12-2018

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Accepted version.
This paper was published as: van Welie, M. J., Cherunya, P. C., Truffer, B., & Murphy, J. T. (2018). Analysing transition pathways in developing cities: The case of Nairobi's splintered sanitation regime. *Technological Forecasting and Social Change, 137*, 259-271.
https://doi.org/10.1016/j.techfore.2018.07.059

Analyzing transition pathways in developing cities: The case of Nairobi`s splintered sanitation regime

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Abstract

Today`s rapid global urbanization highlights the need for long-term transformations of basic service sectors in developing cities in order to improve the livelihoods of the urban poor. Sustainability transitions frameworks have proven fruitful for addressing these sort of challenges. However, they have been at pains so far in accounting for the heterogeneity and complexities that typically characterize informal settlements in the Global South. We therefore propose a conceptual framework that extends the conventional analysis of socio-technical regimes by distinguishing the two levels of *sectoral regime* and *service regime*. Challenges for sustainability transitions may then be identified by missing alignments within and among the two regime levels. The framework is applied to the sanitation sector of Nairobi, Kenya, a city experiencing rapid population growth and a highly uneven provision of basic services. Drawing on a set of 152 in-depth interviews and five focus groups, the paper reconstructs the prevailing service regimes and shows how they suffer from misalignments and dysfunctionalities creating all sorts of problems at a sectoral level. We conclude that Nairobi's sanitation sector can best be characterized as representing a *splintered regime*. The paper concludes with a discussion of how the new conceptualization of socio-technical regimes suggests some new sustainable transition pathways and how this framework might also be instructive for transition challenges in cities of the Global North.

Keywords: socio-technical regime; service regime; sectoral regime; transition pathways; Global South; sanitation

1. Introduction

We are currently witnessing urbanization at a scale like never before. Fifty-four percent of the world`s population is living in cities and the urban growth rates are particularly high in the developing parts of the world, especially in Africa (UN-Habitat, 2016). Rapid urbanization creates huge challenges for city planners, who are not able to keep pace with the number of people moving into developing cities in search for work and life opportunities.[1] New city dwellers often end up impoverished, living in informal settlements without access to proper basic services and infrastructure, such as housing, safe drinking water and sanitation, solid waste management, reliable electricity and access to healthcare (UN-Habitat, 2004). Such circumstances demand long-term transformations to basic services and infrastructure such that the urban poor are able to improve the quality and resilience of their livelihood strategies.

In order to identify ways to improve service delivery to the urban poor, we maintain that a socio-technical system perspective offers a promising approach, one able to account for the socioeconomic complexities of basic service provisioning in developing cities while providing a means to analyse the dynamics of transition processes with respect to these (Markard et al., 2012). Particularly useful is the concept of a 'socio-technical regime' – the institutionalized set of rules in an organizational field related to actors, artefacts, and markets that governs the presence of basic services and which determines the pace and direction of transition processes (Fuenfschilling and Truffer, 2014; Geels, 2004). Regimes related to urban basic services are key determinants of their quality, accessibility, affordability, sustainability, and resilience in the face of rapid urbanization. As such, they provide a critical object of analysis through which one can understand the challenges to and possibilities for improvements to service delivery systems.

Much of the literature related to socio-technical regimes and their evolution is based on analyses in advanced industrialized countries and regions. In these contexts, basic service regimes are often uniform spatially, characterized by a dominant governing authority, and marked by consistent levels of quality throughout (de Haan et al., 2015; Fuenfschilling and Binz, Forthcoming). This is not the case in developing cities of the Global South[2], however, as recent applications of socio-technical transition frameworks have demonstrated (Ramos-Mejía et al., 2017). In such contexts, conventional

[1] With "developing city" we mean a city in a low-income (GNI per capita < $1.005) or lower-middle-income economy (GNI per capita $1.006 to $3.955). Kenya is a lower-middle-income economy (http://data.worldbank.org/about/country-and-lending-groups; accessed 5 February 2018).

[2] The terms Global North and Global South in this paper are not direct reference to the Northern and Southern Hemispheres, but applied to differentiate nations in terms of socio-economic capabilities and related characteristics. Global North are higher-income nations (with a GNI per capita > $3,956), while Global South are lower-income nations (GNI per capita < $3.955). For more discussions on these contested terms, see (Pagel, Ranke, Hempel, & Köhler, 2014). We also use "industrialized countries" in this paper interchangeably to refer to countries in the "Global North".

interpretations of socio-technical regimes are too simplistic given the complexity of basic service sectors and the highly uneven distribution of infrastructure in these cities (Fernández-Maldonado, 2008). For example, in urban East Africa multiple arrangements of actors, artefacts, and spaces coexist to meet the sanitation needs of residents (Letema et al., 2014).

Given the limitations, a reconceptualization of socio-technical system analysis is needed in order to enable the analysis of multiple co-existing regimes (Konrad et al., 2008b; Raven and Verbong, 2007). Such a reframing would take into account works that highlight the heterogeneity that exists in the basic service sectors of developing cities – such as the modernized mixtures approach (Letema et al., 2014; Van Vliet et al., 2014) and recent scholarship on the "splintering" of infrastructure services along socioeconomic, racial, gender, and other lines of difference (Graham and Marvin, 2001; Jaglin, 2008; Swilling, 2014). These perspectives acknowledge that large, centralized and homogenous infrastructures may fail to account for the present-day realities facing urban residents, and thus fail to offer realistic visions for sustainability transitions. Instead, service differentiation, spatial heterogeneity, and pro-poor distributions of services may be crucial strategies to achieve decent living conditions for the city dwellers (Botton and Gouvello, 2008). All told, sustainability transitions frameworks need to better account for the heterogeneity and unevenness of actually-existing socio-technical regimes in developing cities so that planners, policymakers, and donors might better develop alternative pathways to sustainability.

The goal of this paper is to make a conceptual contribution to the literature on socio-technical transitions. We propose a conceptual framework that seeks to overcome the limitations on extant regime conceptualizations, particularly related to highly heterogeneous contexts such as those in developing cities. We do so by re-conceptualizing socio-technical regimes at two levels: the level of service provision and the level of the sector. "Service regimes" form around specific institutionalized combinations of technologies, user routines and organizational forms for providing the service. An example would be the automobile regime as a means to provide personal mobility services. "Sectoral regimes" refer to the provision of broad societal functions like transport, food, safe urban water, electricity and so forth. In making this distinction, the goal is to provide conceptual space wherein the configurations of service options as well as the alignments between them are more clearly visible. Alignments, as in the complementarities of various services and smooth inter-operability between the different service regimes, increase the strength of the sectoral regime while making it more accessible to a diverse range of residents. As such, the mixtures of service options and their alignments might help to better understand prospective pathways toward future sustainable regime structures in developing cities and beyond.

We further argue that analysing the multiple service regimes constituting sectoral regimes in developing cities requires a grounded approach, one able to inductively identify these differentiations and their

characteristics. To do so, we draw on insights from practice theory (Jones and Murphy, 2011; Shove, 2004; Shove and Walker, 2010) in order to reveal the agencies, structural features, spaces, times, social interactions, and material factors that constitute differentiated service regimes and which make them more or less aligned within the context of sectoral regimes. We deploy the conceptual framework through an analysis of sanitation supply, demand, and use practices in a developing city (Nairobi, Kenya). Our analysis reveals the differentiated service regimes that constitute the city's sanitation (sectoral) regime, the strength of their alignments both internally and with respect to other service regimes, and the obstacles that service providers and consumers/users face in making transitions toward sanitation regimes that provide higher quality, sustainable, and more justly distributed services.

The case of Nairobi's sanitation sector is well suited to demonstrate the value of this approach. The city is facing significant infrastructure challenges as it rapidly grows and the gap between the rich and the poor has become increasingly extreme in recent years. Adequate provision of sanitation services is a fundamental challenge to the city`s inhabitants, and a major task for city officials, especially in the informal settlements where 36% of Nairobi`s population lives (Mansour et al., 2017). The highly uneven spatial differentiation of sanitation configurations was initiated during the colonial period of residential segregation and it has become more pronounced and complicated during the era of neoliberalism (Nyanchaga and Ombongi, 2007). The sanitation sector today is characterized by a high variety of access options and conditions, multiple providers, different institutional arrangements, different spatial structures and user practices, and complex formal and informal governance structures (Juuti et al., 2007; van Vliet et al., 2013). Complicating matters further is the fact that different sanitation configurations are operated within single geographical areas and residents typically use more than one configuration in the course of their day. To describe these complexities our analysis draws on semi-structured interviews with experts from the sanitation sector, direct observations, and focus group discussions with residents collected by two of the co-authors over a five-month period in 2016.

The paper is structured as follows. In the next section, the literature on transition studies of infrastructures and basic services in developing cities is reviewed followed by a discussion of the relevance of practice theory for socio-technical regime analysis. We then introduce a conceptual approach to identify regime structures in developing cities` basic service sectors. The framework is then applied to the case of Nairobi`s sanitation sector. The results identify the variety of service regimes which coexist in the sanitation sector in Nairobi. The final sections discuss the implications of these findings for sustainability transitions in Nairobi and highlight the broader relevance of the conceptual approach for transitions studies in general.

2. Sustainability transitions in developing cities: Basic services and their heterogeneity

Basic service sectors can be understood as socio-technical systems consisting of (networks of) actors and institutions, as well as material artefacts and knowledge (Markard et al., 2012). In order to understand the dynamics of socio-technical systems, the concept of socio-technical regimes is used to analyse the logic and direction for incremental socio-technical change along established pathways of development (Markard et al., 2012). An adequate understanding of a socio-technical regime in a developing city is an important starting point to identify potential future transition pathways of a basic service sector. However, sustainability transition research has only recently started to focus on the Global South, while the origins of transition research are based on empirical cases in industrialized countries. The recent increase of empirical applications in the Global South is challenging the conventional notions of transitions frameworks (Ahlborg, 2015; Byrne, 2011; Murphy, 2015; Ramos-Mejía et al., 2017).

Some previous transition studies recognize the complexitiy of regimes in the Global South. Sengers and Raven (2014) note that diverse (informal) services characterize the urban transport regime in Bangkok and van Eijck and Romijn (2008) state that the energy regime in Tanzania consist several or sub-systems that can be separate regimes on their own. However, these studies lack an explicit analysis of how these diverse socio-technical structures constitute a regime. Other studies do not specifically mention the diversity of regimes in their cases in the Global South, but apply a rather highly aggreagated understanding of what a regime could be: the "energy/power regime" in India (Verbong et al., 2010) or the "energy regime" in Malaysia (Hansen and Nygaard, 2013) to just name a few. Lastly, several studies have predominantly focussed on niche growth and diffusion of new technologies in the Global South without elaborating how the regime looks like towards which these developments could contribute (Blum et al., 2015; Kamp and Vanheule, 2015; Tigabu et al., 2015a).

2.1 Heterogeneity of basic services in developing cities

Although sustainability transition research has not extensively dealt with urban contexts in the Global South, much can be learned from other literature on basic services and infrastructures in developing cites (Kooy and Bakker, 2008; McFarlane and Rutherford, 2008; Ranganathan, 2014; Rutherford and Coutard, 2014). These works reveal the material and political challenges associated with potential transition pathways and highlight the inadequacy of extant transition frameworks for understanding the complexity and heterogeneity of basic service regimes and identifying potential transition pathways in the short-to-medium term. Negative or unsustainable urbanization pathways are often associated with the "splintering" of urban infrastructures and basic services along class, gender, or ethnic lines which can create extreme inequalities with respect to public utility access and social services (Amin and Graham, 1997; Graham and Marvin, 2001; Jaglin, 2008; Swilling, 2014). Such intra-city differentiations

occur when there is insufficient redistribution or investment in infrastructure and social services such that the poorest urbanites and recent migrants are forced to rely on informal, *ad hoc*, inefficient, and/or low-quality alternatives in order to meet their basic needs. Splintering processes undermine the "modern infrastructural ideal" of ubiquitous, monopolistic, integrated and standardized networks of service provisioning, which was common until the 1960s; serving as a regressive development dynamic that have driven the withdrawal of the State from urban planning decision-making processes.

Perhaps most significantly, the splintered urbanism literature highlights the heterogeneity, spatial unevenness, and complexity of basic services in most cities, regardless of whether they are developed or developing. While Coutard (2008) argues that there has never been a modern infrastructure ideal in many contexts, this is especially true in developing cities (Kooy and Bakker, 2008). Rather than there being a short-term potential for a universalized ideal of service provision, there will be a persistent pattern of differentiation of services. As such, one should be wary to view such a city with a "Northern lens", and to instead be sensitive to coexisting systems of basic services (Bakker et al., 2008; Furlong, 2014; Kooy and Bakker, 2008).

Beyond the splintered urbanisms literature, the modernized mixtures approach also acknowledges the diverse governance structures in service provision and links them with the institutional and technological diversities, thereby moving away from the binary about technology and management as either being centralized or decentralized. Building on socio-technical approaches for sustainable provision of services, the approach conceptualizes urban infrastructures and services as an interplay of spatial, social and technical dimensions, capturing the various possible combinations of actors and technologies other than only large centralized networks (Van Vliet et al., 2014). It argues that multiple regimes can operate in a single geographical area (Letema et al., 2014), such as a city, where they are embedded in the different socio-spatial contexts found in close proximity.

In sum, the literature highlights intra-urban differentiations of basic services and infrastructures in developing cities, demonstrating the ways in which these are spatially constituted and geographically embedded despite being co-located in a single city. We argue that this heterogeneity should be taken seriously as a means to advance a more geographically sensitive transition approach; one that deploys a place-sensitive analysis of the everyday practices through which people from different neighbourhoods, genders, classes, ethnic groups access and provide infrastructures and services. An alternative framework for a socio-technical regime analysis of a basic service sector in a developing city should be able to identify multiple co-existing regime structures and detail the contextual diversities they are embedded in, resulting from spatial unevenness (Murphy, 2015; Truffer and Coenen, 2012). Doing so will require extensions to the conventional understanding of socio-technical regimes and their evolution. We thus follow Fuenfschilling and Truffer (2014) and recognize that the co-existing regimes

may have different strengths based on their degree of institutionalization. Additionally, we draw on insights from practice theory (Jones and Murphy, 2011; Shove, 2004; Shove and Walker, 2010), to use the everyday practices of users and providers of basic services to create a coherent, grounded, and spatially sensitive framework to analyse transition pathways of the regimes.

3. Conceptualizing and analysing heterogeneous regimes

A framework for a transition analysis of basic services in developing cities needs to embrace the diversity of social and technical structures present, in order to identify potential transition pathways towards more sustainable socio-technical systems. It should also be open for a variety of potential end-points of transitions, and identify what systemic problems hinder these processes. Besides highlighting structural conditions, the framework should account for agency, and be sensitive to the specificities of the broad variety of geographical contexts that are typical for many developing cities.

We maintain that such a framework can be developed by building on the concept of socio-technical regimes, but we have to differentiate the extant interpretation by explicitly distinguishing two levels: "service regimes" and "sectoral regimes". Service regimes form around specific institutionalized combinations of technologies, user routines and organizational forms for providing the service. An example would be the automobile regime as a means to provide personal mobility services. Sectoral regimes refer to broader economic and societal realms (or organizational fields) that cover a societal function like transport, food, safe urban water, electricity and so forth.

Our concept of service regimes is very similar to the term socio-technical regimes as applied in most of the transitions literature. We prefer the term service regime because our concept highlights the specific aspects of everyday life that are often overlooked in socio-technical regimes research. The concept of sectoral regimes has been less consistently addressed in the extant literature. Many studies merely refer to the broader "sector" or "domain" where specific socio-technical regimes are embedded (e.g. the transport sector, when the analysis deals with the automobile regime or the "electricity sector" in studies about wind power). In some studies the sectoral context was claimed to constitute the broader socio-technical system in which the regime is embedded (Geels, 2004). In sectors that are dominated by specific socio-technical configurations, scholars have claimed that the two levels are identical, for example in the transport domain, the automobile regime is used as the dominant regime in an assessment of the transition to low-carbon transport systems (Geels, 2012). Others proposed that delimiting different hierarchical levels would be a pure question of the specific analytical interest of the researcher (Geels and Schot, 2007). Only very few scholars have endeavoured to elaborate regime structures at and between different levels of abstraction (Konrad et al., 2008a; Raven and Verbong, 2007).

In most cases, a hierarchical relationship exists between service regimes and a specific sectoral regime. The latter will typically consist of various service regimes. E.g. the personal mobility regime (sectoral level) typically consists of more or less aligned service regimes related to i) the automobile, ii) busses and trams, iii) bicycling, iv) trains and v) pedestrian mobility forms. Each one of these service regimes consists of coherent and institutionalized arrangements of technologies, infrastructures, regulations, symbolic meanings, user routines and public discourses. And all of them interact with each other at the sectoral level to provide the specific services in a more or less seamless way. In the following, we first describe our approach for studying regimes based on practice theory. We then specify the different components that constitute service and sectoral regimes, describe how we assess the strength of these regimes.

3.1 Analysing regimes: A practice-oriented approach

Before unpacking service and sectoral regimes conceptually, it is important to highlight the epistemological/methodological strategy that we apply to their analysis. Our approach focuses on the everyday practices that consumers and suppliers employ in the use, provisioning, maintenance, etc. of basic services.[3] Practice theory has been applied to socio-technical transitions research but the conceptualization and delineation of practices and their constitutive elements is sometimes underspecified (Cohen and Ilieva, 2015; McMeekin and Southerton, 2012; Shove, 2010; Shove and Walker, 2010). The contributions of these studies are significant and helpful, but we think that practice theory can be deployed more productively, specifically to identify key features that stabilize regimes and/or offer points of intervention not otherwise visible through a focus on technological artefacts or individualized behaviours.

Following Jones and Murphy (2011, p. 367), we define practices as the `stabilized, routinized, or improvised social actions that constitute and reproduce economic space, and through and within which socio-economic actors and communities embed knowledge, organize production activities, and interpret and derive meaning from the world`. Practices are constituted, enabled, and shaped by behaviour patterns, performances, perceptions, power relations, materials, and the time-space contexts where they are normally carried out. While the precise details of each of these elements may vary by individual, there are generalizable trends that mark and differentiate service regimes. In order to discern these elements and their differentiations, our approach examines the practices associated with particular combinations of technologies, user/supplier routines, organizational forms, and shared meanings in

[3] Following Giddens (1979; 1984), Bourdieu (1980), de Certeau (1984), Wenger (1998), Reckwitz (2002), Schatzki (2005), and others, practice has been of interest to social scientists, particularly those striving to navigate between individualist and structuralist explanations for how institutions, organizational fields, firms, and other socioeconomic phenomena function, reproduce themselves, become embedded in particular contexts, and change over time.

order to construct generalized heuristics or models of service regimes. The focus on practices allows us to identify service regimes such that we can then determine how, why, where, and how strongly they are embedded in the city.

3.2 Service regimes

We consider a specific configuration of technologies and their associated user and provider practices as a *service regime*. A stabilized service regime is marked by routinized practices that may be difficult to change once established. This stability is caused by various processes and patterns, like the reproduction of professional routines such as shared protocols about how to install water pipes or connect households to the electricity grid, or when there is a clear division of roles and responsibilities among service providers in a well-established value chain. Additionally, service regimes may be stabilized through shared understandings about how, when and where to provide and use a basic service. An example is the structured habit of households putting their old paper waste at the street in countries like Switzerland on a weekly basis, for regularized waste collection. Providers and users know when, where and how to arrange this service of picking up old waste paper. In more specific terms, we conceptualize the processes and patterns associated with service regimes along five basic dimensions that we reveal through an analysis of sanitation servicing practices: infrastructure and artefacts; organizational mode; time and space; rationale/meaning; and social interaction. When these dimensions are aligned with one another a stabilized service regime comes into being. These dimensions are:

(1) *Infrastructure & artefacts*: artefacts are physical material entities (Shove et al., 2012) such as toilets, water taps. Infrastructures are physical structures that enable the functioning of collections of artefacts (Shove et al., 2015), for example water pipelines, or electricity lines.

(2) *Organizational mode:* an organizational mode is a group of actors with complementary strategies and a particular set of capabilities and procedures to fulfil the provisioning of basic-services. Within a certain organizational mode a group of actors typically have a shared understanding about the hardware and services they provide. A core practice in the organizational mode concerns operating and maintaining the artefacts and infrastructures, i.e. all the activities that are required for the day-to-day running of a basic service facility and its long-term regular maintenance. Specific forms of expertise and "competence" (Shove et al., 2015) are important preconditions for operations to be carried out successfully.

(3) *Time and space* are the "when? why then?" and the "where? why there?" of accessing basic services (Jones and Murphy, 2011). Operations and services of providers, as well as everyday operational activities of users, are performed within or in relation to particular times and spaces. Basic services are operated in specific spatial locations and the timing for access is regulated.

(4) *Rationale/meaning*: the mental activities, emotions and motivational knowledge, which represent social and symbolic significance of participation, or doing something, at any one moment (Shove et al., 2012). They enable for an understanding of an actor`s role and expectations, and the rules, both formal and informal, that govern the provision and access to a basic service.

(5) *Social interaction*: the contact and exchanges between people as they are enabled/scripted by specific artefacts. Through social performances, one can identify the social roles, rules, power asymmetries and intentions (Jones and Murphy, 2011). Social interactions form an important enabling or hindering factor for users` access to basic services and for providers to maintain regular practices, because they can lead to mutual understanding, trust building, social capital and help to identify roles and identities.

These five dimensions of a service regime may be (mis)aligned with each other to a higher and lesser degree, and by this determining the strength of the regime. Alignments at the service regime level are determined by the complementarities between different service regime dimensions. Alignments between rationale/meanings and time and space dimensions of a service regime would, for example, result from a shared understanding among the users and providers about their roles and the timing and location of a provided service/artefact. Such alignments create mutual trust among users and providers and stabilize the service regime. Another example would be when artefacts are aligned with users` preferences such that the service is more accessible given resource, mobility, and capability constraints.

In contrast, misalignments occur when there is a lack of complementarity among the dimensions. For example the provision of a service that does not fit the expectations and wishes of the users, because of the type of infrastructures that are used. Another misalignment can be an inconvenient location to access the service, or a complex organizational mode that leads to misunderstandings or conflicts about the expected roles of users and providers. Typically in the course of service regime maturation, socio-technical configurations will become increasingly aligned internally. This is the process that is commonly described in manifold niche maturation accounts and the historical reconstructions of regime emergence (Geels, 2005; Raven and Gregersen, 2007).

In addition to the alignments between the dimensions, the strength of a regime and its degree of institutionalization depends on how widely diffused and taken for granted certain characteristics of the regime are, how long it has been in place, and to what degree it is contested by different societal actors (e.g. because of being exposed to conflicting institutional logics) (Fuenfschilling and Truffer, 2014, p. 777). A service regime is stronger when there is a shared consensus about the technical design, while a service regime that inhabits various heterogeneous designs will be less persistent and less strong. A service regime is strong when large populations of providers and users take it for granted.

Importantly, the service regime needs to fit with the manifold external structures and local contexts where it is situated, which also determines its strength (Bergek et al., 2015; Fuenfschilling and Truffer, 2014). A strong service regime will in general be in congruence with the major social, geographical and technological requirements that often coincide with so-called landscape forces (Geels and Schot, 2007). The better this fit, the more stable a service regime will be. Beyond landscape fit, an effective service regime also has to fit in with or be embedded in sometimes complex local contexts (Bergek et al. 2015). Because local conditions may vary quite substantially within close spatial distances, generic service regimes need to be adapted and modified such that they can function effectively in a wide range of contexts. To do so, a regime has to fit the heterogeneous practices, competences, beliefs and routines, and the physical conditions that mark a particular location.

All said, service regimes may be ranked regarding their strengths. On the one extreme we may witness very well established internal alignments, a good fit with contextual requirements (local or landscape factors) and a low level of contestation by different actors. However, service regimes may also show deficiencies in one or several of these dimensions and thus appear as being only semi-coherent (Fuenfschilling and Truffer, 2014; Geels, 2004). They may exhibit only partial alignments, be it in contradiction with rapidly changing and/or locally specific external conditions or being contested by powerful actors. At the other extreme we may witness very weak service regime structures, where several of the dimensions are not well established yet and alignments are poorly developed or even creating tensions. We therefore propose to conceive regime strength as a gradient that varies from uncontested dominant regimes towards weakly structured, newly emerging regimes (which may under certain conditions equal emerging niches). By this we aim to overcome a binary depiction of the relationship between regime and niches and to capture, conceptually, the heterogeneity of service regimes in developing cities (Fuenfschilling and Truffer, 2014; Geels, 2011; Smith et al., 2005).

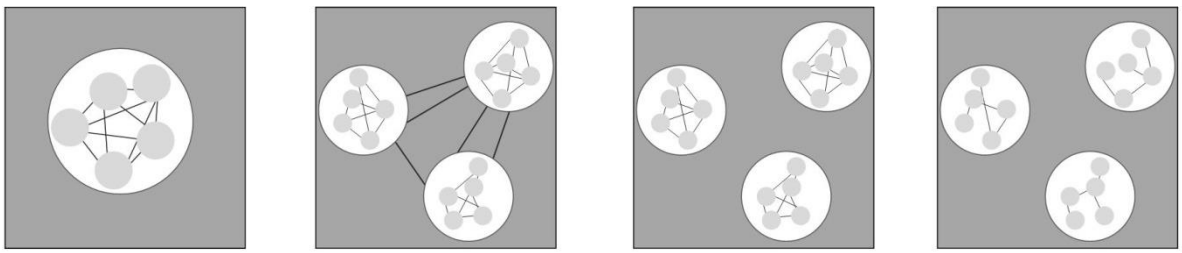
This conceptualization immediately begs the question of how the strength of particular regimes relates to negative outcomes or externalities. Negative outcomes can affect society as a whole or hamper the functioning of other sectors (environmental pollution or high costs for accessing or providing a basic service), and can also lead to local conflicts and frictions with prevailing social or economic structures (low acceptance of a technology or shame when using a basic service without privacy). Weak service regimes can generate negative outcomes mainly through poor quality of service delivery or misalignments with other services and infrastructures. But also strong service regimes, can cause substantial social, economic, or environmental problems. (e.g., fossil fuelled power plants contributing to global warming). While positive externalities can help to further stabilize a service regime, negative outcomes do not inevitably destabilize them as long as internal alignments and fit connections with other contextual factors remain strong (e.g. fossil fuel prices remain affordable through subsidies).

3.3 Sectoral regimes

Sectoral regimes typically encompass several service regimes. A sectoral regime is characterized by alignments or misalignments between the different service regimes. Alignments at the sectoral level are a function of the complementarities between various services and inter-operability between the different service regimes. Well-aligned sectoral regimes typically ensure that: (1) users have access to a combination of different complementary and matching service regimes; (2) infrastructures which are used in the different service regimes complement each other and are connected by appropriate interfaces; (3) providers in different service regimes complement each other's competences and offerings; and (4) sectoral regulations are in place to warrant the smooth inter-operability between the different service regimes. Misaligned sectoral regimes instead may correspondingly suffer from one or several problems: (1) inefficiency in service provisioning in the different service regimes (e.g. basic service providers are not complementing each other in order to improve their services); , (2) physical infrastructures that could align the different service regimes are absent; (3) the differentiated needs of users can only be met through the users' own efforts to actively find a way to meet their daily basic needs; and (4) regulations or policy actors do not recognize all the service regimes that exist (e.g., marginalizing certain practices) and/or are not supportive of novel service regimes.

This leads us to propose four basic configurations of sectoral regimes (Figure 2):

- *Monolithic regime*: a sectoral regime consisting of one dominant service regime.
  For example: urban water management in countries like the Netherlands and Switzerland, where the dominant service regime takes up about 95% of the service structures in the sector.
- *Polycentric regime*: a sectoral regime that consists of several service regimes. At the sectoral level, the different service regimes are well-aligned with each other.
  For example: transport in the Netherlands, where the service regimes of automobile, biking and public transport exist in parallel and are well-aligned because physical infrastructures for bicycles exist, and both formal and informal rules of using the physical road infrastructures for biking and driving a car are in place.
- *Fragmented regime*: a sectoral regime that consists of several service regimes, however at the sectoral level the service regimes are misaligned.
  For example: transport in most parts of the US, where the regimes of automobile and biking exist in parallel but where physical infrastructures for bicycles and sector standards for managing bicycles on the roads are often missing or unevenly distributed.
- *Splintered regime*: a sectoral regime that consists of several service regimes that are partially aligned internally. At the sectoral level the service regimes are misaligned.
  For example: many basic service sectors in developing cities.



Monolithic regime Polycentric regime Fragmented regime Splintered regime

Figure 1 Four typologies of sectoral regimes - sectoral regime (grey square), service regimes (white circles), dimensions of service regimes (grey circles), alignments (lines)

3.4 Transitions in sectoral regimes

In dynamic terms, the sectoral regime typology enables the identification of alternative future configurations towards which a sectoral regime could transition. Transitions have been defined as "changes from one socio-technical regime to another" (Geels and Schot, 2007, p. 399). However much of the literature focused on transitions from one dominant regime to an alternative one. According to our framework, we may identify a variety of end-points that a transition could lead to. For example, transition processes can be characterized by improvements of the alignments between the service regimes in the sectoral regime. Service regimes can become better aligned, whereby a sectoral regime transitions from a splintered to a fragmented or polycentric regime. Obviously, all sorts of partial trajectories, or different transition pathways (Geels and Schot, 2007) are possible as well and these can lead to various different end-points of a transition.

The different transition end points cannot be ranked a priori in terms of their sustainability performance. A splintered regime for instance is typically associated with many negative outcomes in a developing city such as limited access to basic services for users, or non-organized and unproductive competition between alternative service providers. A fragmented regime may equally show negative outcomes due to misalignments between the different service regimes. However, polycentric and monolithic sectoral regimes may also be riddled with negative environmental, economic or social externalities. A centralized approach to urban water management may for instance lead to excessive waste, pollution, and costs when compared to a polycentric regime which allows decentralized service regimes to coexist and serve specific user segments. The analysis of sectoral regime typologies can help to identify a broader range of future end-points of transition process compared to the conventional view.

To summarize, the framework provides a conceptual approach for mapping diverse basic service structures present in a developing city and to specify alternative transition pathways. This approach can be instructive for researchers, policy makers, and practitioners for systemically identifying barriers to sustainability transitions in a specific sector. The framework differentiates between problems of

misalignments within service regimes, such as too high costs for accessing or providing a basic service, and misalignments between service regimes at sectoral level, which for example lead to coordination problems between basic services.

4. Methodology

The empirical analysis of this paper is based on qualitative data collected through interviews and observations during two stays in Nairobi the first one between February and March and the second one between September and December 2016. In the first stay, two of the co-authors conducted a total of 49 semi-structured interviews with a diverse range of actors within the sanitation sector. In the second period, we conducted 152 further interviews that went deeper into aspects of practices. Relevant people in government agencies, the local government, Non-Governmental Organizations, international agencies, sanitation enterprises, formalized and non-formalized sanitation service providers, individual inhabitants were interviewed (Table 1). We selected the interviewees based on their knowledge about - and experience with the sanitation sector, and through snowball sampling. Additionally, we conducted five focus groups in informal settlements with women community groups. We combined these focus group discussions with visits to the homes of 32 residents in three informal settlements to discuss and observe their living conditions and their everyday domestic practices. Lastly, we analysed relevant documents such as policies and action plans, as well as available literature on sanitation access and provisioning in Nairobi.

We were interested in developing an understanding of user and provider perspectives and practices in the sanitation sector in Nairobi in order to be able to reconstruct distinct service regimes and to understand and document the alignments and strengths of the city's sanitation sectoral regime. The data collection was guided by the current user, provider and governance situation of sanitation in Nairobi, and important historical developments, which led to this situation; developments and innovations taking place; and the actors` perceptions of the future of the sector. We continued the interviews until no major new information about the sector`s situation emerged.

All interviews were recorded, transcribed and coded using the qualitative data coding software MAXQDA 12. The coding process led to an extensive coding scheme covering the major characteristics, developments, challenges and future predictions of the sanitation sector in Nairobi. This organized data was used in an iterative process, together with information found in literature, to develop the conceptual framework. Thus, in the development of the framework both inductive and deductive thinking were applied. In the section that follows, we deploy these data and this analysis to reconstruct how Nairobi's sanitation sector can actually be characterized as a splintered sectoral regime.

Table 1. Overview interviews

Interviewees
Governmental agencies (22)
Local government (11)
Non-Governmental Organizations (36)
International agencies (8)
University (1)
Enterprises (17)
Sanitation waste collectors (7)
Key local informants in informal settlements (18)
Residents of informal settlements (32)
Focus group discussions (FGDs) (5, with 8 to 10 participants in each)

5. Nairobi`s splintered sanitation regime

5.1 Identifying the set of service regimes

Through the analysis of practices and the study of secondary data, we identified five service regimes that operate in Nairobi. For this we characterized the core dimensions of each of these. The five service regimes vary greatly in one or more of their dimensions: (1) The domestic sewer regime, encompasses a flushing toilet used by one household, connected to the sewer system which is provided and operated by the utility. (2) The shared on-site sanitation regime encompasses a shared on-site toilet located either inside a plot or off-plot. It is shared by multiple households and mostly provided and installed by the landlord of the plot or by an NGO. (3) The public sanitation regime consists of toilet services in public places which provide pay-per-use services. They are mostly operated by Community Based Organizations (CBOs) or by private enterprises. (4) The coping sanitation regime, denotes practices of people to relieve themselves in their homes using improvised domestic items or defecation in the open. Finally, (5) the container based regime consists of toilets equipped with containers or biodegradable bags to collect the faeces and the urine. The containers or bags are regularly collected and the waste is normally treated and the resulting sludge is re-used. Container-based services function as a public pay-per use or as in-home toilets, and are provided by social enterprises. The core dimensions of the five service regimes are summarized and compared in Table 2.

Table 2. The detailed dimensions of the service regimes

	infrastructure & artefacts	rationale & meaning	social interaction	organizational mode	time & space
domestic sewer regime	central sewer system + (pour) flush toilet	- users: comfortable, good image, costly, consumes too much water - provider: sanitation using high quality modern technologies	none	- daily maintenances by households - waste management by utility	- timing users: anytime - location: inside the house or on the plot
shared on-site regime	latrine + pit or septic tank	- users: accessible, convenient, low costs, dirty conflicts among households - provider: arranging sanitation for tenants	coordinating access and cleaning among households	- organized by landlords or NGOs - daily maintenance by households - waste management by manual emptiers or private exhauster trucks	- timing users: anytime when on-plot and only during the day-time when off-plot - location: off-plot or on-plot
public sanitation regime	- latrine + pit or septic tank - bio- & compost latrines - hanging toilet - central sewer system + pour flush toilet	- users: convenient, costly, dirty, risk of diseases, insecure during the night - provider: business opportunity	- trust building: being a "customer" - everyday interaction between operator and user	- daily commercial operations by CBO, NGO or enterprise - waste management by manual emptiers, private exhauster trucks or utility	- timing users: during the day when user has money - location: commercial areas, public residential, hanging over a river
coping sanitation regime	cleaning bucket, plastic bag	convenient option, no costs, useful in the setting of informal settlements, shameful, indignity, bad smell, done secretly, dirty, risk of diseases, insecure, acceptable for children	coordination within the family, being accompanied by others	- organized by households and individuals - no safe disposal of the waste	- timing users: anytime - location: inside the house, close to the home, around shared toilets, at open defecation hotspots (rivers, bushes)
container based sanitation regime	waterless system with urine diversion, biodegradable bags, containers	*As in-house service* - users: convenient, indignity, not appropriate for adults, culturally unfit & uncomfortable for men, useful for children, useful at night *As public service* - users: convenient, costly, risk of diseases - provider: environmental friendly sanitation, creating value from recycling waste	*As in-house service* - coordination within the family *As public service* - trust building, being a „customer", a lot of interaction between operator and user	*As in-house service* - daily operations by household - enterprise collects the waste and re-uses it as fertilizer, biogas, animal feed *As public service* - daily commercial operations by enterprise - waste is collected and re-used as fertilizer, biogas, animal feed	*As in-house service* - timing users: anytime, especially at night - location: in-house toilet *As public service* - timing users: during the day when user has money - location: public locations: commercial areas, public residential

The different service regimes show quite high levels of institutionalization of their core elements and varying degrees of internal alignment. In the following, we will illustrate major examples of how the different alignments play out in each service regime. The *domestic sewer sanitation* regime is

characterized by the internationally established dominant design of sewer technologies for domestic use. The service regime is internally well-aligned. The dimensions fit well together, for example the operational aspects are neatly aligned with the shape and positon of the artefacts, for example the installed water meters that measure the water consumption (the water that is also required for flushing toilets) are easy to reach for meter reading or repairing:

> *„…they (utility staff) are dealing with areas which are well organized. And the issues are clear such that if you would want to disconnect a meter in a formal area, it is easy for you to find that meter."* (Utility officer)

The rationale of the utility is to deliver a high quality and modern service, and the users perceive this service as comfortable. The organizational mode and infrastructure thus align well with the users` perceptions and meanings:

> *"The good thing about having a sewered option is because they are cemented* (thus clean) *and also they have flush-water inside the toilet* (so you do not have to carry yourself)" (Informal dweller 1)

The regime is strongly embedded in certain (mainly higher-end) neighbourhoods of the city but does not fit well with the material and socio-spatial conditions faced by the majority of residents in the informal settlements.[4] Insecurity of tenure and low economic capabilities in informal areas, for example, have limited investments into sewer systems by dwellers:

> *"I would have really liked to connect my house with a sewered toilet, but I think to myself – what if I invest then the government decides to resettle me somewhere else?"* (Informal dweller 1)

All-in-all this is a strongly institutionalized and persistent service regime in certain areas of the city, because the dimensions align well among each other. Additionally, it is strengthened through ties to the international networks and actors associated with the global sanitation sector and their preference for large-scale centralized infrastructure (Fuenfschilling and Binz, Forthcoming).

A second common service regime is the *shared on-site sanitation regime*. This regime is characterized by sanitation options that are not connected to the centralized sewer system, but that are constructed as pit latrines or toilets connected to a septic tank. Landlords typically provide this service to their tenants. Alternatively some community groups install these toilets with the help of NGOs and provide maintenance. Several households typically share such a toilet. Manual pit emptiers and exhauster trucks

[4] Estimates of the percentage of Nairobi`s total population that is connected to the sewer vary (48% or 66%) (CCN, 2007; UN-Habitat, 2016), as well as for the percentage of Nairobi`s informal settlements population that is formally connected to the sewer (10% or 12%) (CCN, 2007; Gulyani et al., 2006). Additionally, these estimates do not only include domestic connections, but also sewer connections to public and shared toilets. The exact percentage of households that have a domestic sewer connection is thus unknown, but we estimate it to be lower than these numbers.

are hired to periodically remove and manage the waste. This is a well-aligned aspect of the organizational mode in this service regime, as a Water Sanitation and Hygiene (WASH) coordinator of an NGO explains about the situation in the informal settlements:

> *"…they* (residents) *normally opt for the manual pit emptiers to exhaust because they are affordable and they are easily reachable"*

Also the social relationships between the landlords and tenants are well-developed and relatively well-aligned with the organizational aspect of hiring exhauster services:

> *"When the toilet needs to be exhausted, the landlord is responsible. He pays for the service (…) when the landlord delays we contribute towards the services as tenants, since we have a plot representative. He will inform the landlord and the amount will be deducted from the upcoming rent"* (Informal dweller 2)

Despite the fact that waste management is well organized in practical terms for users, it has a negative effect on the environment, because many manual pit emptiers dump the waste in rivers. Shared on-site toilets are widespread in the informal settlements, because the service is compatible with the lack of space in these areas[5]. As well in low-income residential areas with high-rise buildings, the service regime is widespread. The service is compatible with low-income housing arrangements in plots and in high-rise buildings where shared facilities are cheaper. The timing and location of this service regime are also matching well with the expectations of the informal settlements` residents. A focus group of women living in one of the informal settlements of Nairobi noted that they perceive shared toilets to be ideal as its location within a gated area makes it secure to visit any time of day or night (FGD1). This service regime is also institutionalized because of the use of simple technologies that are affordable, especially in comparison to sewer connected toilets, as a WASH advisor of an international NGO explains:

> *"…it is not easy to have those* (sewer) *connections, so in a way that was a major reason why they* (residents of informal settlements) *would go for onsite sanitation solutions."*

Some misalignments in this service regime derive from the fact that users often perceive the infrastructure as dirty and because conflicts can arise among the households about the maintenance aspect of the organizational mode. In a focus group discussion with women (FGD1), they noted that cleanliness is sometimes a challenge in shared toilets because it is difficult to agree on a protocol for maintenance among many people. All-in-all, because of several well-aligned and a few misaligned

[5] In two of Nairobi`s large informal settlements (Mukuru & Kibera) 50% of the households share a latrine with other households (O`Keefe et al., 2015). We would like to emphasize that informal settlement`s residents often use more than one option every day.

dimensions within the service regime, and the fit with the local context, this is a strong and persistent service regime in the informal settlements and suburban areas of Nairobi.

Another persistent service regime is the *public sanitation regime*. This service regime is characterized by sanitation services that are offered in public places. Several different artefacts and infrastructures are used to provide public sanitation services in Nairobi, from pit latrines to pour flush toilets that are connected to the sewer. This service regime is historically found in many commercial neighbourhoods and the city centre of Nairobi (Ngugi and Ndegwa, 1992; Njeru, 2014). Additionally, today this service regime is widespread in informal areas where public services are used by many people as an important daily sanitation option.[6] Despite the important role of this service regime in informal settlements, the timing, location, and cost of these services are often misaligned with the realities facing users, thus forcing them to rely on adaptive and coping strategies (see below) to fulfil their needs. As a founder of a social-enterprise and a resident explain:

> *"… most people who are using it have to walk, maybe half a kilometer or something to get there. Maybe it's right around the corner but the majority of the users are going to come from further…"*

Sometimes the services are perceived as costly:

> *"Public toilets are very costly. If you calculate the cost for large family like mine on a monthly or annual basis it's a lot of money (…) this competes with other domestic needs like food so we often opt for coping strategies"* (Informal dweller 3)

At the same time, various providers profit from this regime. The public services are run by a diversity of actors, among others, private enterprises, CBOs and Non-Governmental Organizations (NGOs). As such public sanitation services provide a business opportunity for community members in informal settlements that form CBOs that operate public toilets.

> *"Public toilet groups give opportunities for jobless youths to earn an income (…) they saw the opportunity to provide better management of the toilets and the users were happy because the toilets became cleaner*" (Informal dweller 4)

Also some community members consider public toilets ideal because many users lack land tenure rights and hence would not want to invest in private toilets. There is a risk that they are relocated because of insecure land tenure.

[6] In two of Nairobi`s large informal settlements (Mukuru & Kibera) 45% of the population use pay-per-use facilities (O`Keefe et al., 2015). We would like to emphasize that informal settlement`s residents often use more than one option every day.

"I am fine with the public toilet. What if I build a private one then eventually I am relocated? I will waste a lot of money" (Informal dweller 1)

All told, despite several misalignments in the public sanitation regime, it remains relatively highly institutionalized because the services are widespread, match the context conditions for majority of city dwellers without tenure rights, and are perceived a business opportunity by community groups.

In the absence of public, domestic or shared sanitation services in certain areas of Nairobi, mainly in the informal settlements, people have developed coping strategies to relieve themselves[7]. These services constitute the *coping sanitation regime*. Different coping strategies are practiced, for example, using a bucket or a plastic bag inside the house or open defecation. These services are organized by individuals themselves in the informal settlements, in order to have a low-cost and safe sanitation solution. This service regime is highly institutionalized, because of several well-aligned dimensions. For example people in the informal settlements perceive these practices as normal strategy to manoeuver the lack of other alternatives, despite the fact that they think that it is undignified and unhygienic. A WASH advisor of an international NGO explains:

"…If you look at the social norms perspective, it`s accepted. If you go in a nice park and really defecate there people would not dare to do that, as nobody is doing it. That's the kind of perception, like I cannot do it here. But, if you go to the urban areas you go to this corner that corner, there is so much of dirt here and there so they feel like everyone is doing it, well I can do it."

Practices associated with coping strategies, like having specific hot-spots for defecation or a popularly adapted practice known as "flying toilets"[8] become commonplace - as coping is compatible in regard to timing – used at night when other public toilets are closed and people do not dare to go out because of insecurities (FGD1). All-in-all these alignments and fit with the local context result in a relatively strong coping sanitation regime.

The fifth regime observed in Nairobi - the *container-based regime* - is based on (urine-diverting) dry toilets. This regime has gained legitimacy among international development donors in recent years as an attempt to break with the stagnant situation of the failure of existing options to serve all the millions of people in informal settlements during the last several decades. In Nairobi, this service regime is initiated by international enterprises who provide dry sanitation services such as urine diversion toilets using containers or biodegradable bags that are collected on a regular basis. These services are clean and environmental friendly, because waste management is in place and the waste is treated and re-

[7] 6% of Nairobi`s informal settlements residents dwellers have no toilet facility and use "flying toilets" (Gulyani et al., 2006, p. 48).

[8] Flying toilet is when a plastic bag is used for defecation, then secretly thrown away in ditches and on rooftops.

used. These services are only found in the informal settlements and their embedding is not so extensive because several dimensions of the service regime still need to be aligned. For example the placing of the container toilet inside the house misaligns with the perceptions of the users on privacy and dignity:

> *"…the men refused to use it. They perceive it as a "potty" for children (…) men would not want to sit on it and the rest of the family is in the small one or two roomed house."* (Informal dweller 5)

Also, the perception among users of this service does not align with social norms and interactions, it is by some perceived as strange:

> *"When this* (a container-based option) *was introduced we* (the women) *were not shy to use it. We didn't have other options, toilets were very far away. Now that we have more public options we question and laugh at ourselves really what this is that we used"* (Informal dweller 6)

The providers in this service regime are also struggling to find a well-functioning efficient organizational mode concerning the waste collection and transport in the informal settlements as one of the employees of a social enterprise explains about the amount of toilets somebody can collect per day:

> *"...in some other areas where we don't have a dense network then someone will have to move long distances then you will find able to collect maybe ten toilets per day in that area so depending on things like those and also the topography of that area it varies between maybe ten to twenty toilets"*

And then there is the challenge of accurately timing when to collect waste from inside people`s homes:

> *"… accessing the toilet faeces inside somebody's house could be a bit challenging for us, so we have to learn the behaviours of the users, or rather of the owners* (of the houses)*…"*

Providers in this service regime struggle with aligning their organizational mode; the timing of accessing the houses in which container-based toilets are used, and the location where the users can leave them efficiently for the collectors. They are also still improving the frequency of waste collections. Despite these misalignments, the service regime is scaling-up[9] in certain informal settlements thanks to the support of international actors such as donors, who like the fact that the waste is safely managed and treated in this service regime. The providers in this regime work on the legitimation of their services among (potential) users, and try to improve the alignments of the service to the times and spaces that

[9] One of the large providers in this regime started its operations in 2011 and currently franchises more than 1100 container-based toilets, which serve over 53.000 people per day in Nairobi`s informal settlements (Sanergy, 2018).

match with the daily practices of potential users. All-in-all this service regime is not strongly institutionalized but it is maturing quickly as internal alignments are being strengthened.

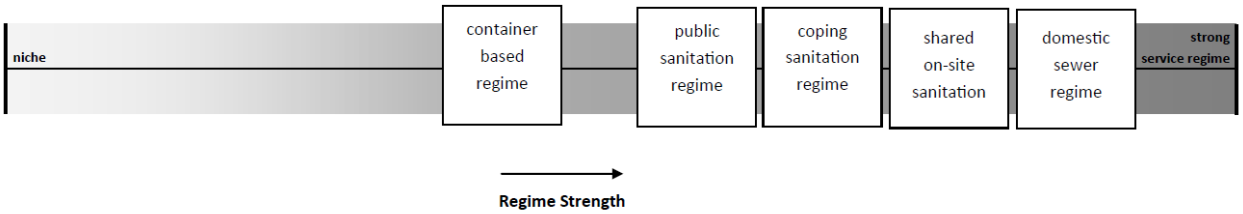


Figure 3. Regime strength of the five service regimes

Overall, all the five service regimes have different degrees of internal alignments and all show relatively strong degrees of institutionalization of certain elements. The five service regimes all have a different fit with the local context and are each more or less contested. We used this section`s analysis of the (mis)alignments, the fit to the local context, and the contestation of the various service regimes to create Figure 3 which illustrates the differing strengths of the service regimes in Nairobi. Regime strength is rather high for all service regimes. This is at odds with some of the preconceived views on sanitation in informal settlements, which see non-sewered options as provisional or informal and easy to replace, once a "better" solution would be available. It also illustrates that we cannot clearly oppose between regimes and niches in such complex environments. Such as container based options, which are still very much under-development, but have already still a number of highly institutionalized elements and local embedding. Other options like public or shared toilets or open defecation show quite high degrees of institutionalization while creating many externalities to its residents. Sewered systems are expanded into informal settlements as rather provisional and experimental simplified sewer projects, which have a number of characteristics of niche processes. With our framework, we can therefore replace the rather dichotomous niche-regime distinction which has been prevalent in the literature so far, by a gradient of alternative service regimes exhibiting different degrees of regime strengths and local embeddedness.

Taken together these five service regimes constitute the city's splintered sanitation regime at the sector level. However, not every service regime is present everywhere as some neighbourhoods are characterized by a single service regime (e.g. high-end areas have only the domestic sewer regime) or a mixture of two-to-three (e.g. certain low-income residential areas have shared on-site sanitation regime and public sanitation regime). Because all five service regimes are institutionalized to a certain degree, it is unlikely that one of the service regimes will suddenly replace another or disappear on a city-scale in the near future.

5.2 Mapping out the splintered sectoral regime

The five services regimes identified in Nairobi have different strengths, not one of them is dominant, and they are weakly aligned thus meaning that the city's sectoral regime has to be characterized as *splintered*. One indicator for weak sectoral alignments is the lack of adequate sanitation planning as expressed by the program manager of an international NGO working on sanitation issues:

> *"… when they* (the utility) *are doing their masterplan they must consider different technologies in terms of a mix of technologies, but they won't do that. They will only do a masterplan for sewerage, if they do that. So, that's where you have the big gap"*

The absence of effective planning is part and parcel of more general lack of effective governance structures, translating in unilateral legislation[10] favouring sewer systems and not providing standards for different types of service regimes:

> *"Nairobi city by-law does not recognize pit latrines and does not recognize any other sanitation option except the sewer connection"* (WASH program officer, international NGO)
>
> *"I can assure you that there is no day an on-site system can meet the conventional treatment standards. It is not possible. So we need some kind of a flexible standard"* (Lecturer, Kenyan University)

Misalignments are also visible in the coordination deficits between the different sanitation providers, for example between NGOs and public utilities:

> "*The problem with all these interventions is there is a disconnectedness (…) so everybody just kind of puts up their own intervention"* (Executive director Kenyan NGO)
>
> *"They* (NGOs) *don't consult when they are trying to provide solutions (…) we are unable to provide services there because one of the risks and again because of the vandalism so the community tends to feel that it is our company that is refusing to offer the services, but you see right from the word go, we are not involved"* (Community development officer, utility).

Lastly, physical infrastructures that could align different service regimes are absent:

> *"…in the areas where we work there are no sewer trunks that is where you find there is the biggest issue of fecal sludge management. So currently what we are doing we are now having a talk with them (the utility) how to handle this if nearby we have a sewer place so how can we be able to support these communities? Because you find they will not be able actually when the pit*

[10] In May 2016 a new "Environmental Sanitation and Hygiene Policy 2016-2030" has been launched by the Kenyan Ministry of Health which might improve this situation in future.

fills up to dig another one because there is not that space" (WASH coordinator, international NGO)

All told, the splintered sectoral regime results in a situation in which the differentiated needs of users can only be met through the users` own efforts to actively find a way to meet their daily basic needs, often resulting in negative outcomes. For example, the lack of access to public toilets at night, leaves many users with coping mechanisms at home:

"You have to go like three hundred meters to get access to the toilet and there you passing through alleys and there is no lighting." (Project officer, Kenyan NGO)

"The toilet is closed for the day at 10pm in the night. We have to persevere until morning or we just decide to use a small container (coping strategy) *in the bathroom then very early in the morning before others wake up we dump the faeces into the drainage outside."* (Informal dweller 6)

And children, in particular, suffer from a lack of complementary/accessible services:

"The performance, (…) the attentiveness of the kids during the classes. It's impaired, because this kid needs to go and help himself or herself but it comes, they don't have anywhere to go. So they are waiting to go home in the evening to relieve themselves." (Country program manager, international NGO)

These circumstances mean that the user has to put much more effort into serving her/his needs, and this has a knock-on negative effect on productivity, security, and, in the case of education, the development of human capital.

In order to visualize the splintered nature of the sanitation sector, we constructed a stylized map of Nairobi's sanitation provision depicting the mixtures of service regimes that prevail in several parts of the city (see Figure 4). The most complex constellations are found particularly in informal settlements and low-income residential areas. Wealthy neighbourhoods and the central business district (CBD) have sectoral regimes that are more homogenous.

How could a future more sustainable sanitation map look like? Most of the city planners assume that, over time, the heterogeneity will disappear in parallel with economic development. As a consequence the domestic sewer service regime will become dominant and the sectoral regime will change from splintered to monolithic. Based on our analysis, we argue however that other developments could be much more realistic. The sectoral regime in low-income and informal settlements will probably not see a strong diffusion of the domestic sewer service regime for still some time into the future. Therefore other improved service regimes (i.e., the container-based, public sanitation, and shared on-site

regimes) should still be improved and alignments among them at the sectoral level could have a strong effect on service quality for the residents. The sectoral regime would transition from a splintered state to a perhaps fragmented or even a polycentric typology. If this can be achieved, a replacement of the still- widespread coping regime and the negative externalities related to it are likely to disappear. The discussion that follows outlines a few inroads for potential pathways for such a transition.

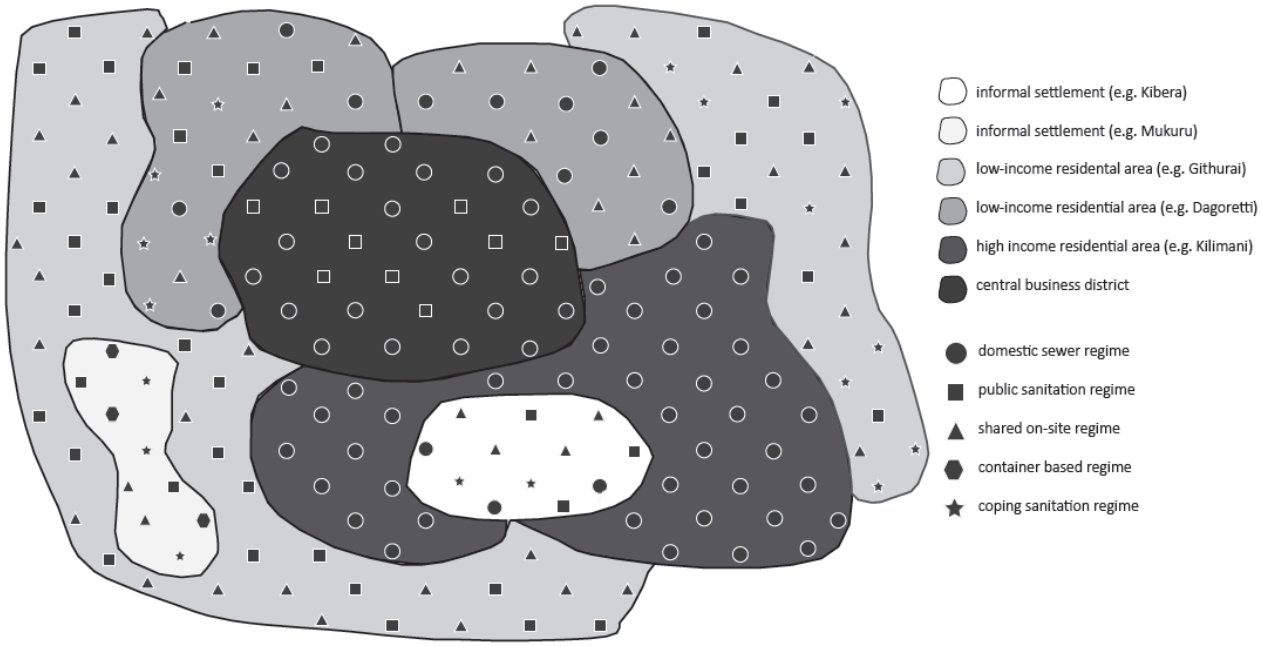


Figure 4. Conceptual representation of Nairobi showing the splintering in the sanitation sector of Nairobi projected in space

6. Discussion: Potential transition pathways in Nairobi's sanitation sector

The thorough identification and mapping of the socio-technical structures that create the service regimes and sectoral regime of sanitation in Nairobi gives pointers for how the transition from the current splintered regime towards a well-aligned polycentric regime could happen. This would lead towards a sanitation sector that provides higher quality, sustainable, and more justly distributed services. Potential transitions will depend on how the five service regimes develop individually and whether developments will lead to better alignments among one another. The primary goal is to assure that basic needs can be met twenty-four hours a day without having residents resort to coping regimes.

The systemic analysis of the splintered regime presented in this paper helps to identify possible strategies to overcome misalignments at the sectoral regime level. This is useful because actors usually work and innovate mostly within their service regimes. For example, providers improve the design of container-based toilets or the waste collection carts, improve the payment systems of toilets in a community centre, or improve the conversion of waste into biogas or fertilizer. As these examples show, these innovations are rather incremental changes within service regimes, while misalignments at the

sectoral regime are not recognized. Actors within the different service regimes have their specific independent views on the future of Nairobi`s sanitation sector, and work on specific projects to achieve this goal.

For example, the future pathway that is envisioned by the actors in the *domestic sewer regim*e is mostly focused on the "Nairobi as a modern city ideal": a complete sewerage system covering the whole city. Achieving this in medium term (next 10-20 years) is unrealistic and contested given the costs, pace, and complexities associated with the installation of sewerage infrastructure. Regardless, Nairobi City Water and Sewerage Company remains mainly focused on this pathway (NCWSC, 2014). The domestic sewer regime is politically expedient, supported by large international donors, and is well-aligned with a business-as-usual approach. More diverse service models and technologies would require new forms of knowledge, skills and experiences that are currently unavailable.

In order for the utility to be able to serve more people in the different neighbourhoods, other capabilities and service models are needed. Possible alignment building process could stem from the development of sanitation policies that address the needs of all five service regimes. The capabilities to manage and further develop the other service regimes are typically available with other actors (i.e. NGOs, CBOs, etc.). The public utility would therefore have to collaborate more closely with non-state actors and private enterprises in order to provide reliable services.

> "*For now I think we are still stuck up to our old system where we improve the sewer line, but for the future we are very open to such innovations* (i.e. dry sanitation) *(…) but I don't think we have the capacity now to start doing this*" (Project officer at the utility).

Other scenarios might call for improved alignments between the *public sanitation regime* and the *shared on-site sanitation regime*. In both service regimes, NGOs, CBOs and self-help groups are actively involving the residents in the informal settlements in service provisioning. Consequently, these non-state actors envision delegated service provision as the ideal future. A local NGO representative noted:

> *"neighbourhood associations are new opportunities that have come with devolution in the government (constitution of Kenya of 2010) (…) the so called illegal illicit supply of water, electricity, sanitation and waste services (…) communities can negotiate to be delegated some service provision functions by the local government (…) this will enable better revenue collection."*

Currently, the public and shared service regimes are not well-aligned. The (international) NGOs and CBOs in both service regimes are not purposely referring to each other. The organizational modes of CBOs and NGOs could be improved by learning from each other's service approaches. For example, the timing and

location of the services could be improved regarding the manual pit emptier services. These are used in both service regimes, but are not officially recognized, and thus not regulated and coordinated:

> "*we need to have guidelines on issues of faecal sludge management, they* (the authorities) *need to recognize the manual pit emptiers as much as they are saying they are illegal they are playing an important role in the sanitation value chain so they need to be recognized*" (Program coordinator, international NGO)

Another scenario relates to entrepreneurial strategies in the *container-based regime*. These actors typically imagine a future in which private enterprises play a key role and would collaborate with actors in the domestic sewer regime. Such public-private partnerships could support their preferred transition pathway.

Furthermore, there is some potential for collaborations in the field of waste treatment between actors of the *container-based regime*, the *public sanitation regime*, and the *shared on-site sanitation regime*. The first is focused on treating and re-using sanitation waste but does not always collect enough waste from its containers, while in the shared and public sanitation regime a lot of waste is collected from pit latrines without it being properly treated or disposed. Collaborations would lead to positive environmental outcomes.

Through the systemic perspective on splintered regimes that we developed, an overview of a broader set of possible transition pathways could be identified. Disregarding the issue of inter-service alignments will likely lead to the prolonging the state of splinteredness for a long time into the future.

7. Conclusion

Sustainability transitions frameworks are increasingly called to account for the heterogeneity and unevenness of socio-technical systems in developing cities. In this paper, we developed a conceptual framework that extends conventional regime analyses by differentiating two levels: *sectoral regime* and *service regime.* The use of a practice-oriented perspective leads to a coherent, grounded, and spatially sensitive framework to analyse transition pathways of heterogeneous regimes in various complex contexts, not only in developing cities.

In a wider sense, the hope is that this paper's contribution will find applications beyond developing city contexts such that socio-technical transitions research moves beyond its oft overly homogeneous interpretation of regimes and towards a recognition of the diversity of service regimes that mark sectors like transport, food, water, electricity etc. in all cities. In doing so, it will be possible to more systematically distinguish between, for example, the transport regime in Dutch cities in which several service regimes (automobile, busses and trams, bicycling, trains, pedestrian mobility forms) are well-

aligned, compared to US cities where the regime is often more fragmented (e.g., the bicycling service regime is not well aligned to the other service regimes). Through such comparisons the framework enables the identification of a broader set of alternative transition pathways and ultimately more fine grained policy advice may be derived from a regime bases analysis. In particular, the approach enables to overcoming of the niche-regime binary which is implicitly oriented at the overthrowing of a monolithic sectoral regime. This paper opens up for much more heterogeneous and uneven sector constellations and therefore provides new perspectives for planners, service providers and policy makers. The framework finally also provides a useful starting point to gain a spatially more sensitive understanding of regime configurations. The practice inspired interpretation in particular enables to emphasize the importance of local contexts for successful transition processes.

Acknowledgments

We would like to thank all the interviewees in Nairobi for sharing their knowledge and views with us. We want to thank the anonymous reviewer for the constructive comments we received, and Rob Raven and Bas van Vliet for their thoughtful feedback on an earlier version. Our gratitude also goes to the SUSARA project team for their contributions to the bigger research project of which this paper is part: Helene Ahlborg, Susanne Wymann von Dach, Christoph Lüthi and Heiko Gebauer. This work was supported by the Swiss National ScienceFoundation (grant number 10001A_159300).

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