, Government of Kenya and World Bank Group, Nakuru, Kenya.

NEMA, 2014. The National Solid Waste Management Strategy. National Environment Management Authority (NEMA), Kenya, Nairobi, Kenya.

Newell, P., Pattberg, P., Schroeder, H., 2012. Multiactor governance and the environment. Annu. Rev. Environ. Resour. 37, 365–387. https://doi.org/10.1146/annurev-environ-020911-094659.

Ostrom, E., 1990. Governing the Commons: The Evolution of Institutions for Collective Action, first ed. Cambridge University Press, Cambridge, United Kingdom.

Otoo, M., Drechsel, P., 2018. Resource Recovery from Waste: Business Models for Energy, Nutrients and Water Reuse, first ed. Routledge, London. https://doi.org/10.4324/9781315780863.

Pahl-Wostl, C., 2009. A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes. Global Environ. Change 19, 354–365. https://doi.org/10.1016/j.gloenvcha.2009.06.001.

Phelps, N.A., Tewdwr-Jones, M., 2000. Scratching the surface of collaborative and associative governance: identifying the diversity of social action in institutional capacity building. Environ. Plann. 32, 111–130. https://doi.org/10.1068/a31175.

Polprasert, C., 2007. Organic Waste Recycling: Technology and Management, third ed. IWA Publishing, London, UK.

Prendeville, S., Cherim, E., Bocken, N., 2018. Circular cities: mapping six cities in transition. Environ. Innov. Soc. Transit. 26, 171–194. https://doi.org/10.1016/j.eist.2017.03.002.

Preston, F., Lehne, J., Wellesley, L., 2019. An Inclusive Circular Economy: Priorities for Developing Countries. Chatham House: the Royal Institute of International Affairs, London, United Kingdom.

Republic of Kenya, 2012. The County Governments Act - No. 17 of 2012. Parliament, Republic of Kenya.

Rieck, C., Onyango, P., 2010. Public Toilet with Biogas Plant and Water Kiosk in Naivasha, Kenya, Case Study of Sustainable Sanitation Projects. Sustainable Sanitation Alliance (SuSanA), Naivasha, Kenya.

Rist, S., Chidambaranathan, M., Escobar, C., Wiesmann, U., Zimmermann, A., 2007. Moving from sustainable management to sustainable governance of natural resources: the role of social learning processes in rural India, Bolivia and Mali. J. Rural Stud. 23, 23–37. https://doi.org/10.1016/j.jrurstud.2006.02.006.

Rose, C., Parker, A., Jefferson, B., Cartmell, E., 2015. The characterization of feces and urine: a review of the literature to inform advanced treatment technology. Crit. Rev. Environ. Sci. Technol. 45, 1827–1879. https://doi.org/10.1080/10643389.2014.1000761.

Rowley, J., 2007. The wisdom hierarchy: representations of the DIKW hierarchy. J. Inf. Sci. 33, 163–180. https://doi.org/10.1177/0165551506070706.

Rydin, Y., Pennington, M., 2000. Public Participation and Local Environmental Planning: the collective action problem and the potential of social capital. Local Environ. 5, 153–169. https://doi.org/10.1080/13549830050009328.

Schot, J., Geels, F.W., 2008. Strategic niche management and sustainable innovation journeys: theory, findings, research agenda, and policy. Technol. Anal. Strat. Manag. 20, 537–554. https://doi.org/10.1080/09537320802292651.

Soezer, A., 2016. Nationally appropriate mitigation action (NAMA) on circular economy solid waste management approach for urban areas in Kenya. In: The Ministry of Environament and Natural Resources of Kenya and UNDP Low Emission Capacity Building. LECB) Programme, Nairobi, Kenya.

Šteflová, M., Koop, S., Elelman, R., Vinyoles, J., Van Leeuwen, C., 2018. Governing non-potable water-reuse to alleviate water stress: the case of sabadell, Spain. Water 10, 739. https://doi.org/10.3390/w10060739.

Stephens, J.C., Graham, A.C., 2008. Climate science to citizen action: energizing nonformal climate science education. Eos Trans. Am. Geophys. Union 89, 204. https://doi.org/10.1029/2008EO220010.

Strande, L., Ronteltap, M., Brdjanovic, D., 2014. Faecal Sludge Management: Systems Approach for Implementation and Operation, first ed. IWA Publishing, London, UK.

UN DESA, 2019. World Urbanization Prospects 2018: Highlights (ST/ESA/SER.A/421. United Nations, Department of Economic and Social Affairs (UN DESA), Population Division, New York, NY, USA.

van Leeuwen, K., de Vries, E., Koop, S., Roest, K., 2018. The energy & raw materials factory: role and potential contribution to the circular economy of the Netherlands. Environ. Manag. 61, 786–795. https://doi.org/10.1007/s00267-018-0995-8.

van Rensburg, P., 2016. Overcoming global water reuse barriers: the Windhoek experience. Int. J. Water Resour. Dev. 32, 622–636. https://doi.org/10.1080/07900627.2015.1129319.

van Rijswick, M., Edelenbos, J., Hellegers, P., Kok, M., Kuks, S., 2014. Ten building blocks for sustainable water governance: an integrated method to assess the

governance of water. Water Int. 39, 725–742. https://doi.org/10.1080/02508060.2014.951828.

Velenturf, A., 2016. Analysing the governance system for the promotion of industrial symbiosis in the Humber region, UK. People Place Pol. 10, 146–173. https://doi.org/10.3351/ppp.0010.0002.0003. Online.

Velenturf, A.P.M., Jopson, J.S., 2019. Making the business case for resource recovery. Sci. Total Environ. 648, 1031–1041. https://doi.org/10.1016/j.scitotenv.2018.08.224.

Verbyla, M.E., Oakley, S.M., Mihelcic, J.R., 2013. Wastewater infrastructure for small cities in an urbanizing world: integrating protection of human health and the environment with resource recovery and food security. Environ. Sci. Technol. 47, 3598–3605. https://doi.org/10.1021/es3050955.

Webler, T., Tuler, S., Krueger, R., 2001. What is a good public participation process? Five perspectives from the public. Environ. Manag. 27, 435–450. https://doi.org/10.1007/s002670010160.

Williams, J., 2019. Circular cities: challenges to implementing looping actions. Sustainability 11, 423. https://doi.org/10.3390/su11020423.