Water infrastructure governance: practices, modalities, spatialities and pricing beyond the utility in Dar es Salaam

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Dedicated to

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Abstract

Cities in the global South have been typified as geographies where networked water infrastructure remains uneven in terms of coverage. They are also characterized as geographies where networked and heterogeneous non-utility-networked water infrastructure co-exist. These comprised, community shared water schemes, protected wells, boreholes with hand pumps, tanker trucks water delivery, water kiosks, pushcarts, rainwater harvesting, and private mechanized networked water infrastructure that supply water beyond the utility. While networked water infrastructures exist in tandem with these infrastructures in cities of the global South, access to water is yet problematic. In the context of rapid urbanization and climate change, urban scholars have advocated for the adoption of varied water infrastructures that supply water beyond the utility network as alternative ways to lessen the burden of networked water infrastructure. Scholarly advocacy on thinking beyond the network infrastructure, encourages policymakers and urban scholars to pay attention to non-utility-networked water infrastructures. They highlight how rainwater harvesting, groundwater, boreholes, tanker truck water supply, Community-based water schemes, and wastewater recycling just to mention a few—hold potentials for adapting water supply to the present changing socio-ecological conditions. Likewise, they demonstrate the crucial role of governance in facilitating water access within multiple water infrastructures, especially infrastructures beyond the utility network.

In sub-Saharan African cities, heterogeneous non-utility-networked water infrastructures such as boreholes, shallow wells, tanker trucks for water distribution, pushcarts, and protected deep and shallow aquifers (tubes), supply water beyond the utility network. Though state governance via the institution of formal policy mechanisms and enforcement can promote public and environmental health and improve water access, the governance of water supply of the aforementioned infrastructures remains understudied and less understood in urban studies. This dissertation focuses on the governance of heterogeneous non-utility-networked water infrastructures in cities in the global South. It examines the extent to which water supply beyond the utility is governed, the practices mediating water supply of the non-utility-networked water infrastructure, and how governance of water production and distribution beyond the utility network can improve water access. I frame governance as a "practice, an act of doing" grounded in practice theory through which I, (i) explore and analyze the governance arrangements of heterogeneous non-utility-networked water infrastructures, in terms of water production and distribution beyond the utility, (ii) determine how everyday practices of non-state actors mediate the development of water infrastructures and the mechanisms that sustain such infrastructure for water supply; (iii) analyse the practice of pricing water, the mechanisms that determine water prices, and how they are regulated, and (iv) evaluate the potentials and limits of the ordinary ways in which water supply (production and distribution) beyond the utility is governed in Dar es Salaam.

Drawing on an inductive approach alongside a case study strategy, I conducted interviews and surveys, Focus group discussions, and household case studies in the city of Dar es Salaam. Additionally, I developed a comprehensive framework of governance modalities, actors, and interactions within heterogeneous infrastructures as a heuristic device for analyzing non-utility-networked water infrastructures in terms of their governance. The findings reveal the existence of varied categories of water infrastructures, including privately networked water (non-utility pipe

water supply systems), self-supply water infrastructure, communal/shared water infrastructure, and hydro-mobile infrastructure. The study highlights the dominant governance modes facilitating water supply beyond the utility to include (in)formal co-production, market-oriented governance and self-governance. Residents used low-cost water servicing models, including drilling and mechanizing water systems, to address water issues. Other activities included installing equipment and storage tanks, extending PVC pipelines to interested neighbours that could afford the cost, and negotiating with plumbers for water network extensions. These practices were varied based on the type of water infrastructure and the water delivery model.

Prices were determined by factors specific to different water infrastructures and providers, including distance, fuel costs, vehicle maintenance, profit margins, recurring costs like electricity, material technologies, repairs, maintenance, and paying employees. These practices improved spatial access to water but were limited in terms of quality and cost. The study suggests mixed governance model: co-governance, co-management, formal co-production as means of fostering collaboration between state and non-state actors and improving water access beyond the utility network.

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BWB	Water Basin Board
CBO	Community-Based Organization
CSO	Civil Society Organization
CWSO	Community-owned Water Supply Organization
CWI	Community-owned Water Infrastructure
DAWASA	Dar es Salaam Water Supply Agency
DAWASCO	Dar es Salaam Water Supply Company
EWURA	Energy and Water Regulatory Authority
FBO	Faith Based Organization
FDG	Focus Group Discussion
HIC	Heterogeneous Infrastructure Configuration
KII	Key Informant Interview
MOH	Ministry of Health
MOW	Ministry of Water
MVP	Maximum Variation Purposive Sampling
MWE	Municipal Water Engineer
NGO	Non-Governmental Organization
NUA	New Urban Agenda
PMO	Planning and Monitory Officer
PMIWNO	Privately Mechanized in-house Water Network Owners
PVC	Polymerizing Vingl Chloride
SDG	Sustainable Development Goals
TANESCO	Tanzania Electricity Supply Company Limited
TSZ	Tanzania Shilling
URT	United Republic of Tanzania
UNICEF	United Nations International Children's Emergency Fund
WHO	World Health Organization
WCM/C	Water Committee Members and Council

CHAPTER ONE

INTRODUCTION

1.1 Background and outline of research problem

Networked water infrastructure has been influential in shaping the functioning of other critical infrastructures in the past decades (Graham & Marvin, 2001; Gandy, 2006; McFarlane, 2008). Especially facilitating hydroelectricity generation, transportation, public health, and the sanitization of urban spaces (Gleick, 2000; Gandy, 2006; Domènech, 2011). Beyond societal well-being, it has been instrumental in promoting economic productivity of cities (Collier & Venables, 2016; Cirolia & Rode, 2019), fostering equitable access, and reshaping cities through centralized governance (Gandy, 2004; Monstadt & Schramm, 2017; Coutard & Shove, 2018; Addie, Glass, & Nelles, 2020). Although its emergence was largely shaped by rapid urbanization and industrialization in the global North, the sanitization of urban spaces in response to public health concerns (Gandy, 2006; Domènech, 2011; Wamuchiru, 2017), its goal of universalizing water access and sanitizing the urban environment has been hindered by present-day urbanization particularly in Southern cities (e.g., Gleick, 2000; Graham & Marvin, 2001; Mcfarlane, 2008; Furlong, 2014). This is apparent with the uneven distribution of networked water and the spatial disparities and injustices concerning access to water in many African cities and beyond (Bakker et al., 2008; Sultana, 2018; Coutard & Shove, 2018; Adams et al., 2018).

In the context of uneven distribution, rapid urbanization, and climate change, urban scholars have advocated for non-utility-networked water infrastructures to minimize the risks associated with monolithic networked infrastructure (Wright-Contreras et al., 2017; Domènech, 2011; Bichai et al., 2015; Leigh & Lee, 2019). Some scholars have advocated for water conservation or for shifting governance modalities for water supply (Furlong & Bakker, 2011). Elsewhere in the global South, scholars (e.g., Böhm et al., 2011; Schramm, 2011), have demonstrated the instrumental roles of semi-centralized network infrastructure in limiting the burden of large-scale water network. In particular, Gleick characterizes the early 2000s as a period of paradigm change where scholarly advocacy for moving beyond networked infrastructure evolved rapidly (Gleick, 2000). Studies on networked water supply complexity, semi-centralized, decentralized, and centralized water infrastructure, as well as thinking beyond the network, encourage policy-makers and urban scholars to pay attention to alternative water infrastructure solutions (e.g., Domènech, 2011; Bichai et al., 2015; Furlong & Kooy, 2017; Leigh & Lee, 2019). They highlight how rainwater harvesting, groundwater, and wastewater recycling – just to mention a few – hold potentials for adapting water supply to present changing socio-ecological conditions (Grigg 2010; Reymond et al., 2020).

In the global North, for example, Australia, Spain, and parts of the United States (Arizona, California) amongst others, water supply is evolving from the networked more towards infrastructures that supply water beyond the utility network. These include, but are not limited to, stormwater collection, rainwater harvesting, wastewater treatment, and greywater recycling. These

water infrastructures are decentralized governed by local government authorities, private organizations and operate as either an integrated system or a standalone system (Böhm et al., 2011; Schramm, 2011; Gómez-Román et al., 2020). Additionally, they formally serve as complementary water systems to the networked infrastructure (Gleick, 2000; Domènech, 2011; Grigg, 2010; Bichai et al., 2015). For example, in Metropolitan regions such as Barcelona, local regulations have been enacted to govern the production, distribution, and use of greywater, rainwater harvesting, and wastewater as alternative solutions (Domènech, 2011). The direct roles of local government authorities, institutions, and the enforcement of formal regulations, as well as the provision of subsidies and technical incentives, work to promote the adoption of semi-centralized and decentralized water infrastructure as alternative solutions to individuals' and households' water needs (Grigg, 2010).

Similarly, in cities in the global South, wastewater recycling and reuse, greywater collection, and stormwater collection can play a crucial role (e.g., Reymond et al., 2020; Sapkota et al., 2015; Singh et al., 2015; Prins et al., 2022) in complementing historically incomplete networked infrastructure (Anand et al., 2018; Addie et al., 2020; Cirolia, 2020; Guma, 2022). However, non-utility-networked water infrastructures such as boreholes fitted with hand pumps, mechanized boreholes, the use of tanker trucks for water distribution, and pushcarts, co-exist with the utility as complementary water infrastructures, especially in Sub-Saharan African cities. These infrastructures supply water beyond the utility network, serving urban populations either experiencing network failure or without network connectivity (Dill, 2010; Wutich et al., 2016; Furlong & Kooy, 2017; Allen et al., 2017). Though state governance via the institution of formal policy mechanisms and enforcement can promote public health and improve water access in the context of multiple infrastructure systems (Pakizer & Lieberherr, 2018; Grönwall & Danert, 2020; Reymond et al., 2020), the governance of water supply beyond the utility network especially via non-utility-networked water infrastructures remains understudied and less understood in urban studies. For instance, it is unclear how the provision, production and distribution water outside the utility network through boreholes equipped with hand pumps, mechanized boreholes, tanker trucks for water delivery, and pushcarts, are governed. What is apparent in cities in the global South is that networked water infrastructure, governed by the state, is still the dream (Hall & Lobina, 2006; Kundu & Chatterjee, 2020). Both the state (government agencies) and private companies are actively working on (re)configuring, regulating, and distributing networked water with the hope of attaining even coverage (Pakizer & Lieberherr, 2018; Furlong & Bakker, 2011; Cirolia et al., 2021).

In light of the evolving conditions of networked water supply and varied water infrastructures beyond the utility network, scholars urge planners and policymakers to draw clues from the ordinary practices of households (e.g., the act of producing and distributing water beyond the utility network) as a way of coping, diversifying, and moving beyond the networked infrastructure (Grönwall & Oduro-Kwarteng, 2018). This advocacy, amidst the evolving scholarly discourses on thinking beyond the utility network, offers ground for further theorization of urban water supply beyond the utility (e.g., Furlong & Kooy, 2017). However, expanding debate on thinking beyond the utility network also requires questioning: For example, "How can thinking beyond the utility network in aspects of urban water supply foster universal access or improve water access situations in cities of the global South?" In response to this, I argue that a deeper understanding of the governance arrangements, especially of the practices, modalities, spatialities, and how water is

priced and distributed beyond the utility network in the global South, is imperative in this regard. Such an understanding can provide the possibility for further reflection on the practice of producing and distributing water beyond the utility network, especially in relation to the ways in which water is produced and supplied for domestic use. Secondly, questioning how governance of water supply beyond the utility can improve water access is crucial in an era where networked water infrastructure disruptions and fragility prevail due to climate change and rapid urbanization (e.g., Bichai et al., 2015; Furlong & Kooy, 2017; Mapunda et al., 2018). Thirdly, it may help to reduce the potential risks of water contamination through the varied ways in which water is produced and distributed beyond the utility network, especially in the global South. In addition, it can provide the opportunity for building collaboration between non-state water supply actors and utility authorities towards improving urban water supply (Dos Santos & LeGrand, 2013; Björkman, 2014). To pursue this agenda, I frame governance as a "practice of governing" grounded in the theory of practice (Rouse, 2006) to demonstrate the "practices" that mediate water infrastructure provision, water supply, and access beyond the utility network and how the practices are governed. Alongside, I draw debates from "thinking beyond the network for water supply" (see Gleick, 2000; Domènech, 2011; Furlong & Kooy, 2017) as a heuristic position through which I provide discussions and conclusions. The next section presents a review and further conceptualizations of debates concerning networked water infrastructure in the context of the global South, governance, and debates about thinking beyond the utility network.

1.2 Conceptual framework

This section presents concepts and the state of research on urban water infrastructure governance. It further clarifies the various concepts used in the dissertation, including debates about moving beyond the networked water infrastructure, the concept of urban water infrastructure and water supply beyond the utility network, urban water infrastructure governance, and the practice theory. Following the review and conceptualization, the dissertation further develops an analytical perspective on the "practice of governing water supply beyond the utility network". This served as the broader framework that encapsulates and demonstrates the linkage between the Chapters of the dissertation.

1.2.1 Understanding urban water infrastructure and water supply beyond the utility

Urban infrastructures in all categories are integrated parts of cities; they shape cities and urban formation processes and structure the everyday lives of people in the urban environment (Graham & Marvin, 2001; Larkin, 2013; Schorn & Humer, 2021). Historically, "infrastructure" was largely seen as a technical system associated with material and physical composition. As a technical system, it was generally defined as "any connections that facilitate the operations or a system to work" or a "complex linkage of waterways, roadways, and communication networks" that assist military organizations (Collier & Venables, 2016). Studies differentiate infrastructure as technical and material systems from other forms of material artefacts, by indicating the functional roles of infrastructure. Technical systems such as objects and material artefacts become infrastructure

"when they are connected to and function within broader networks." Therefore, "Infrastructures are matter that enables works of other matter" (Larkin 2013, p. 329). By this notion, the pipe becomes infrastructure only when it is connected to the broader network of pipes that collect and transport water for domestic use (e.g., Massey & Gunter, 2020). This perspective ignores the multiple dimensions of infrastructure. Because seeing infrastructure as a technical system suggests that engineers and technocrats hold the absolute capacity to (re)configure systems to mediate the flow of water.

At present, the notion of infrastructure as a technical system has been stretched beyond the material artefacts to a "socio-technical system" in urban planning (Graham & McFarlane, 2015, p. 214; Pilo', 2017; Rateau & Jaglin, 2020). By this understanding, infrastructure can be viewed as a multi-dimensional system, as either political, technical, socio-technical, techno-political, social infrastructures (public spaces, schools, recreations, sports, and cultural facilities), or economic infrastructures such as restaurants and hotels, amongst others (Graham, 2009; Monstadt & Coutard, 2019; Schorn & Humer, 2021). Graham and Marvin's distinct infrastructure as an absolute technical system, but as a set of material objects and technologies entangled with social practices, meanings, and values, seamlessly woven into the material, political, and economic fabric of contemporary cities (Graham & Marvin, 2001). This sets the pace for de-constructing infrastructure as an absolute technical system. Rather, it is a socio-technical system that is believed to revolve around cables, pipes, and sewage for social systems such as health care, education, social housing, green infrastructure, parks, and recreational zones (Schorn & Humer, 2021). Technical systems are hard material networks, physically configured artefacts such as highways and streets, roads and bridges, mass transit, airports and airways, pipes, cables, and sewage that mediate the movement of people, energy, goods, information, water, and waste (Addie et al., 2020; Schorn & Humer, 2021a).

The present view of infrastructure as a socio-technical system is the notion of this dissertation. However, this view of infrastructure as a socio-technical system can be traced to the earlier works of Tavistock in the 1950s on "socio-technical system theory" (Pasmore, 1993; Imran & Kantola, 2019) as well as System theory, especially the notion of *Ludwig von Bertalanffly*. These scholars show how the components of human society and the human body are interrelated in nature and tend to collaborate to perform functions. They argue that the functions of the human body and societies can be better realized through the connection between social and technical systems. Urban planners furthered the socio-technical system's notion by conceptualizing urban infrastructures as "material substrates of the city" that are interconnected in nature, and work to influence the functioning of an urban environment (Massey & Gunter, 2020, p. 85). While this perspective has not directly defined water infrastructure, theoretical standpoints such as the interrelations of the social and technical systems offer a holistic standpoint for understanding how water infrastructure functions (e.g., Pasmore, 1993), especially how they work to produce and distribute water for commercial and domestic use and beyond the utility network. Seeing water infrastructure as a socio-technical systems also suggest that the social and technical elements are interrelated and work together to facilitate the production and distribution of water within and beyond the utility network. By this notion, the technical elements comprise the equipment, methods, and technologies that facilitate the production of water (e.g., Moglia et al., 2011; Geels, 2002; Rateau &

Jaglin, 2020) by the utility and beyond the utility network. While the social elements comprise of the actors, people, and commitment to responsibilities, institutions, skills, legislations, and regulations that mediate the production and distribution of water through the utility networked infrastructure and beyond. Some scholars disentangle the socio-technical assemblage of networked water infrastructure by revealing how the technical properties such as direction, dimension, and conditions are intertwined with non-physical, or soft, intangible dimensions such as the practices (Massey & Gunter, 2020). These also include the planning, designing, implementation, capturing, storing, operating, controlling, and maintenance of the water infrastructure (Tiwale, 2019; Massey & Gunter, 2020). In this continuum, the user groups, or norms, interact with the material technologies to perform an intended function, such as production and distribution of water.

Though socio-technical system scholars, provide an insightful perspective into the lived experiences, governance, and socio-spatial reordering of infrastructure (Graham, 2009; Lawhon et al., 2018; Ramakrishnan et al., 2021), the view of water infrastructure as a socio-technical system has also been theorized in anthropomorphic intellect. For example, Simone (2004), notions of "people as infrastructure" highlight the bodily works of people and demonstrate how people connect and share information in the urban environment. Practice theorists share this notion as they reveal how "human bodies act as both the locus of agency and the locus of action" to perform functions (Rouse, 2006, p. 512). This perspective places "people" at the centre of actions as well as the pivot through which material infrastructure functions and circulates. Because people build networks, they share ideas to synergistically mediate the flow of water (Schorn & Humer, 2021) via the network and beyond the network. For instance, further *"anthropomorphization"* of infrastructure as a socio-technical system sees the "body as an infrastructure" by highlighting how the bodily works of women facilitate the production and distribution of water via the networked infrastructure and beyond the utility (Truelove & Ruszczyk, 2022; Andueza et al., 2021). Anthropomorphising "body as infrastructure" does not de-limit the roles of material and technical artefacts in the performance of water supply functions. For example, the humanization of infrastructure suggests that women's bodies act as water infrastructures as they collect and transport water beyond the pipes. The arrangements, practices and processes that mediate water collection, transportation, and storage are invariably connected to diverse material artefacts, such as metallic and plastic containers (Dakyaga et al., 2018a; Kasper & Schramm, 2022). Studies reveal how socio-material artefacts and nature, such as wellsprings and tube wells, act as infrastructures from which water is produced and distributed beyond the utility (Sultana, 2013; Meehan, 2014; Truelove, 2018). Others define water infrastructure "as consisting of dams, levees, canals, pipes, pumps, and water treatment plants (machines)" (Adeniran, 2022, p. 2).

Recent studies such as Kasper and Schramm introduce the *"infrastructuring"* of storage, revealing how diverse material artefacts, metallic and plastic containers, and water tankers mediate water storage for use (Kasper & Schramm, 2022). They argue that understanding water storage as infrastructure and the processes associated with it, can improve our theorization of how water flows beyond the utility for domestic use (Kasper & Schramm, 2022). Although "storage" is inherently embodied in water production and distribution, storage as infrastructure becomes more visible in the absence or failure of networked water infrastructure, especially in the global South (Dakyaga et

al., 2018). Building on the evolving notions of infrastructure, I define non-utility-networked water infrastructures as multiple or heterogeneous water systems that are indirectly connected to the utility network, and supply water beyond the utility network. These consist of the pipes, mechanized boreholes, tube wells, wellsprings, pumps, people, pushcart water supply, and tanker water supply through which water is produced and distributed beyond the utility (Meehan, 2014). These water infrastructures are decentralized micro-water grids that are not directly connected to the utility. Therefore, I used the aforementioned concepts interchangeably in the dissertation. The next section presents the concept of urban water infrastructure governance, focusing discussion on the governance of water supply beyond the utility network.

1.2.2 Understanding urban water infrastructure governance

The concept of "governance" emerged in 1989 as a response to the developmental challenges faced by Sub-Saharan African countries. The World Bank's depiction of the development situations in Sub-Saharan Africa as "a crisis of governance" (World Bank, 2016, p. 2), spawned governance as a concept and a development strategy in practice, and encourage Sub-Saharan African countries to move from the command-and-control culture dominated by the state, towards fostering participation as a means to economic development. This entails, active participation of citizens, engaging in developmental initiatives based on their own capabilities, promoting partnerships guided by defined rules, with the state acting as a catalyst or facilitator (World Bank, 2016). Currently, governance has gained widespread recognition and usage across various spheres, including politics, economics, socio-cultural aspects, the environment, and even in varied dimensions of urban studies (Mcfarlane & Rutherford, 2008; Obeng-Odoom, 2012; Truelove & Cornea, 2020). Additionally, is regarded as an analytical tool or framework (e.g., Hufty, 2011), a theory, a strategy, an approach, as well as a practice (Chhotray et al., 2009). The notion of governance is distinct from government or centralized state control as it places emphasis on partnerships, the involvement of non-state actors in the planning and policy decision-making process. In this context, both state and non-state actors are expected to play pivotal roles in cities' affairs, being responsible and accountable to each other through appointed bodies and defined rules (Obeng-Odoom, 2012; Grönwall, 2016; World Bank, 2016). Nevertheless, in governance, the primary authority resides with state actors in aspects of promoting active inclusion, enacting and enforcing legislation, and achieving specific objectives (Obeng-Odoom, 2017; Nederhand et al., 2019).

In the context of water infrastructure, governance entails "those that determine *who gets what water*, *when* and *how,* and *who* has the right to potable water and related service, and their benefits", (Cleaver et al., 2005). It is an act of doing driven by a clearly defined objective towards an intended outcome. The concept of governance also highlights the central role of actors as active "agents" responsible for determining the provision and distribution of water services to those being governed. Though governance is crucial for managing water infrastructure, its ability to ensure the availability of safe drinking water and sanitation services depends on the mechanisms and

modalities that steer water provision and distribution (Bakker et al., 2008; Millington & Scheba, 2021). For example, addressing water supply equity, democratization, injustices, human welfare in terms of water access, and ecological factors that limit water availability are issues yet to be addressed in water governance discourses (Perreault, 2014; Millington & Scheba, 2021). These together make water infrastructure governance a complex and multi-level process requiring multiple actors, including state water utilities, private companies, civil society organizations and local communities, amongst others (Domènech, 2011). By focusing on the heterogeneous non-utility-networked water infrastructure, I define water infrastructure governance as "a practice" "or act of doing" in which the involved actors develop regulatory framework, define modes of interactions, and establish decision-making structures and processes to determine who gets what water, when, how, and from whom (World Water Forum, 2000; UNESCO, 2003; Cleaver et al., 2005; Jiménez and Pérez-Foguet, 2010).

By this framing, water infrastructure governance, requires the establishment of legal frameworks and the enforcement of regulations to guide actors' engagement and interactions towards water infrastructure development and service delivery. In practice, the actors may define rules and regulations and exercise power and agency towards the production and distribution of water (Truelove, 2020), towards improving the quality, reliability, spatial proximity, and affordability of water (Smiley, 2017). The existing rules and regulations may define the modes of water supply of the varied non-utility-networked water infrastructures (Adams et al., 2018). Unlike networked water infrastructure, non-utility-networked water infrastructure tends to be governed by varied actors, comprising private individuals, communities, families, neighbourhoods, and associations or groups, volunteers, Non-Governmental Organizations (NGOs) and Community-Based Organizations (CBOs) (Domènech, 2011; Allen et al., 2017; Wamuchiru, 2017b; Moretto et al., 2018). The dissertation pursues the governance of the varied non-utility-networked water infrastructures such as mechanized boreholes, tube wells, wellsprings pumps, people, pushcart water supply, and tanker water supply, amongst others. I conceptualize governance of non-utility-networked water infrastructure as a "practice" of governing or an act of doing, driven by assemblage and/or multiple actors beyond the formal state utility network. Together, I examine the practice of governing water production and distribution, and how governance of the varied non-utility-networked water infrastructures can improve water access beyond the utility network. The next section presents a situated understanding of networked water supply in the global South.

1.2.3 Problematizing the network: Water supply in the global South

Cities in the global South have been vulnerable to networked water infrastructure fragility due to uneven coverage (Furlong & Bakker, 2011; Guma, 2022). While land use order is a prerequisite for even networked extension and coverage, land uses, especially in African cities, are less ordered to provide fruitful grounds for standardized implementation and universalization (Monstadt & Schramm, 2017). In this geography, informal and peri-urbanization are the dominant modes of urbanization. Informal settlements are either congested with high density or located farther beyond

the utility pipe coverage (Andreasen & Møller-Jensen, 2016). Due to the sunk capital cost required for utility network extension (Cirolia, 2020), peripheral and (sub)urban areas are often less connected with networked water (Wright-Contreras et al., 2017). In these areas, residents tend to live without adequate access to the pipe network marginalized by their geographical locations (Dill & Crow, 2014; Uitermark & Tieleman, 2021; Andreasen & Møller-Jensen, 2016; Peloso & Morinville, 2014; Tiwale et al., 2018). Even in places with network connections, several residents often remain un-serviced, due to lacking pressure or small pipe diameters (Jambadu et al., 2021; Furlong & Kooy, 2017; Anand, 2011).

In relation to spatial segregations, scholars have reported how high- and middle-class residents, especially in the urban core and the outer zones, tend to gain better connectivity, such as a relatively reliable flow of water, higher networked connectivity, than the informal settlements, where most low-income residents dwell (Goff & Crow, 2014; Dakyaga, 2022). But in the event of extreme failure, affluent residents tend to opt out of the utility network for private wells to gain sufficient water supply (Graham, 2009; Furlong & Kooy, 2017; Uitermark & Tieleman, 2021). This failure of the flow of pipe has historically perpetuated division. It has produced intra-spatial variations, segregations, and inequalities in terms of physical networked connectivity and water collection (Graham, 2009; Wright-Contreras et al., 2017). This has been apparently visible between the "urban" and "peri-urban areas" of African cities (Grönwall, 2016; Adams, 2018a; Guma, 2022a). Residents in the latter are often affected by inadequate water supply due to the temporal incompleteness of the networked water infrastructure (Nganyanyuka et al., 2015; Schramm & Wright-Contreras, 2017). These tend to result in an increasing number of urban dwellers depending on water supply beyond the utility network, such as water from tube-wells, boreholes, and other forms of small-scale water distribution. Cities in the global South, especially in Africa, may not realize the prerequisites of networked water infrastructure for standardized implementation. Thinking beyond the utility network may be the urban water futures of African cities, in terms of meeting the growing water needs.

But while tube-wells, water kiosks, mechanized boreholes, and tanker trucks play a role in terms of water supply, either alleviating or minimizing the water situations of the several residents unserved by the utility (e.g., Ranganathan, 2014; Wutich et al., 2016; Keough et al., 2021; Truelove, 2020), the governance of these water infrastructure remain understudied. Existing studies have shown that the daily routine of collecting water from these water infrastructures is complex (Smiley, 2013; ; Sarkar, 2020b). Rather, it involves multiple acts such as producing and distributing water beyond the pipe (e.g., Peloso & Morinville, 2014; Grönwall, 2016; Wamuchiru, 2017). Water collection from these infrastructures is often entangled within multiple forms of negotiations and procedural arrangements, power, and politics (Wutich et al., 2016; Wutich et al., 2018; Furlong & Kooy, 2017; Alba et al., 2020). The daily work of women enables the collection and transportation of water beyond the utility network (Truelove & Ruszczyk, 2022). Residents engage in diverse trade-offs, circumventing risks to collect and/or supply water (Dos Santos and LeGrand, 2013; Sarkar, 2020). Observing the ordinary daily acts through which water is collected and supplied beyond the utility as well as how they are governed can offer a novel insight into households' water (in)security, socio-economic inequality, water (in)justices, water poverty, and marginalization within and beyond the

utility network (Sultana, 2018; Enqvist & Ziervogel, 2019; Adams et al., 2020; Adams et al., 2022). It is through ordinary acts that the realities of water access and supply beyond the utility; such as who gets what water, when, and by whom, can be determined and better understood (Alba & Bruns, 2021; Rusca & Cleaver, 2022).

In Accra (Ghana), Peloso & Morinville (2014) report how residents "chase water" daily from multiple water providers. These daily hurdles are sometimes influenced not only by the scarcity of water in terms of flow, but also by unequal water distribution and the marginalization of low-income residents in development plans (Crow and Odaba 2010). However, our imaginations of these daily hurdles can be broadened by understanding the governance of the varied water infrastructures that supply water beyond the utility network. In South-West Nigeria, Emenike et al., (2017) report how the fate and confidence of the citizens declined over public water supply due to water pricing inequity. In Dar es Salaam (Tanzania), the disparity between the increasing population and the limited capacity of the utility to produce water challenges the utility's efforts in attaining even coverage (Kyessi, 2011; Mcgranahan et al., 2016). Some scholars have attributed the mismatch to less attention given to water infrastructure provision by both colonial and post-colonial regimes (Smiley, 2013; McGranahan et al., 2016; Todd et al., 2019). These compel urbanites to seek alternatives beyond the utility network to cope with networked water failures (Herslund & Mguni, 2019; Bender, 2021). These suggest that, while water access complexities are evolving as a global challenge, the effects may be felt in varied ways and across cities in the global South. Therefore, it is imperative to pay attention to the governance and sustainability of water infrastructures that provide water beyond the utility network. The next section expands on perspectives on thinking beyond the utility network.

1.2.4 Thinking beyond the utility network infrastructure for urban water supply

As stated earlier, large-scale water infrastructure, also known as the networked city (Courtard & Rutherford, 2016), the modernist infrastructure ideal (Graham and Marvin, 2001), as well as the universal access approach (Cirolia & Rode, 2019), has laid an unerodable foundation for urban water supply in the past decades. Although its evolution can be traced to the global North, networked water infrastructure has been the archetype shaping global water circulation. In the global South, water infrastructure provisioning is guided by the modernist infrastructure ideal (e.g., Montadt & Schramm, 2017; Schramm & Wright-Contreras, 2017; Tiwale, 2019). Although this ideal is the aspiration of Urban planners, policy-makers, politicians, development practitioners, city authorities, and residents (Anand et al., 2018; Crow & Odaba, 2010; Smiley, 2020), attaining even distribution of water is still a challenge in cities in the global South (e.g., Dos Santos & LeGrand, 2013; Schramm & Wright-Contreras, 2017; Kundu & Chatterjee, 2021; Guma, 2022).

Evolving debates about thinking beyond the utility in terms of urban water supply offer novel perspectives and fruitful grounds for deconstructing and perhaps better positioning non-utility-networked water infrastructures in the urban water supply landscape (Furlong, 2014). It urges urban planners and city authorities to reflect on what and how water can be better supplied to meet the

growing water needs of urbanites (Furlong & Kooy, 2017). Thinking beyond the mono-centric networked infrastructure may broaden our imaginations of the varied materiality of urban water infrastructure and thereby help us appreciate their roles in shaping urban spaces and social relations. Similarly, the notion of "Infrastructural turn" suggests a move beyond engineering feasibility in the aspect of water supply, towards the technical, socio-cultural, political, and spatial realities that engineer water flow (Cirolia and Rode, 2019; Rosinger et al., 2020; Ford et al., 2022). In addition, it demonstrates the need to decentre scholarly understanding of water infrastructure beyond the traditional utility-based model. This also suggests paying attention to the governance of the alternative infrastructure that offers possibilities for water collection by urbanites outside the network (Furlong, 2014; Furlong & Kooy, 2017; Grönwall & Oduro-Kwarteng, 2018). In so doing, it defies the promises and prioritized standardization of infrastructure and technical efficiency, driven by the state's provisioning, more towards the promotion of environmentally friendly, sustainable, and cost-effective water alternatives (e.g., Wright-Contreras et al., 2017; Leigh & Lee, 2019). Also, it recognizes the roles of the citizens as water consumers and producers whose efforts are (in)directly connected to the flow of water beyond the utility but across cities (Liddle, Mager, & Nel, 2016; Schramm & Wright-Contreras, 2017). Thinking beyond networked water offers the possibility of a fuller understanding of the urbanization of water in cities in global South (Furlong & Kooy, 2017).

While this debate remains central to dialogues concerning urban water supply complexities, urban infrastructure resilience, and water scarcity (Smiley, 2013; Leigh & Lee, 2019; Bender, 2021), much remains to be desired in efforts towards improving access to water, and minimizing scarcity. A comprehensive framework for analysing heterogeneous non-utility-networked water infrastructure, the practices through which such infrastructures are developed and sustained, and the mechanisms for pricing are critical inputs towards the global ambition of thinking beyond the utility network in the aspect of water supply. Seeing from a governance perspective can unveil the question of who and how prices are determined to mediate water collection and distribution beyond the utility network. Non-utility-networked water infrastructures in this context, entail the varied decentralized, micro-grid water systems that are not directly connected to the utility but supply water for domestic use. In the context of global South, they comprised rainwater collection, tanker trucks water supply, pushcarts, groundwater wells, self-supply water systems, and community-owned and managed water infrastructures (Kyessi, 2005; Grönwall, 2016; Truelove, 2019). Others include wastewater recycling/greywater reuse, stormwater, and black water amongst others (Allen et al., 2016; Prins et al., 2022). These infrastructures mediate water supply via socio-technical processes and relational ways, (in)directly outside the state or utility-defined standards and regulations (Lawhon et al., 2018; Allen et al., 2016).

De-limiting scholarly dialogue from the absence of networked water infrastructure towards the varied practices and technologies that connect people and ecology, especially in the global South, is imperious (Furlong & Kooy, 2017). Such reflections, especially over the complex socio-political processes that mediate water supply beyond the utility network, can broaden our imaginations of the ways in which water flows in the absence of the network. Secondly, paying attention to the water infrastructures beyond the utility, particularly the processes through which water is produced

and collected, can improve our understanding of real water access situations, and their allied vulnerabilities (Furlong, 2017, p. 901). This perspective resonates with the present study, which places emphasis on the governance of the varied non-utility-networked water infrastructure, seeking to contribute to the debate on de-centering modernist infrastructure ideal, towards heterogeneous water infrastructure in the context of the global South. With references to uneven coverage of networked water infrastructure in cities such as Hanoi, scholars have demonstrated how paying to attention to alternative, decentralized water infrastructures can promote "distributional justice, inclusive decision-making and cost-effective water sources for consumption and use" (Wright-Contreras et al., 2017, p. 72). These discourses more or less urged utility actors and scholars to evolve beyond the assumption of the centrality of pipes for water supply, towards further understanding of the ways in which widespread local infrastructural solutions such as hand-dug wells work to minimize the challenges residents encounter in the absence of networked water (Liddle et al., 2016; Chávez et al., 2020; Mapunda et al., 2018). Some scholars emphasized the above, by highlighting how varied non-utility-networked water infrastructures are flexible and adaptive to local situations, produced through communities-based practices, and more embedded in cultural norms (Kyessi, 2005; Liddle et al., 2016; Dakyaga et al., 2018). The practices and technologies beyond the network can unite and supply water even in the context of complex socio-ecological politics of water (Furlong & Kooy 2017). Small-scale water technologies and ordinary processes of urban residents are deemed capable of re-configuring the performance, arrangements, state monopoly, politics, and power dynamics that tend to characterizes piped water supply in the global South (see Furlong & Kooy, 2017 p. 6; Guma & Schramm, 2019). Unlike the networked infrastructure, the failure of water subsystems may not necessarily contribute to disruption in water services in cities and communities (Otto-Zimmermann, 2012; Birkmann et al., 2016; Leigh & Lee, 2019).

Nevertheless, the perspective on thinking beyond the utility network has also received diverse criticism. For example, Lemanski (2021) argues that the collection of water beyond the utility network is not usually an option in the midst of an adequate utility water supply, but an option in times of failure. She argues that the act of relying on groundwater via boreholes usually emerges as a political decision, adopted by the affluent residents of the global South. Although the configuration of water infrastructure beyond the utility network produces a "new infrastructure cape" for water supply, such infrastructure may work to limit state capacities in the provision and redistribution of networked water infrastructure (Lemanski, 2021). Beyond this, it holds the possibility of producing uneven access, in geographies of differentiated powers as well as the marginalization of disadvantaged residents in terms of possession and claiming ownership (Hofstetter et al., 2021). Correspondingly, Furlong and Kooy reveal the double-edged aspects of relying on water supply beyond the utility network by highlighting the unequal relationships that characterise water intermediaries, and how these serve as a vacuum for perpetuating inequities in water access and unreliable water supply (Furlong & Kooy, 2017). Therefore, though the dependency on groundwater via self-provisioning is growing, enabling residents to exercise their right to water, it may also exacerbate future water challenges, including chronic water insecurity due to groundwater depletion (Grönwall & Danert, 2020). In light of this, scholars such as Grönwall & Danert (2020), advocate for institutional, technological, and state regulation of groundwater

extractions as a growing alternative to networked water. In another context, thinking beyond the utility network for water supply also signifies an effort to promote and re-connect with the ancient and ecological-based water infrastructural solutions such as hand pumps wells, aquifers, and ponds that became oblivion through the advent of large-scale water infrastructure in the earlier nineteenth century (e.g., Gleick, 2000; Gandy, 2006; Domènech, 2011). Reflecting on the above, I argue that the key concern of the growing emphasis on local infrastructural solutions or decentralized infrastructure is yet the lack of clarity of the ways in which local infrastructural solutions are governed for sustaining water access and public health, especially in Sub-Saharan Africa. In light of this, I argue that the complexities surrounding the non-utility-networked water infrastructures require "thinking" as well as "re-thinking" beyond the utility network. Because such evolution requires the critical role of governance in facilitating equity as well as the sustainability of infrastructure (see Elkington, 2006). The next section presents a conceptual review of governance as a "practice of governing water supply beyond the utility network".

1.2.5 Governance as a "practice of governing" water supply beyond the utility

Governance has received varied conceptualization and understandings since its evolution. For some scholars, governance is theory, a strategy or an approach, as well as a practice. In this study, governance is a "practice of governing" the act of doing through which varied non-utility-networked water infrastructures are developed and supply water beyond the utility network (e.g., Reckwitz, 2004; Rouse, 2006). Governance is a "way of doing" involving the definition of (in)formal procedures, actors, and modalities of interactions. This perspective informs the central question of the dissertation such as, "How are the production and distribution of water beyond the utility network governed? And how can the governance of water supply beyond the utility network improve water access? In response to the broader question, Urban water scholars, Urban planners, geographers and anthropologists invite us to engage with the notion of *"everyday governance"* and *"everyday practices"* grounded on practice theory, especially where situated to the phenomenon in the global South (Cornea et al., 2017; Truelove, 2019; Iossifova, 2015; Rusca & Cleaver, 2022). They suggest that "governance" in its broader context offers little analytical power for analyzing practices, especially the ways in which varied non-utility-networked water infrastructures are produced and distributed water beyond the utility network (Rusca & Cleaver, 2022; Cornea et al., 2016). Therefore, situating practice theory alongside governance offers foundations to highlight the diversity of actors and institutions involved in water supply beyond the utility and the ways in which the involved actors interact to shape policy and decision-making processes and mediate the flow of water. This offers the possibility to understand the everyday making of water infrastructures, the materiality of water, the social relations, and the diverse practices that shape water supply across spatial contexts.

With this understanding, seeing water infrastructure governance as a "practice" – an act of doing – helps appreciate the procedural arrangements, the modalities, and the actors involved in the practices. These together can help shed light on how urbanites engage, produce, and distribute water every day (Cornea, 2016; Cornea et al., 2017; Perazzone, 2020; Cirolia, 2020a; Serin & Irak,

2022; Guarneros-Meza, 2022). This lens of inquiry has received scholarly consideration in the past decades in diverse fields, most especially water infrastructure studies (e.g., Le Meur & Lund, 2001; Strengers, 2010; Cornea et al., 2017; Alba et al., 2019; Glad, 2017; Kundu & Chatterjee, 2021). Everyday practice and governance entail the ordinary ways in which the involved actors structure processes, define rules and regulations, and devise mechanisms towards the production and distribution of water beyond the utility network (Dakyaga et al., 2020; Zhen et al., 2019).

Practice-related studies show how the everyday practice lens can improve understanding of the ways in which urbanites adapt to infrastructure, especially during periods of disruption (Eledi et al., 2023). People interact among themselves and with diverse artefacts, power relations (Rouse, 2006; Graham, 2009), and societal structures to produce and deliver services within urban spaces (Pilo', 2022). In the context of water supply, practices to collect water manifest in "multiple and repetitive actions" such as fetching, storing, and saving water for domestic use (Sarkar, 2020a). In such geographies, the variegated water infrastructures owned and improvised by individual residents fill water access gaps (Lawhon et al., 2018; Adams, 2018; Crow & Odaba, 2010; Sultana, 2018; WHO/UNICEF, 2020). Water is collected from vendors, truck drivers, standpipes, shallow or tube wells, and mechanized boreholes (Sarkar, 2020a). Local residents, plumbers, pump engineers, and hydrologists may work to (re)configure and sustain the flow of water beyond the utility network, drawing on technical knowledge, creativity, and learning by doing in their everyday engagement with infrastructure beyond the utility (Strenger, 2011).

Practice theorists offer clarity to the everyday practices lens by highlighting the specificity of practices (Rouse, 2006; Reckwitz, 2004), and their natures and encouraging scholars to pay attention to the routine acts of urbanites that are somehow redundant in the urban environment (Eledi et al., 2023). These also include acts that pave the way for the delivery of water infrastructure and services. In governance, mundane acts are connected to the material and social aspects of everyday life, including rules, norms, conventions, and social meanings (Rouse, 2006). Practices extend beyond the mundane aspects of everyday life to include the performance of highly structured short- and long-term activities, verily across urban spaces. The practice of governing may be localized, geographically bonded, historic in nature, or generic across society in rare contexts (Rouse, 2006). The practice of governing water supply by the actors can be acquired and transmitted to others, and can contribute to the (re)production of ordinary acts (Strengers, 2011). As a set of norms, rules regarding water supply beyond the utility can be self-interpreted by the varied actors involved, as well as obeying and/or going against them (Rouse, 2006). In light of this, rules and regulations can improve water supply as well as deepening inequality in access to water, when supplied beyond the utility and when less regulated (Hofstetter et al., 2021).

In the sphere of urban water supply, the existence of rules and adhering to defined formal or informal regulations constitute "a practice" for an outcome. Although tanker truck drivers, pushcart operators, mechanized borehole providers, and plumbers work to develop situational hydraulic infrastructures, providing differentiated water services in the absence and failure of the network (Allen et al., 2006; Sarkar, 2019), their existence and adhering to existing regulations represent an act for improving water access. The practice of tinkering with the pipe by citizens serves as an

alternative process for securing water illegally from the utility (Wamuchiru, 2017a; Rateau & Jaglin, 2020). By nature, tinkering with the utility pipe represents a practice that enables the actors to gain access to water and satisfy their interests but may also deprive the utility of revenue (Kjellén, 2007). Generally, it can challenge the effort of the utility to foster water access, especially increasing coverage at the city scale. Practice theory is thus important for unravelling these acts (Rouse, 2006), which are pivotal to human life but constitute the water access trajectories of cities in the global South. They constitute the actions of ordinary individuals and practitioners but are somehow hidden in the everyday theorization of urban water supply and governance. Understanding the governance of water supply beyond the utility network requires an analysis of the governance framework mediating the varied infrastructures that supply water beyond the utility network, the ways in which such infrastructures are developed, the mechanisms sustaining these infrastructures, as well as pricing determination. The next section presents an analytical framework on the "practice of governing water supply" towards improving water access.

1.2.6 Analytical framework: Practice of governing water supply

The review of concepts and practice theory shows that cities in the global South are characterized by networked and non-utility-networked water infrastructures. Moreover, an understanding of the ways in which water supply beyond the utility network is governed, can offer a holistic insight for improving water access. Based on the review, I suggest four interconnected factors that need to be examined in order to enhance understanding of the governance of water supply beyond the utility network. Firstly, an understanding of the framework guiding the provision of heterogeneous non-utility-networked water infrastructures. Secondly, understanding the rules and regulations that mediate the (re)reproduction, of varied non-utility-networked water infrastructures and how they sustained over time for water supply. Thirdly, how pricing of water beyond the utility is produced and regulated, especially the mechanisms that determine water pricing and the agents that mediate such processes, and fourthly, an evaluation of the potentials and limits of the ways in which water is produced and distributed beyond the utility for improving water access.

Governance framework guiding water supply beyond the utility network: A governance framework is central for understanding how water is supplied beyond the utility network. Governance mechanisms steer actors towards water supply activities. These mechanisms include formal, informal, and market-based instruments. Formal mechanisms encompass legally instituted rules, regulations, legislative instruments, and sanctions that ensure adherence to operational and quality standards. The informal mechanisms consist of rules such as social norms and values, local laws, and sanctions. Regulatory mechanisms guide actors' behaviour by rewarding conformity and sanctioning non-conformity. Governing mechanisms determine ownership, decision-making processes, accountability, monitoring, evaluation mechanisms, and entry/exit protocols for the involved actors. The modes of entry and exit may be defined by institutional procedures such as accessing licensing and registrations, permitting, and adherence to rules and regulations guiding water extraction. The framework can also define water quality monitoring standards for monitoring and evaluating the performance of the actors and how the actors relate to the existing standards

required for both commercial and domestic water provision and usage (Pakizer & Lieberherr, 2018). Within the procedures, the state actors may be responsible for assessing and standardising water quality. These procedures have the possibility of increasing the confidence of the actors engaged in water supply beyond the utility network. As indicated in Figure. 1.1, governance mechanisms and actors are central to the governance of water supply beyond the utility network. *Chapter 3* of the dissertation presents a comprehensive framework of governance modalities, and actors' interactions within heterogeneous infrastructures (see Figure 1.1).

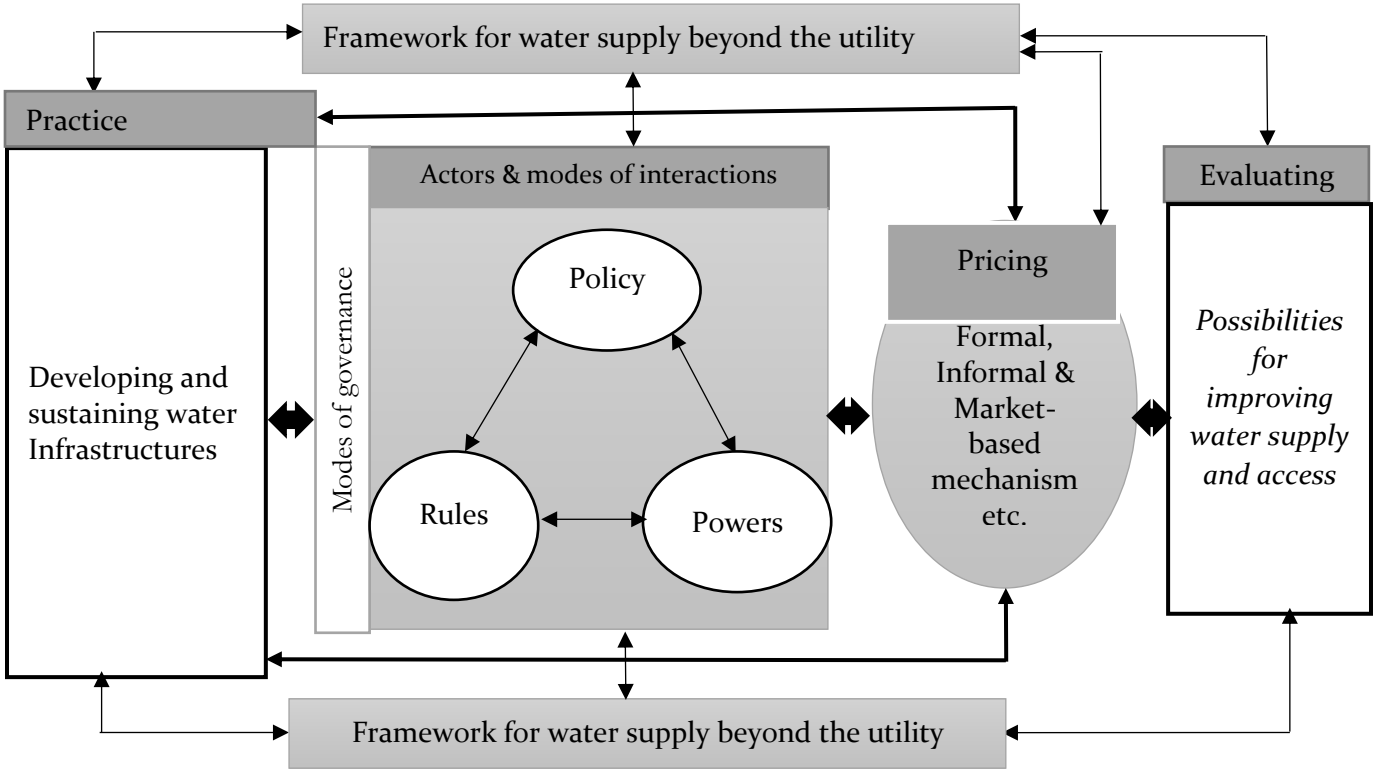

Figure 1.1 Conceptual framework: Practice of governing water supply for improving water access

Source: Author's construct, 2023.

The practice of developing water infrastructure: As indicated earlier, non-utility-networked water infrastructures are micro-grid water systems that mediate the production and distribution of water beyond the utility network. These water infrastructures are outputs of "practices" engaged in by varied actors. They emerge through the practice of (re)making, maintaining and connecting systems (Alba et al., 2020). Alba and others argue that understanding the socio-technical practice of establishing connections helps deepen understanding beyond the structural processes and societal relations that (re)produce urban water inequalities (ibid.). Water supply beyond the utility network revolves around a complex and interdependent practice, where social, cultural, and political environmental conditions foster the provision and distribution of water (Linton & Budds, 2014). The activities of the actors towards the development of water infrastructure may be shaped

by the knowledge and technologies acquired or introduced to the actors from elsewhere, or transmitted by generations towards water provision (Rouse, 2006). The adoption of the acts and technologies by residents may be driven by the capacities of the actors; including human resource/skill abilities, materials to facilitate routine access, and technical know-how to operate and maintain water infrastructure. Individuals, groups, and associations Community-based organizations (CBOs), Civil Society Organizations (CSO), development partners, and private sector actors with technical know-how, innovation, and resource capacities may engage in ordinary activities by providing and managing water supply beyond the utility network (Kyessi, 2005; Dill, 2010). These actors may finance the provision and operations of water systems to provide water service (Pakizer & Lieberherr, 2018). *Chapter 4* of the dissertation, details the various acts engaged by non-state actors to develop water infrastructures for water supply beyond the utility network, and how such infrastructures are sustained for water supply. The Chapter offers clarity about how the involved actors secure resources, the activities and discourses surrounding such actions, and the existing rules governing water supply beyond the utility network.

Water pricing governance beyond the utility network: Pricing is a practice, a critical issue that requires governance or regulations. Pricing is central to sustaining water infrastructure and crucial to fostering equity and minimizing inequalities in water distribution and access. As an act of doing, it offers the possibility of saving water and recovering the cost of water supply (Jaglin, 2002). Who and how prices of water are regulated can challenge repairs and maintenance of the infrastructure, and foster (in)equality in access to water. This makes pricing regulation imperative for water supply, especially in geographies where water is predominately supplied beyond the utility network. In the context of governance, the existence of (in)formally defined procedures and mechanisms can be useful for determining the unit cost of water supply and minimizing inequalities and exploitations in access to water. As stated earlier, inequity, injustices, inequalities, and human welfare have been raised as key concerns that need to be addressed by water governance (Perreault, 2014; Millington & Scheba, 2021). Water pricing practices are not exempted in the roadmap towards reducing inequality, inequity and improving human welfare, especially the right to water and "water as life" (Velzeboer et al., 2017) and (in)security (e.g., Wutich, 2020; Ford et al., 2022). Pricing is much linked to demand and supply and more unpredictable (Echternacht 2014). This makes the existence of regulations for guiding pricing determinations, and mediating interactions between producers, distributors, and consumers more crucial. In the informal dimension, these can take the form of existing associations, groups, and individuals, defining and regulating prices for equitable water supply.

Evaluating the outcomes of governance: discourses in water governance as an act of doing, is often geared towards a defined objective. In other words, processes and activities undertaken by the actors involved, are aimed at achieving an intended goal. Whereas governance issues may vary, the central notion of all is an understanding of the outcomes of such practice. However, such outcomes can be better understood through monitoring as well as evaluation of the ways in which water is produced and distributed. Tracking and evaluating water-related practices are critical in water

infrastructure governance, especially where water is literally supplied beyond the utility network. In this context, evaluation involves analyzing the potentials and limits of everyday practice of producing and distributing water, concerning how they shape water access (availability, affordability, reliability, quality, and spatial distance) beyond the utility network. Considering the possible risk associated with water delivery beyond the utility network (Sakijege, 2019), and how risks are navigated every day towards water collection (Björkman, 2014), evaluating everyday practice of producing and distributing water beyond the utility network can offer the possibility of clarifying contradictions about the outcomes of water supply beyond the utility network on the residents/persons being governed – households without network water who rely on water supply beyond the utility network. The results of the evaluation can provide precedent for regulatory policy formulations and strategies towards the varied non-utility-networked water infrastructure that supply water to residents.

1.3 Justifying the thesis focus in Dar es Salaam

Water supply beyond the utility network is a historical phenomenon in Dar es Salaam's waterscape. A city that is facing growing water scarcity shaped by complex factors ranging from rapid urbanization, climate change, and weak governance of network water distribution (Bender, 2021; Rugemalila & Gibbs, 2015; Nganyanyuka et al., 2015; McGranahan et al., 2016). Amidst the institutional challenges, unequal coverage of network water supply, and fluctuating patterns of water flow, diverse non-utility-networked water infrastructure coexist, produce and distribute water beyond the conventional network (Kjellén, 2000; Allen et al., 2017; Dill, 2010; Kyessi & Lupala, 2016). Studies have evolved about the ordinary practices that mediate the flow of water outside the utility in Dar es Salaam and the complex ways in which urbanites access water (Dakyaga et al., 2018b; Smiley & Hambati, 2019; Hofmann, 2022). Some scholars continue to highlight the coping strategies of residents and the roles of alternative water systems in the midst of water supply complexities (Nganyanyuka et al., 2015; Mapunda et al., 2018).

Whereas governance is central to minimizing water scarcity and facilitating water distribution and access (Nastar, 2014; Reymond et al., 2020), the governance of the varied non-utility-networked water infrastructures of Dar es Salaam's waterscape has been understudied. Related dissertations such as Kjellén, (2007) "explore the roles of the public and private sectors in water supply, and the tension between collectively organized and individually devised solutions to access water" (p. 19). Through the continua of public-private, individual-collective, and local-global, Kjellén shows that private actors and individuals shaped how water was distributed and accessed in Dar es Salaam. Kjellén's work offered a reflection of the peculiar works of artisans and residents and how they work to divert investments from the network water provision. Bourque (2010) builds on the above by focusing on the power relations – the relationships that characterize the buying and selling of water at different scales in Dar es Salaam. Bourque reveals the roles of Community-Based Organizations (CBOs), individuals, Non-governmental Organizations (NGOs), Municipal-piped providers, international donors, household resellers of water, public civil societies, *Mtaa* (local leaders), and

water users, revealing how these actors interact within the contour of diverse powers to influence water supply in a suburb of Dar es Salaam (Bourque, 2010).

While these aforementioned dissertations shed light on the varied ways through which water is supplied beyond the utility network in Dar es Salaam, a lacuna remains about how the practices especially concerning water supply beyond the utility network, are governed towards improving water supply. Particularly the varied practices that mediate water production and distribution in the equally varied non-utility-networked water infrastructures and how governance of these water infrastructures can improve water access beyond the utility network. In this dissertation, I build on the aforementioned studies by distinctly situating governance as "a practice" grounded in practice theory (see Rouse, 2006). I argue that a clear understanding of the governance of the varied water infrastructures that supply water beyond the utility network requires moving beyond the analysis of power relations towards developing a comprehensive framework for holistic analysis of the ways in which water is produced and distributed. A comprehensive framework can aid scholarly understanding of the governance of varied non-utility-networked water infrastructures as well as the practices through which these infrastructures are produced and supplied beyond the utility network. However, these remain lacking in the scholarly theorization of water infrastructure governance in Dar es Salaam. Secondly, understanding the practices of the varied actors, operating beyond the utility network, how non-utility-networked water infrastructures are developed, the kind of resources involved, and where and how they are secured for water infrastructure development and sustainable water supply is critical in the context of everyday water supply. Especially, who and how prices of water are determined are critical elements for water infrastructure governance. Lastly, bringing all these together can provide an understanding of the extent to which the repetitive everyday practices beyond the utility network may contribute to enhancing water access. Reflecting on these components in the context of socio-economically heterogeneous urban settings such as cities in the global South is crucial for spatial planning and for contributing to urban water discourses.

Previous dissertations, such as Neves Alves (2016) elsewhere, focusing on place-based practices in water provision in Bafatá, a Guinea-Bissauan city, call for urban scholars to pay attention to the evolving practices that concern urban water provision and access, towards understanding the pattern, dimensions, how alternative water infrastructures are governed, and how they relate to other forms of governance. Who are governed and are affected, as well as how these can foster access to safe water in cities. I also acknowledge the ever-growing studies on water infrastructure governance (e.g., Tortajada, 2010; Cleaver & Hamada, 2010; Domènech, 2011; Adams et al., 2020; Alba et al., 2019; Furlong, 2012; Allen et al., 2016; Truelove, 2019; Neves Alves, 2016) that researched various dimensions of water governance such as community governance, power relations in water provision and supply (Adéníran, 2022). This dissertation builds on the aforementioned studies with a distinct focus on the fragmented practices that mediate water infrastructure provision, the governance modalities, pricing mechanisms, and how far these practices and processes can foster improvement in access to water. Rouse (2006) shows that, if practices are transmitted and (re)produced over time, then it is imperative to unravel how they are governed and sustained

overtime. These can offer a nuanced imagination of the ways in which infrastructures are configured to facilitate water flow beyond the utility network and their possibilities for improving water supply.

Following the aforementioned justification, this dissertation ***examines the extent to which heterogeneous water infrastructures beyond the utility network are governed, the practices mediating such water infrastructure provision, and how governance of the infrastructures can improve water access beyond the utility network.*** To fulfil this agenda, I focused on the practices, the governance modalities mediating water supply, the pricing of water and an evaluation of the limits and potentials of the practices associated with water supply beyond the utility network. In so doing, I frame governance as a "practice of governing" grounded in practice theory (e.g., Rouse, 2006). Alongside, I invoke debates on thinking beyond the utility network to follow the mundane acts of urbanites in the aspect of socio-technical configurations such as non-utility-networked water infrastructure provision. These are further presented as follows:

RQ 1. *What framework can foster a comprehensive understanding and analysis of the governance arrangements of heterogeneous non-utility-networked water infrastructures that produce and supply water beyond the utility network?*

This question sought to explore and analyse the governance arrangements of heterogeneous water infrastructures beyond the utility network. The study addressed this question, by proposing a framework of governance modalities, actors' and interactions within heterogeneous water infrastructure. The proposed framework was built based on a review of urban water infrastructure, everyday and governance. Through the proposed framework, I empirically analysed the everyday governance arrangements of the heterogeneous water infrastructures that supply water beyond the utility network in Dar es Salaam, Tanzania. In so doing, I highlight the categorises of water infrastructures that produce and supply water beyond the utility network, their modes of governance, the actors and modes of interactions through which water is produced and distributed beyond the utility network, and the power and regulatory mechanisms governing water supply beyond the utility network (*see Chapter 3*).

RQ 2: *How do the everyday practices of non-state actors mediate the development of non-utility-networked water infrastructure beyond the utility network? What mechanisms determine the sustainability of such infrastructures for water supply beyond the utility network?*

This question sought to explore the ordinary ingenuities of non-state actors, particularly, focusing on how they develop and sustain non-utility-networked water infrastructures to supply water beyond the utility network. In so doing, the study draws on debates from everyday practices and governance for sustainability as an analytical lens to explore the practices of non-state actors in relation to how they develop and sustain water infrastructure. It highlights the key actors/agents involved in the practice, the kind of resources and sources of funding for water infrastructure development, the discourses concerning water supply, the activities undertaken by the various actors towards infrastructure development, as well as the rules and mechanisms that shaped the

sustainability of the infrastructure for water provision. This research question builds on question **RQ 1** in the thesis (*See Chapter 4*).

RQ 3: *How is the pricing of water provided beyond the utility network governed?*

This question sought to explore the mechanisms that determine the pricing of heterogeneous non-utility-networked water infrastructures that produce and distribute water beyond the utility network, the actors involved, and the ways prices are regulated. In so doing, I draw on debates about heterogeneous water infrastructures beyond the utility network alongside the everyday practice of pricing water beyond the utility. These helped to reveal the varied water prices of the varied infrastructures, how water was distributed and paid for, the ways in which prices of water were produced, who regulated the prices of water, and how such regulations manifested in reality. This question builds on **RQ 1** and **RQ 2** of the thesis (*see Chapter 5*).

RQ 4: *What are the potentials and limits of the ordinary practice of governing non-utility-networked water supply beyond the utility for improving water access?*

The findings of **RQ 1, RQ 2,** and **RQ 3,** showed that varied governance modalities governed the production and distribution of water in the non-utility-networked waterscape. The practices were stimulated by the ordinary acts of the activists and exhibited as co-production, but more embodied in self-governance. Therefore, this research question sought to build on **RQ 1, RQ 2,** and **RQ 3** by evaluating the limits and potentials of the ways in which non-utility-networked water infrastructures are governed. It helps provide a nuanced understanding of what such practices really achieved in terms of water access: quality, affordability, reliability, and distance to water. The practice of self-supplying water is further highlighted and assessed in connection to quality of water, reliability, availability, and distance. This was done by drawing debates from everyday practices, and self-governance alongside the concept of water access *(see Chapter 6).*

1.4 Rationale

The dissertation contributes broadly to scholarly discourses on urban water infrastructure governance relevant to cities in the global South and to urban water policy. In terms of scholarly contributions, the dissertation furthers debate on water supply beyond the utility network in the context of urban studies by unravelling the governance of fragmented infrastructures associated water supply beyond the utility. It highlights the nature, artefacts, modalities, and varied spaces and acts that (un)shape these practices. Especially the mechanisms embodied in the pricing of water in everyday water production, distribution, and collection. Additionally, the dissertation contributes to urban water infrastructure governance discourse by proposing a novel framework of governance modalities, actors, and interactions within heterogeneous infrastructures. This offers the possibility for a comprehensive analysis of what people actually do beyond the networked infrastructure, the embodied practices, and how these practices work to supply water in diverse spaces. Again, the dissertation contributes to the debate on thinking beyond the utility network by interrogating and analyzing how far the practices mediating water supply beyond the utility can go

towards improving water access in cities in the global South. It did so by highlighting the implications of water supply beyond the utility network.

Beyond the scholarly contribution, the dissertation provides useful insights into urban water infrastructure governance, policy formulation, and planning beyond the city of Dar es Salaam, by providing a vivid assessment of what local-level arrangements really achieve. Cities and communities cannot be sustainable and resilient without water infrastructure. The Sustainable Development Goals (SDGs) (targets 6.1 and 9.5a), call for the need to achieve universal and equitable access to safe and affordable drinking water for all. In the context of African cities, this can be realized through the development of sustainable and resilient water infrastructure (United Nations, 2016). In addition, realizing SDG 6 requires the collective effort of state and non-state actors engaged in water supply. Therefore, this dissertation brings to light the ordinary acts that non-state actors devise to produce water infrastructure beyond the utility network as well as how they are sustained for water supply. In so doing, it contributes to Sustainable Development Goal 6, which aims to ensure the availability and sustainability of water and sanitation for all. How? – it demonstrates how water is made available and sustained outside the frontiers of state governance. It acknowledges the centrality of water in the context of human rights and health and the role of governance in reducing inequalities and inequities in the distribution of water. The governance arrangements in which water infrastructures are developed and sustained helped highlight the existing gaps and challenges that need to be addressed towards improving urban water supply in African cities. Additionally, the dissertation contributes to urban planning and policy by providing a comprehensive mapping of the various actors involved and the modes of interactions towards pricing determinations and the processes and mechanisms governing the provisions and operations of water supply outside the utility. It provides a categorization of the varied non-utility-networked water infrastructures beyond the utility network as the basis for proposing and aligning policy directions towards building collaboration as well as regulatory measures. The limits and potentials of water infrastructures that supply water beyond the utility network for improving water access have also been demonstrated. The findings and recommendations from this study aim at informing urban planners and policymakers, towards (re)thinking beyond the utility network in efforts towards improving urban water supply in the global South. In effect, it cautions that water supply beyond the utility is useful for improving water access, however, not all categorizes of non-utility-networked water infrastructure may foster improvements in access to water beyond the utility network.

1.5 Outline of the dissertation

The dissertation collectively presents the research problem and the overarching objective of the study. The entire dissertation comprised seven Chapters.

Chapter 2: presents the research methodology. It draws on the inductive research approach alongside the case study method to examine the governance of non-utility-networked water infrastructure – delving into the practices in which water is supplied beyond the utility and how

such practices can improve urban water supply. It presents a justification for the selection of the case study city and the settlements.

Chapter 3: draws on everyday practice and governance to holistically propose a framework of governance modalities, actors' interactions within heterogeneous infrastructure beyond the utility network. The proposed framework was built by drawing on reviews of urban water infrastructure literature alongside everyday practice and governance. Through the proposed framework, I empirically analysed the everyday governance arrangements of the heterogeneous water infrastructures that supply water beyond the utility network in Dar es Salaam, Tanzania. In so doing, it highlights the categorises of the water infrastructures beyond the utility network through which water was produced and distributed, the modes of governance of the various water infrastructures, the actors and the modes of interactions through which water was produced and distributed, and the power and regulatory mechanisms governing water supply.

Chapter 4: draws perspective from governance for sustainability alongside the everyday practices of non-state actors to explore the mundane acts of non-state actors about how they develop and sustain water infrastructure for supply beyond the utility network. It highlights the key actors/agents involved in the practice, the resources, where and how the engaged actors' source (non)material resources to develop non-utility-networked water infrastructures such as boreholes, tanker water supply, wells, the discourses concerning water supply, the activities undertaken by the actors towards the infrastructure development, as well as the rules and mechanisms that shape the sustainability of the infrastructures for water provision.

Chapter 5: draws perspective from heterogeneous non-utility-networked water infrastructures alongside everyday practice for pricing water to explore the mechanisms that determine the pricing of water in the non-utility-networked waterscape, particularly the practices that determine the prices of water per cubic meter among the various non-utility-networked water infrastructures. It highlights the prices of water in the varied non-utility-networked infrastructures in Dar es Salaam, how water was distributed and paid for, the processes through which prices of water were produced, who regulates the prices of water, and how such regulatory efforts manifest in reality, (see Table 1.1).

Table 1.1 Outline of chapters and publications

Linkages	Research questions	Chapters	Manuscripts	Publication status
3 (Governance framework for non-utilityonetworked water infrastructures)	**RQ1:** What framework can foster a comprehensive understanding and analysis of the governance arrangements of heterogeneous water infrastructures that produce and supply water beyond the utility network?	3	Geographies of Infrastructure: Everyday governance of urban water supply beyond the utility network in Dar es Salaam	***Accepted***: 18/05/2023 in, *Water Alternatives*
4 (Practice of developing infrastructure)	**RQ2:** How do everyday practices of non-state actors mediate the development of water infrastructures beyond the utility? What mechanisms determine the sustainability of such infrastructures for water supply beyond the utility network?	4	Governing ourselves for sustainability: Everyday ingenuities in the governance of water infrastructure in the informal settlements of Dar es Salaam	***Published:*** 15th November 2020 in *Urban Forum,* (Latest article): *doi.org/10.1007/s12132-020-09412-6.*
5 (Practice of pricing water)	**RQ3:** Who are the actors? And what mechanisms determine the pricing of water in heterogeneous infrastructures beyond the utility network? And how are such prices regulated?	5	Charging the non-networked: Governing water pricing of heterogeneous infrastructure in Dar es Salaam	***Submitted:*** 17th March 2023 in *Environment and Planning: Politics & Space*: Major Revision decision made on 30th May 2023.
6 (Evaluating outcomes of governance)	**RQ4:** What are the potentials and limits of the ordinary practice and processes of self-governing non-utility-networked water infrastructures beyond the utility network in terms of improving access to water?	6	Between self-help and emerging water markets: Self-Governance, everyday practices and the spatiality of water access in Dar es Salaam	***Published:*** 9th July 2022 in *Urban Geography;* (Latest article): doi.org/10.1080/02723638.2022.2106054

Chapter 6: builds on Chapters 3, 4, and 5 by evaluating the limits and potentials of the ways in which non-utility-networked water infrastructures are governed, presenting the nature of such practices, and providing a nuanced understanding of what such practices really achieve in terms of water access: quality, affordability, reliability, and distance to water. The chapter highlights the everydayness of self-supply arrangements for residents, the ways in which water is priced beyond the utility to mediate collection, the governance modalities of such water supply arrangements, and the spatialities of these arrangements. This was done by drawing debates from everyday practices, and self-governance alongside the concept of water access (see Table 1.1).

Chapter 7: presents the conclusion and discussion by synthesizing the findings presented in Chapter 3, 4, 5, and 6. The chapter also provides reflections on the major findings, vis-à-vis the theory and perspective, such as the practice theory and the perspective on thinking beyond the utility network. It also highlights the main contributions of the dissertation, the Policy planning recommendations, and the limitations

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CHAPTER TWO

RESEARCH METHODOLOGY

2.1 Study setting: City of Dar es Salaam, Tanzania

Dar es Salaam is the most urbanized city in Tanzania and one of the fastest-growing cities in Africa. The city comprises of five political administrative municipalities: Ilala, Temeke, Ubungo, Kinondoni and Kigamboni. These municipalities are headed by Director Commissioners (Todd et al., 2019). As of 2020, the city had a land area of about 1,393 square kilometres, with a population of 6.4 million and a density of about 3,100 persons per square kilometre. By the year 2022, its population had evolved from 6.4 million to 7.4 million people, with a growth rate of 5.08%. Like many cities in the global South, Dar es Salaam's population is largely influenced by rural-urban migration and inter-urban migrations as well as natural increase (Todd et al., 2019). The rising population and its geographical location places Dar es Salaam as a pivotal economic centre of mainland Tanzania, the centre of manufacturing and basic industries (Todd et al., 2019). It is the anticipated destination of several people from other parts of Tanzania, typified as the destination for livelihoods and for economic prospects. These factors and reasons have continued to shape Dar es Salaam's urban nature, including infrastructure and services access and coverage. Rapid nature of Dar es Salaam's urbanization, places the city as one of the potential Megacities of Africa. Its population is anticipated to reach more than 10 million by 2030 (Bhanjee & Zhang, 2018). This character of urbanization is an exemplary one, that could serve as a guide in term of experiences and challenges to Tanzania, the mainland and other cities of Africa, especially in the aspect of infrastructure provision.

Although efforts to promote equitable distribution of services across the entire country led to a shift in the capital city from Dar es Salaam to Dodoma in 1973, Dar es Salaam yet holds the primacy in Tanzania in terms of population concentration, and political administration (offices of political appointees) and concentration of investments in infrastructure and services. Economically, it constitutes the largest economic pillar of the mainland influenced by its natural economic features such as the Ocean and several beaches. Most importantly, it hosts the famous port where trading activities revolve in East Africa (Todd et al., 2019). While rapid urbanization, induced by population constitutes more or less a fortune in propelling urban centres to act as vibrant engines of growth, Dar es Salaam's rapid urbanization has been characterized by infrastructure and services deficiencies ranging from transportation, waste management, healthcare, housing, sanitation and water infrastructure amongst others (Andreasen & Møller-Jensen, 2017; Mkalawa & Haixiao, 2014; Kirama & Mayo, 2016; Swere, 2016). Specifically, Dar es Salaam water infrastructure has historically lagged behind the growing urban population, challenging the already frail water production capacity of the utility, the Dar es Salaam Water Supply and Sewerage Agency (DAWASA), (Todd et al., 2019). The challenge of infrastructure and services has been endemic since the colonial era. From a post-colonial perspective, the existing gaps in infrastructure and services provision in Dar es Salaam is as result of the colonial history of segregation (Smiley, 2013; Todd et al., 2019). However,

in the postcolonial discourses, infrastructure and services deficiency in Dar es Salaam is more an account of governance failure (Rugemalila & Gibbs, 2015). These challenges have not only undermined network coverage but also the quality of water, reliable water flow as well as inequity in the distribution (Bourque, 2010; Dakyaga et al., 2018b; Nganyanyuka et al., 2015).

The Energy, Water and Utility Regulatory Agency (EWURA), exercised regulatory authority over utility service provisions including petroleum, electricity and water and to protect the interest of the consumers. Over the years, the network water supply of Dar es Salaam has been largely sourced from the Lower Ruvu near Bagamoyo, Upper Ruvu near Mlandizi, Mtoni in the Temeke District and boreholes. Water sourced from these four major sources is developed and distributed to the various parts of the city (Kjellen, 2007; McGranahan et al., 2016). Among the above-mentioned, the Lower Ruvu Scheme, established in 1976, is the largest waterworks in Dar es Salaam. The original design capacity of the treatment plant was 182,000m3/day, however, its capacity has increased to 270 m3/day following maintenance and rehabilitation works (McGranahan et al., 2016), (See Table 2.1). Before 2018, the networked water supply was governed by the Dar es Salaam Water and Sewerage Agency (DAWASA) and the Dar es Salaam Water and Sewerage Company (DAWASCO) as formally mandated state institutions tasked with water distribution mainly in the city of Dar es Salaam. In this, arrangement, DAWASCO played the role of the service provider, responsible for the production and distribution of water to residents and collection of water bills. DAWASCO was accountable to DAWASA who exercised the role of asset Manager (Bourque, 2010). Due to rising leakages, redundancy, erratic flow and uneven distribution of pipe water, these two agencies were merged in 2018 with the aim to improve water supply in the city. As a result, DAWASA presently represents the service provider as well as the manager of the asset. However, the outcome of this arrangement is yet to be realized as the networked water supply remains uneven in the city. This arrangement resonates with the premise of the networked water infrastructure, being the aspirations of city authorities and residents (Smiley, 2013), and the major archetype shaping urban water supply in global South cities (e.g., Monstadt & Schramm, 2017).

In addition, Non-Governmental Organizations (NGOs) such as WaterAid, Community-based organizations (CBOs), and PLAN International amongst others have been formally complementing the utility of distributing water (Smiley, 2016). NGOs and development agencies develop and manage alternative water supply systems especially in low-income areas of Dar es Salaam. These serve as a complement to the surface water collected, treated and distributed by the utility (Moretto et al., 2018; Faldi et al., 2019). These agents are the major formal actors managing and supplying water (McGranahan et al., 2016). As an additional effort to enhance water supply, the Water Supply and Sanitation Act of 2009 made provision for the establishment of non-utility-networked water systems, such as Community-Owned Water Supply Organizations (CWSO). These organizations consist of formally established water-kiosk operators and boreholes located in the informal or peri-urban areas, working in partnership with the utility (Kjellén, 2000; Dill, 2009; Kyessi, 2005; McGranahan et al., 2016). Despite the variety of formal water infrastructure in Dar es Salaam complementing the utility, water supply and access remain complex, characterised by inequitable distribution and coverage of the network, high cost, low quality and unreliable supply (Smiley,

2013). Households with access to clean and safe drinking water stood at 47% in 2010 and only grew to 51.7% in 2013 and up to 68% in 2016 (McGranahan et al. 2016).

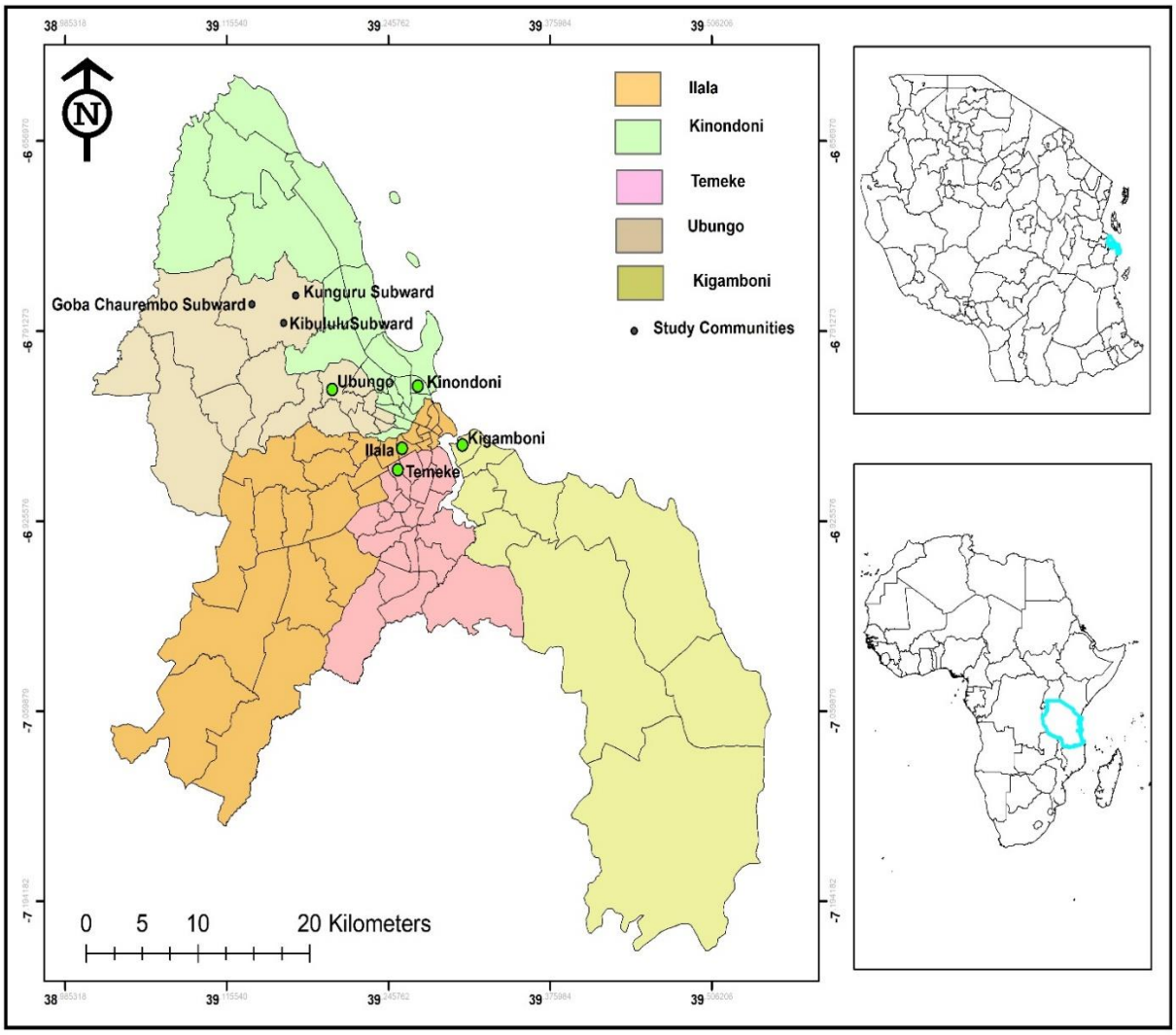

Figure 2.1 Map of Dar es Salaam showing the municipalities

Table 2.1 Dar es Salaam's Utility water sources and production capacity

Sources	No	Production Capacity in 2014 (m^3/day)	Production Capacity in 2016	Water Demand in 2032
Lower Ruvu	1	182,000	270,000	-
Upper Ruvu	1	82,000	196,000	-
Mtoni	1	9,000	9,000	-
Boreholes	850	27000	260,00	-
Total	-	300,000	735,000	900,000

Source: McGranahan et al., (2016)

About 38% of the households in Dar es Salaam remain unserved with running water most of which are located in the peri-urban areas of the city (ibid). However, 68% with access to clean water do not necessarily imply access to running water in their households but also comprised outdoor water systems (Smiley, 2020). Water from the utility has been unreliable in terms of flow, and less perceived by residents as improved for drinking. Consequently, whereas households may be connected to the network, several others tend to be connected to groundwater systems mediated by mechanized boreholes. These represented ways of coping and adapting to the utility water supply (Nganyanyuka et al., 2015; Mapunda et al., 2018). Residents do not only cope and adapt to water-related challenges in the city but also to electricity (Eledi et al., 2023).

Citizenry attempts towards coping and adapting to the utility failure are occasioning an increasing proliferation of varied water infrastructures in the city as alternative systems of water supply. These varied water infrastructures range from wells, private standpipes, water kiosks, mechanized boreholes providing running to neighbourhoods, water resellers, tanker trucks, rainwater harvesting, pushcarts, and self-supply boreholes amongst others (Allen et al., 2016; Moretto et al., 2018). These infrastructures produce and distribute water beyond the utility network to service urbanites in the city. While state actors continue to influence the production and distribution of network water in the city, the governance of the aforementioned water infrastructures remain understudied. However, evolving debate on thinking beyond the utility network, especially in the global South (e.g., Gleick, 2000; Domènech, 2011; Furlong & Kooy, 2017), provides groundings for expanding understanding of the practices in which water infrastructures beyond the utility network are developed. Overall, it is argued that understanding water pricing and distribution beyond the utility can improve our imaginations of the ways in which water flows beyond the utility. This can provide the basis for developing and planning water infrastructure and for improving water supply beyond the utility network.

2.2 Research approach and methods

Here, I present the step-by-step logic that informed the dissertation and the conduct of the empirical studies towards the realization of the overall research goal. Thus, how water supply beyond the utility network is governed, the practices that mediate such water supply, and how governance of water infrastructure that supply water beyond the utility network can improve water access in Dar es Salaam. It details the dissertations' approach to thinking or reasoning, methods and research strategy and the selection of the case studies in response to the overarching research goal. Approaches to thinking in social science research vary, to including; the inductive, deductive and the so-called hybrid/abductive approaches (Kjellen, 2007; Gregory & Muntermann, 2011; Neuman, 2014). These are varyingly referred to as methods of thinking in social science research (Kothari, 2004), approaches to reasoning (Neuman, 2014), as well as theorizing strategies (e.g., Gregory & Muntermann, 2011; Yin, 2018). However, in the context of this dissertation, I regard these as approaches to reasoning in social science, as they assist in framing and setting the pace for social science research. The inductive approach to reasoning focuses on in-depth observation of specific empirical cases or individual phenomena often with the aim of building and generating theories.

This approach to social science research has been more or less associated with qualitative research and case study research. From the viewpoint of Creswell, the inductive approach to social science reasoning aligns more with the perspective of qualitative research (Creswell, 2016). While deductive research aligns more or less with the quantitative research. Yin argues that the collection of quantitative data tends to provide an "additional promise" to the inductive approach especially when applied to an empirical case study strategy (Yin, 2018). The deductive approach is often referred to as the "top-down' approach to theory building, where theorizing starts from the existing knowledge that is typically codified in the extant literature" (Gregory & Muntermann, 2011, p. 9). The abductive approach brings together the notion of induction and deduction to social science theorization, concerning the creation of theory by drawing on real-world observations, that are inductively observed (drawing on theoretical viewpoints, premises, conceptual patterns) and as well as inductively inferred (Gregory & Muntermann 2011).

Nevertheless, these approaches to social science research are interrelated and hence useful for framing social scientists' thoughts, intent and motives (Neuman, 2014). This dissertation follows the perspective of Neuman (2014), who regards these as approaches to social science reasoning, arguing that they offer first-hand direction for the examination or investigation of every given scientific piece or phenomenon. In light of this, the dissertation employs the inductive approach to reasoning with the aim to develop, explore, explain and further understand how water supply beyond the utility network is governance. This helped to adequately demonstrate, *Who, How* and to *What* extent governance of water infrastructure beyond the utility can improve water supply, especially in cities characterised by temporal incomplete network water infrastructure, but more or less dominated by non-utility-networked water infrastructures as co-existing systems. The inductive approach to social science reasoning helps to frame the study within the existing body of knowledge such as "the practice of governance" grounded on the practice theory (see Rouse 2006). Gregory & Muntermann (2011) highlight the supremacy of the inductive approach in social science research by revealing that "induction, deduction and abduction play role in inductive theorizing" (p. 10). Drawing on the inductive approach to reasoning, I employed an alternative direction of research questions that emphasize on open-ended questioning and discussions, providing flexibility to participants. This enabled the collection of detailed data, through which I obtained a holistic understanding concerning the governance of non-utility-netowkred water infrastructure; the provision, and the practices mediate water distribution beyond the utility network.

In addition, it helped subsume existing assumptions and concepts as an entry point to empirical enquiry about the governance of water infrastructures that operate beyond the utility network (Neuman, 2014). This theoretical orientation enables the dissertation to build on existing knowledge on non-utility-networked water infrastructure. It moves beyond the simplistic notion of how water is collected by urbanites from these water infrastructures, as it provokes scholarly discussions about water supply beyond the utility network. This enables the dissertation to stimulate debates on "(re)thinking the governance of water infrastructures beyond the utility network" By the inductive approach to reasoning, I sought not to test existing theories on water infrastructure governance but rather placed non-utility-networked water infrastructure within the broader assumption of infrastructure as socio-technical systems whose functioning revolves within

the everyday practice and governance grounded in practice theory (Rouse, 2006). I keenly scrutinized the empirical data collected concerning the practices and processes mediating water supply beyond the utility network, building on the patterns. Together, I contribute to the practice theory (e.g., Rouse 2006), and the evolving debate about thinking beyond the network, especially for urban supply in the global South (e.g., Furlong & Kooy, 2017). By building on this body of knowledge, I expand scholarly understanding on the governance of micro-level phenomenon that pertain to water infrastructure provision and water supply beyond the utility network in Dar es Salaam. While following the advantages of the inductive approach, I also recognize its challenge in the aspect of attaining generalizations and predicting observations of events and/or cases. I seek not to make empirical generalization of findings (Neuman, 2014), but cautiously to make theoretical and comparison-based generalization on the governance of water infrastructure that supply water beyond the utility network.

2.2.1 Research strategy

In line with the inductive approach, the dissertation adopted the case study research strategy with the aim to provide a nuanced examination of how water supply beyond the utility network via non-utility-networked water infrastructures are governed, the practices mediating water supply, and how the governance of such arrangement can improve water access in Dar es Salaam. In doing so, I acknowledge the varied dimensions or forms of case studies research (e.g., explanatory case, descriptive case or exploratory cases), (Yin, 2018). This dissertation employed an explorative case study strategy to provide a nuanced understanding of the governance of water supply beyond the utility network. In so doing, activities and practices associated with the governance of water infrastructures were explored. The dissertation adapts Robert Yin's perspective that suggests complementing quantitative data in a case study. This was necessary as the study seeks not only to unearth how water supply of the varied non-utility-networked water infrastructures are governed beyond the utility network, but also to evaluate the outcomes of such governance arrangements in terms of improving water access.

The case-oriented approach enables the analysis of place-based specific water supply situations (Yin, 2018), such as Dar es Salaam, where manifolds of water infrastructure co-existed within the utility space but beyond the utility. It allows an in-depth exploration of the "cases" such as the activities and practices concerning water provision beyond the utility network. Together, it helped the study to retain a complete and real-life understanding of their governance. While the dissertation focuses broadly on the city of Dar es Salaam by collecting data from policy-makers, utility officials, and experts in water resource management, three peri-urban settlements of Dar es Salaam such as *Goba, Kivule* and *Magogoni* were selected as information-rich cases through which I further situated, triangulated and complemented the data collected. The primary cases analysed in this study were the varied non-utility-networked water infrastructures that provided and/or distributed water beyond the utility network. These comprised; boreholes with hand-pumps, Community-Own Supply Organizations (CWSOs), mechanized boreholes connected to households, protected wells, tanker trucks and water kiosks, vendors) in Dar es Salaam. The dissertation treated these water infrastructures and their actors as multiple cases, but not the

settlements. Because these water infrastructures dominated in the settlements selected, but however with variations in terms of intensity but not peculiarity. This strategy offered the possibility to draw from the varied experiences and practices of multiple actors (state and non-state actors) about the governance of the water infrastructures.

While the chosen strategy was useful for gathering in-depth data through the combination of qualitative and quantitative research data; much focus was placed on the qualitative insight of the respondents, the practices, and processes undertaken by the involved actors to produce and supply water. This offered the opportunity to gain an in-depth view of the various practices and processes undertaken by the actors such as towards water infrastructure development, distributing water, sustaining water infrastructures, and pricing water for distribution beyond the utility network. It allowed for the use of varied methods and procedures for data collection. It fostered triangulation by enabling convergence, integration, and re-enforcing of the qualitative and quantitative data gathered. These together help to produce a complete thought about the practice of governing water infrastructure beyond the utility in Dar es Salaam. As Yin stated, these together increased the promise of the case study data (Yin, 2018). This was expected as neither the "qualitative nor the "quantitative" data could address the aforementioned research questions such as the "*How" "Who" and "What*" regarding the governance of water supply beyond the utility network. The combination of methods was useful in increasing the promise of the empirical data (e.g., Yin 2018), in terms of providing a nuanced understanding of the ways in which water infrastructures beyond the utility network are governed.

The case strategy contributed towards drawing multiple data, from formal and informal urban water actors involved in water supply in Dar es Salaam and households as consumers. It also provided the avenue to examine the different experiences of residents about water provision and access in the selected peri-urban areas. The data gathered using the case study strategy was suitable for basic descriptive analysis. The varied experiences of the actors/agents as well as the individual cases enabled cross-case analysis (Yin, 2018), and offered impetus for synthesizing the findings in concluding the dissertation. The synthesis of the cross-cases was centred on the features of practices of the various water infrastructures and the actors involved. By focusing on the features, I move beyond the variable-based approach, retaining a real-world perspective about the phenomenon such as the varied ways in which water was priced, distributed and governed in spatialities. In conclusion, the focus on the experiences of the participants regarding water supply through the case study helped the dissertation build on existing ideas on water infrastructure governance towards theoretical generalization.

2.2.2 Selection of the case study areas

Having indicated the research approach and strategy of the study, this section aims to sequentially present the underlining steps that guided the selection of the case study city, the case study municipalities, and the case study settlements. The selected case study settlements served as spatial units within which the varied actors and practices were identified and studied. As peculiar to the

case study strategy (e.g., Creswell, 2014; Yin, 2018), the dissertation thus focused on exploration of the practices, and activities undertaken by the actors towards water supply.

Step 1: Selection of the case study city in Tanzania – Dar es Salaam

As indicated earlier, Dar es Salaam is one of the fastest-growing cities ranked 3rd in Africa and 9th worldwide (McGranahan et al., 2016). It is the largest city in Tanzania bordered by the Indian Ocean. Like many cities in the global South, it is rapidly urbanizing, with a low pace of infrastructure provision (Todd et al., 2019). The city's rapid growth has manifested in peri-urban sprawl (Pastore & Pastore, 2016). Dar es Salaam urbanizes at the rate of 5.6 per cent with several pockets of peri-urban neighbourhoods (URT, 2017). For example, between 1990 and 2014 the city expanded from 255.06 km2 to 532.13 km2 (Bhanjee & Zhang, 2018, p. 7). Given that, the study focuses on the governance of water supply beyond the utility network in Sub-Saharan Africa, the city of Dar es Salaam, Tanzania, was purposefully selected as the case study city. The choice of the city of *Dar es Salaam* was informed by its rate of urbanisation and peri-urbanization that further challenge network water infrastructure extension. The increasing reliance on alternative water systems beyond the utility network by residents positions the of city Dar es Salaam as the most suitable geographical location for this study. In Dar es Salaam, peri-urbanization challenges network water extension, occasioning varied forms of local ingenuities in which varied water infrastructures are provided by residents beyond the utility network. These represent threats to the utility, but equally a basket of innovation to cities of global South perhaps less considered in urban studies and infrastructure discourses.

Step 2: Selection of case study municipalities

Given the research issue being studied (governance of non-utility-networked water systems), all the municipalities (*Ilala, Temeke, Kinondoni, Kigamboni and Ubungo*), were suitable case study areas. However, for economic reason, and the duration of the study, three (3) sets of criteria were used to guide the selection/sampling of municipalities with more rich information on the governance of water supply beyond the utility network. The criteria used included (1) the number of wards in each municipality; (2) The prevalence of the DAWASA/Utility network in the Municipality; (3) the prevalence of non-utility-networked water infrastructures (Table 2.2). Although no official data existed about water infrastructures beyond the utility network in the various municipalities, previous studies have shown that residents in peripheral settlements mostly rely on such water infrastructures (Andreasen & Møller-Jensen, 2016; Smiley, 2016; Dakyaga et al., 2018). These criteria were developed, following a review of previous studies, the profiles of the five Municipalities of Dar es Salaam, the 2016-2036 Dar es Salaam city Master Plan, and consultations with Town planners, (see Table 2.2).

Table 2.2 Criteria for the selection of the case study municipalities in Dar es Salaam

Municipalities	*Criteria guiding the selection of the case study municipalities*			
	Number of wards	Prevalence of DAWASA network	Prevalence of non-utility-networked water systems	Remarks
Ilala	26	Medium	High	**Potential case**
Temeke	22	Medium	Medium	Less suitable
Kinondoni	19	High	Medium	Less suitable
Ubungo	14	Low	High	**Potential case**
Kigamboni	9	Low	High	**Potential case**
Total	90			

Source: Based on the 2016 – 2036 Dar es Salaam City Master Plan

Through the assessment, three (3) municipalities (*Kigamboni, Ilala and Ubungo Municipal councils)* exhibited the aforementioned criteria and hence were selected as potential case study municipalities.

Step 3: Selection of peri-urban low-density wards from the selected municipalities

Having selected the three case study municipalities (Ilala, Kigamboni and Ubungo) in step 2, this step aimed at identifying/selecting wards located in the peripheral in each of the selected case study municipalities. Though water infrastructure beyond the utility network cut-across the city of Dar es Salaam, they were more dominant in the peri-urban areas where network water extension was completely non-existence (e.g., Allen et al., 2006; Andreasen & Møller-Jensen, 2016). To do so, the study used three (3) criteria developed with reference to the 2016-2036 Dar es Salaam City Master Plan. The three (3) sets of criteria used to guide the purposive selections included; (1) Wards located 20 – 30+ km away from the inner city of Dar es Salaam; (2) Wards with a population density between 0.5 – 29 persons per unit area; (3) Wards with a population density between 0.5 – 29 persons per unit area but without DAWASA Network (Table 2.3). Through these criteria, eight (8) wards *(Kitunda, Kivule, Chanika, Kibada, Magogoni, Goba, Kibamba, Kwembe*) were selected as potential case study wards (see Table 2.3).

Table 2.3 Criteria for selecting wards located in peri-urban areas in the selected municipalities

Municipalities	Criteria guiding the selection			
	Wards located about 20 – 30+ km away from the inner city	Wards with pop. density (Btw. 0.5 – 29 persons per unit area)	Wards with pop. density btw. 0.5 – 29 persons per unit area but with low or without DAWASA Network	Remarks
Ilala	Tabata	x	x	Not suitable
	Ukonga	x	x	Not suitable
	Kipawa	Kipawa	x	Not suitable
	Kituada	Kituada	Kitunda	Potential case
	Kivule	Kivule	Kivule	Potential case
	Majohe	Majohe	x	Not suitable
	Chanika	Chanika	Chanika	Potential case
	Tabata	x	x	Not suitable
Kigamboni	Mjimwema	Mjimwema	x	Not suitable
	Kibada	Kibada	Kibada	Potential case
	Somangila	Somangila	x	Not suitable
	Kisarawe II	Kisarawe II	x	Not suitable
	Kimbiji	Kimbiji	x	Not suitable
	Magogoni	Magogoni	Magogoni	Potential case
Ubungo	Goba	Goba	Goba	Potential
	Mbezi	Mbezi	x	Not suitable
	Kibamba	Kibamba	Kibamba	Potential case
	Saranga	x	x	Not suitable
	Kwembe	Kwembe	Kwembe	Potential case
	Kimara	x	x	Not suitable
	Ubungo	x	x	Not suitable

Source: Based on the 2016 – 2036 Dar es Salaam city Master Plan

Step 4: Selection of the case study Wards from the potential cases

Having selected the potential case study peri-urban wards in step 3; (Kitunda, Kivule, Chanika, Kibada, Magogoni, Goba, Kibamba, Kwembe), this step aimed to select **one ward** from each municipality as case study area, out of the potential case study wards. To do so, one major criterion was used. Thus, *the level of prevalence of non-utility-networked water infrastructures* such as boreholes with hand-pumps, Community-Own Supply Organizations (CWSO), mechanized boreholes connected to households, protected wells, tanker trucks and water kiosks) was used to select one ward out of the eight (8) potential wards (see Table 2.4).

Table 2.4 Criteria for selecting case study wards among the potential cases

Municipalities	Potential cases	Criteria guiding the selection	Remarks
		Prevalence of non-utility-networked water systems	
Ilala	Kitunda	Moderate	Not suitable
	Kivule	High	**Suitable case study area**
	Chanika	Moderate	Not suitable
Kigamboni	Kibada	Moderate	Not suitable
	Magogoni	High	**Suitable case study area**
Ubungo	Kibamba	Moderate	Not suitable
	Kwembe	Moderate	Not suitable
	Goba	High	**Suitable case study area**

Source: The 2016 – 2036 Dar es Salaam city Master Plan and consultation with residents

Following the aforementioned criteria, *Goba Ward,* located in Ubungo Municipal Council, *Magogoni* located at the periphery of the Kigamboni municipal council and *Kivule* located in the peripheral of Ilala Municipal Council were selected as rich locations in terms of the prevalence of non-utility-networked water infrastructure. These case study areas were confirmed following a review of the profiles of the selected Municipalities, the 2016-2036 Dar es Salaams city Master Plan and consultations with residents with adequate knowledge of the aforementioned wards of Dar es Salaam. However, data were also collected from experts, pump technicians, officials of the utility network who were not settlers of the selected areas.

2.2.3 Sampling techniques and procedures

Having highlighted the step-by-step processes through which the study locations/settlements were selected, this section shows how the various research participants were selected to enable the collection of field data. I acknowledge the varied sampling procedures (probability and non-probability techniques) and the varyingly defined principles, for example, the motive of enquiry

and durations that guide the selection of research participants in the conduct of social science research (Sarantakos, 2013). In line with these, three main sampling techniques comprised of area sampling complemented with simple random sampling (probability sampling technique), purposive sampling technique (non-probability sampling technique) and snowballing sampling techniques (non-probability) were used for the selection of the participants. The choice of these sampling techniques was shaped by the motives, category and nature of participants required for data collection concerning the governance of water supply beyond the utility network. It was also informed by the expected depth of enquiry, the time/duration of the study and the activities, practices and processes required to attain a holistic understanding of the governance of water infrastructure beyond the utility network (e.g., Sarantakos, 2013). These sampling techniques were essential as they enabled the selection of a relatively small number of participants, through which detailed information about the practices were gathered from the selected study settlements, Magogoni, Kivule and Goba (See Table 2.5).

Table 2.5 Basic descriptions of the selected case study settlements

Settlements	Goba	Kivule	Magogoni
Geographical location	Located in *Ubungo* Municipal, App. 7 Kilometres from the centre of Dar es Salaam	Located in *Ilala* Municipal Council, App. 27 kms from Dar es Salaam	Located in *Kigamboni,* App. 23 kilometres from Dar es Salaam
Population & density	Urban ward had pop. of about 54,630, density of App. 903.4/km²	Ward had pop. of about 72,032, density of App. 2,883/km²	Sub-ward of *Kigamboni* of App. 36,701 people.
Income levels	Mixed (low, middle & high)	Mixed (low, middle & high)	Mixed (low, middle & high)
Utility network status	Utility network exist in surrounding neighbourhoods, but not in the study settlement	Absence of utility of network	Absence of utility networks
Alternative water systems	Dominated by self-supply bore-wells with connectivity to residents. Water kiosks/resellers of utility water Private taps Tricycles/pushcarts water sellers Tanker trucks deliveries Rainwater harvesting	Highly concentrated by self-supply boreholes, private networked water distributors. Deep & shallow wells Residents' reliance on alternative water suppliers. Rainwater harvesting	Highly concentrated by Water kiosks/resellers of utility Households' self-supply deep/bore-wells Tanker trucks deliveries Rainwater harvesting.
Planned status	Unplanned settlement	Unplanned settlement	Unplanned settlement
Dominant building types	Single-family houses	Large single-family houses	Single-family houses
Elevation level	High: 2,743 m (8,999 ft)	Low: 41 m (135 ft)	Medium: 144m (472 feet)

Area sampling

The overarching sampling technique employed in this study was the area sampling technique – a multi-stage sampling used to select portions of geographical areas towards more specific observations and detailed data gathering (e.g., Sarantakos, 2013, p. 175). This technique was suitable as it enabled higher concentration of data collection from a smaller geographical area and population. Additionally, it enabled the used of varied techniques such as purposive sampling, simple random sampling as well as snowballing. Through the area sampling technique, I first selected the case study settlements through purposive sampling, and further divided the selected settlements into smaller sizes (sub-wards). I selected sections of the sub-wards in each of the case study settlements perceived with a high concentration of varied non-utility-networked water infrastructures. While this was useful for all settlements, it was much applied to Goba ward, a large but rapidly urbanizing peri-urban settlement highly known for the dominance of water infrastructure that produce and distribute water beyond the utility network of the city of Dar es Salaam. Secondly, the division led to the reduction in the number of sections and provided the opportunity for easier collection of data from lesser households. In so doing, I focused more on sections of the settlement where practices, and physical water infrastructures were more predominant. For example, sections such as *Kibululu*, *Chaurembo,* and *Kunguru* in the Goba ward were selected. This facilitated the collection of data from 292 out of the total 1078 households of the three sections. Information was drawn from the Sub-ward level and not the entire ward (estimated 12,144 households).

Motivated by Yin's perspective, I employed a simple random sampling technique (a probability sampling technique) to select households from the smaller sections. Households in the selected sections of Goba were randomly approached by field research assistants (Sarantakos, 2013). Within the selected households, only persons aged 18 years, with knowledge about how water infrastructures were provided, the quality of water, affordability, availability, reliability, distance and governed were selected. The random approach of households was more suitable for the selection of the households due to the haphazard layout of the selected case study settlements. The survey only targeted households in Goba, an informal peri-urban settlement of Dar es Salaam due to the prevalence of non-utility-networked water infrastructures. Although sample determination is a conventional principle for findings generalization (see Neuman, 2014), I limit generalizations to the empirical comparison of cases and theory but not of findings.

Purposive sampling

In social science research, the purposive sampling technique involves an exploration of research issues usually through the involvement of judged experts and the selection of information-rich cases and research participants with a specific purpose in mind (Sarantakos, 2013; Yin, 2018). In the context of this study, residents who owned water supply infrastructures who engaged in such activities for commercial, self-supply and both (drilled and mechanized boreholes operators and owners), the *Mtaa* leaders, and tanker truck drivers were purposely selected. These participants were deemed to hold relevant knowledge, experiences, opinions, and information about the governance of such water supply beyond the utility network.

The purposely selected participants also included water resource experts, in the city of Dar es Salaam, officials of the utility, especially the Planning and Monitoring Officer (PMO), the off-grid Director of the utility, households as water consumers, and the Municipal water Engineers (MWE) and the Ward Health Officer. These participants were selected based on their in-depth knowledge and opinions on the varied water infrastructures not owned by the utility but supply water for domestic use. The choice of these participants was also informed by my motive and judgement. I took into consideration their level of interactions in terms of water supply, their roles in the city and neighbourhoods' water infrastructure configuration and their relations with the water providers outside of the utility. For example, not all the *Mtaa* leaders were directly engaged in water provision but were directly responsible for monitoring the development of their neighbourhoods including water infrastructure provision of both the utility and residents. This placed these actors as useful participants for the interviews. Also, Utility officials such as the Planning and Monitoring Officer (PMO), and the Director of off-grid water supply. Although these officials were not directly engaged in water provision for self-supply or commercial use, their daily interactions and encounters with non-state actors engaged in water supply offered them useful experiences and perceptions to share about water supply and infrastructure provision beyond the utility network in the city.

Snowball sampling

Snowball sampling was instrumental in enabling the identification of important research participants that were formally invisible in the city of Dar es Salaam. These included the actors/residents directly engaged in water supply beyond the utility but without formal registration. These included self-supply households that drilled and mechanized groundwater for independent use and households that established boreholes for commercial use and self-supply. Other participants who were identified via the snowballing technique included pump technicians, caretakers or operators of the varied water infrastructures, plumbers, and individuals engaged in private network water distribution; these persons drilled groundwater, mechanized it, and distributed water to their neighbourhoods via pipes while collecting monthly water bills based on the cost of consumption of the water.

Several chains of actions and techniques help in the identification and selection of the aforementioned research participants. Besides accidental selection, one of the ways in which I gained contact to caretakers of varied non-utility-networked water infrastructures was by asking the Ward (*Mtaa)* leaders about the locations of the various individuals engaged in water supply beyond the utility network in their settlements. *Mtaa* leaders were able to make reference either by pointing hands and/or providing directions to the respective locations of water providers or the physical infrastructures that mediated water supply. Through this process, I gained contact to the various actors engaged in water provision.

In order to gain further respondents, I inquired from identified actors engaged in water distribution for referrals to colleagues, friends or persons they know equally engaged in similar acts, such as water provision or distribution outside the utility network for domestic use. The various actors exhibited interest often by referring me to other water producers or distributors, such as water

kiosks, protected wells, and self-supply water systems. Considering lack of familiarity with the sections of the various settlements, the support of some residents and *Mtaa* leaders were instrumental as they led me through the sections where the various water providers and distributors were located. However, it was much easier in some settlements, such as *Kivule* and *Magogoni*, where the *Mtaa* leader had prior knowledge about the locations of the various water providers. Therefore, the chain referral technique was used until the respondents and *Mtaa* leaders could not further recount and locate water providers and distributors in their respective settlements. Although snowballing can be useful for developing a sample frame for future research (see Sarandakos, 2013), rapid peri-urbanization coupled with the sporadic ways in which the varied non-utility-networked water infrastructures were developed may challenge the possibility of developing a reliable sample frame for such water systems. Though it is still possible, attaining accuracy database can be tedious, involving weekly and monthly surveying, tracking, and recording evolving infrastructures. The lack of existing data for such water providers limited the sampling procedures, such as surveying, to gain further general details beyond interviews that focused on a few selected participants.

2.2.4 Data collection methods and analysis

The dissertation drew data from two major sources: secondary and primary data. Secondary data were sourced through a review of articles related to water infrastructure governance, especially from the global South context, books, reports, Dar es Salaam's water policy, grey literature, and city profiles such as Dar es Salaam and the 2016–2036 Dar es Salaam's city master plans. Much of the primary data were collected from the selected study settlements (*Goba, Kivule, and Magogoni*) located in the city of Dar es Salaam. These involved the collection of varied information through surveys, interviews, household case studies, observations, and photographs.

Household surveys were conducted via self-administered closed- and open-ended questions to households in *Kunguru, Chaurembo,* and *Kibululu*, all within the Goba ward. The survey data were collected through face-to-face conversation, mediated by an interview guide that contained predetermined closed- and open-ended questions. At the household level, the personal interview method was used to collect data from both males and females between the ages of 18 and above. This enabled the collection of quantitative data from a total of 292 households to complement the qualitative data conducted via interviews, household case studies, focus group discussions, and observations. As indicated earlier in Section 1.2.6, evaluation is critical for assessing the outcomes of interventions. Considering that governance also involves the act of formulating and implementing policy to inform practices, evaluating the outcomes of the practices associated with the provision and distribution of water beyond the utility network is imperative for making policy-informed decisions. Therefore, the essence of the households' surveys was to complement the qualitative case study data gathered about the practices to comprehensively examine how governance of water supply beyond the utility network can improve water access. In this context, data were collected from the participants using both open-ended and closed-ended questions. This enabled the collection of data from diverse categories of participants and socio-economic groups concerning the outcome of such water infrastructure and water supply arrangements. The method

sections of Chapter 6, present the various questions that were asked during the field data collection. Household survey data were analyzed quantitatively with the aid of the Statistical Package for Social Scientists (SPSS), version 20. A cross-tabulation analysis was conducted to compare the visually accessible water access situation across the surveyed settlements and by socio-economic groups (low, middle, and high-income households).

Interviews: multiple face-to-face interviews were conducted to collect data from the varied research participants engaged in water supply beyond the utility network. This represented the primary method through which the bulk of the data for the dissertation was gathered. The varied methods of interviews conducted comprised Key informant interviews and expert or official interviews. Whereas all residents in the study settlements could be termed as key informants on the basis of their lived experiences in the communities, the study purposely selected research participants beyond the criteria of just living in the selected settlements. I first focused on the people (indirectly) involved in the acts or practices. For example, being part of the drilling of the water, being an owner of the water systems, being a worker or caretaker, or being served water by the water operators besides the utility network. Secondly, adequate knowledge about the practices associated with the provision of water beyond the utility network as well as the ability to avail themselves of interviews, communicate, or describe the practices based on the experiences acquired. While prejudging the adequacy of knowledge and experiences of potential can be misleading, the assistants of the *Mtaa* leaders and planners were helpful in selecting interviewees with adequate knowledge and information. Altogether, a total of 81 interviews and 1 Focus group discussion were conducted largely with the water providers, comprising pushcart and tricycle operators, caretakers and owners of water kiosks, resellers of the utility's water, tanker truck drivers, self-supply households, private network water providers, plumbers and water pump technicians, and protected well owners. Additionally, interviews were conducted with the advisor to NGOs on water supply in Dar es Salaam, the Planning and monitoring officer of the utility, the Water engineer, and the off-grid water Director of the Utility. These interviews were also conducted face-to-face to corroborate with the key informant interviews. Data were collected about the ways through which water supply beyond the utility network were governed, the practices through which infrastructures were developed and sustained for water supply, and the ways in which water was priced beyond the utility network. Data from the interviews largely contributed to the development of chapter 3 and 6.

Focus Group Discussions (FGDs) and household case studies; One FDG was conducted with seven (7) tanker truck drivers registered with the utility's kiosk (DAWASA). The FGD was conducted at one of the utility's water kiosks located at *Mbezi*, where most tanker trucks queued to collect for onward distribution. The essence was to gain the perspectives of drivers concerning the rules and regulations governing tanker water supply, and price determination for tanker water supply. With the exception of seven (7) participants, most of the drivers were engaged in filling their tanks and could barely participate in the discussion. In addition, household case studies were conducted with six (6) households in *Goba, Kivule and Magogoni* without utility network connectivity. These comprised low-income households (ungated houses), middle-income households (semi-gated houses), and high-income households (gated households). In context, data were gathered

concerning how the households gained access to water due to lack of connectivity. This involved staying on the premises of households, observing the material artefacts that enabled water storage at household levels, and asking questions about how they collect water, from which water providers, and how they got in contact with such water providers.

Observations were conducted alongside photographs of material artefacts such as robes, water storage systems, pipelines, and central control water pump systems in the selected study wards (Goba, Kivule and Magogoni). These were conducted with varied water providers and infrastructure comprised of tanker trucks, wells, and mechanized boreholes. The aim of the observations and photographs was to gain a vivid imagination of the ways in which water was supplied beyond the utility network. To do so, a transect trip or walk was made across the sites of private network water infrastructure to identify the locations. The observations were conducted at the sites of four (4) private network water providers (residents who drilled groundwater, provided pipe connectivity, and distributed water to their neighbourhoods). This involved walking with the owners and observing the pipeline coverage areas, asking questions about the practices involved in supplying water beyond the utility network. Observing and photographing how pipelines were engineered by private network water providers to facilitate water distribution. The water storage tanks, the repairs and maintenance processes of the pipelines, and the material artefacts, such as water pump machines (see Figure 2.2).

Figure 2.2 Some material artefacts facilitating water distribution

It also involved interrogating the challenges they encounter and the material technologies mediating water supply. Through the process, I observed protected wells, especially in *Kivule* and *Magogoni* settlements, and also obtained data from respective owners and caretakers about the procedures involved in the construction of protected wells and the extent to which they followed or did not follow the existing procedures. The observations also involved visiting the utility water kiosks (where utility-registered tankers were stationed to collect water) and the private water kiosks (where non-utility-registered tankers collected groundwater for onward distribution). In these

areas, I interacted with the various drivers and caretakers and observed the water collection processes of tanker drivers from the utility's kiosks for onward distribution. Details about how the data were analyzed are presented is presented in Chapter 3 and 5.

2.2.5 Data validity and reliability

In the context of a case study, validity relates to constructing validity, internal and external validity, and reliability. I acknowledge that ensuring validity is a tricky task in case study research due to its embeddedness in human understanding of the social phenomenon being studied. Validity raises two significant questions: (1) To what extent are the indicators used to measure the phenomenon being studied measuring the variables intended to be measured? (2) To what extent are the claims made in the case study generalized to other cases? (Sarantakos, 2012, p. 107). The first question raises the issue of internal validity, while the second question raises the issue of external or construct validity. This study acknowledges that addressing both questions is useful in informing decision-making regarding the study results. Therefore, the triangulation technique was used to ensure internal validity. To do so, data were collected from multiple sources (primary and secondary), with multiple participants comprised of experts, Directors of the utility, key informants, and residents at the household level, using multiple methods such as surveys, key informant interviews, observations, household case studies, and focus Group discussions.

Field data were also collected by multiple field Research Assistants to ensure that responses were not influenced by the researchers' biases and to enable some level of comparison of the data for authenticity. Besides, the external validity, which relates to the issue of finding generalization, was ensured through the gathering of qualitative data (through interviews, and key informants) until saturation, and the quantitative data from a representative sample of the households and water systems being studied. This offered the possibility of a theoretical and case-based comparative generalization of the findings of the results collected, but not an empirical generalization.

Similarly, as with validity, ensuring reliability in case study research is equally tricky compared with other methods. In social science, it is assumed that indicators to test the reliability of the study in the context of the case study are limited. Data reliability in this context denotes the degree of stability, applicability, and repeatability of the study results (Sarantakos, 2012, p. 107). The study ensured reliability in two major stages: the field data collection stage and the data analysis, interpretation, and reporting stage. Firstly, at the field data collection stage, errors and biases were minimized by ensuring that the items or questions in the data collection instruments were translated similarly to the different respondents by the different Field Research Assistants throughout the study. To do so, the Research Assistants were trained on the various terms to use where translating the question from English to Swahili. Secondly, during the data analysis, interpretation, and reporting, all procedures that characterized the conduct of the study were explicitly documented. The various steps carried out were further verified and examined.

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CHAPTER THREE

Geographies of Infrastructure: Everyday governance of urban water supply beyond the utility network in Dar es Salaam

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3.0 Introduction

This chapter draws on a review of everyday practice and governance to holistically propose a comprehensive framework of governance modalities, actors, and interactions within heterogeneous infrastructure beyond the utility network. This heuristic framework has been used to analyze the governance arrangements of heterogeneous water infrastructures that produce and distribute water beyond the utility network. To demonstrate the relevance of the framework to urban water infrastructure governance, the chapter concurrently analyzed an empirical case concerning the governance arrangements of the heterogeneous water infrastructure that supply water beyond the utility network in Dar es Salaam, Tanzania. In so doing, it detailed the varied categories of the water infrastructures through which water was produced and supplied beyond the utility network, the modes of governance of the varied categories of water infrastructures, the actors, and the modes of interactions through which water was produced and distributed beyond the utility network. Additionally, the chapter demonstrates the powers and regulatory mechanisms.

Abstract

Due to uneven networked water coverage in the Global South, varied water infrastructures operate beyond utility networks to serve denizens in Global South cities. This study proposes a framework of governance modalities, actors, and interactions to analyse the governance of heterogeneous water infrastructures in Dar es Salaam. This framework builds on existing literature on urban water infrastructure, everyday practices, and governance. The paper demonstrates the coexistence of private water networks, self-supply systems, and communal and hydro-mobile infrastructure that enable water collection beyond utilities. Multiple governance modalities, including co-production, self-governance, market-oriented governance, co-governance, and networked governance, control these infrastructures. Hybrid governance arrangements produce interdependent infrastructures that challenge utility's efforts by supplying water to suburbs beyond the utility's pipes. However, diverse actors and powers, conflicting responsibilities, and (in)formal regulatory mechanisms are still embodied in these modalities. This can result in (un)even water distribution among urbanites and across urban spaces.

3.1 Introduction

Similar to many cities in the Global South, Dar es Salaam, Tanzania, experiences unequal access to water supply. As a result, varied water infrastructures exist alongside the city's utility network to meet

the needs of urban residents (Bender, 2021; Dakyaga et al., 2022). The utilisation and development of these water infrastructures by inhabitants have been significantly influenced by spatial segregation and the unequal allocation of networked water in both the colonial and post-colonial periods (Rugemalila and Gibbs, 2015; Wamuchiru, 2017a; Smiley, 2020). The process of collecting water from the diverse infrastructures in Dar es Salaam involves a complex set of procedures that entail negotiation and bargaining for water from non-utility-networked water producers and distributors (Sweya et al., 2021; Hoffman, 2022). These everyday practices and procedural arrangements adopted by urban residents in coping with the water supply situation represent both 'need-driven' and 'policy-driven' approaches (Allen et al., 2017; Hofmann, 2018; Dakyaga et al., 2020). As observed elsewhere, these arrangements are invisible spaces where hydro-social relations are developed to mediate the collection of water (Sultana, 2013; Keough and Saidou, 2021).

Similarly, studies have demonstrated the varied ways in which urban residents secure water beyond utility networks in cities of the Global South (Cornea et al., 2016; Schramm and Ibrahim, 2019; Kundu and Chatterjee, 2020; 2021). The act of collecting water from diverse non-utility-networked water infrastructures such as bore wells, kiosks, and private taps is a unique urban phenomenon (Lawhon et al., 2018; Truelove, 2019; Smiley, 2020). Scholars suggest that water supply in Global South cities is shifting from the 'network' to the 'archipelagos' of need-driven practices (Bakker, 2003; Allen et al., 2006). Scholars advocating for non-utility-networked water infrastructures emphasise the importance of alternative infrastructures in achieving water coverage (Furlong and Kooy, 2017; Kooy, 2014; Truelove, 2020). Water supply beyond utility networks enables urbanites to collect water regardless of their access to networks (Allen et al., 2017; Chávez et al., 2020; Martínez-Santos et al., 2020). It is argued that multiple water supply systems can cater to different water preferences and choices of socio-economic groups present in Global South cities (Bichai et al., 2015; Dakyaga et al., 2018a; Słyś and Stec, 2020). Studies verifying this claim reveal how about 369 million (79%) of urban residents in Africa secure water from boreholes, water kiosks, carts/tankers, standpipes, or dug wells (Allen et al., 2017; Grönwall and Danert, 2020).

However, studies examining the connection between human health and water supply have cautioned against the use of non-utility-networked water infrastructures (Sultana, 2013; WHO, 2014; Mudege and Zulu, 2014; Martínez-Santo et al., 2020). Studies (e.g.; Alba et al., 2019; Truelove, 2019; Kundu and Chatterjee, 2021) exploring the governance systems and everyday practices associated with urban water tankers and tube wells highlight how these distribution systems can complement utilities' water supply efforts. At the same time, they also suggest that an understanding of the governance arrangements surrounding the production and distribution of water is crucial for safeguarding the health of end users and that developing a framework to comprehensively analyse governance arrangements in heterogeneous infrastructural landscapes is still a challenging task in urban water studies. Such frameworks are important as urban water research on diverse infrastructures in Global South cities is developing (Lawhon, 2018; Smiley, 2020). This paper proposes a framework of governance modalities, actor interactions, and heterogeneous infrastructure landscapes, drawing on literature about urban water infrastructure and observations about everyday practices and

governance systems surrounding heterogeneous infrastructures in Dar es Salaam. In so doing, the paper proposes a framework to concurrently explore, analyse, and categorise the existing governance modalities, actors, and interactions related to water infrastructure beyond utility networks. This kind of framework is critical for deepening and expanding conceptions of the water distribution systems beyond formal utilities in Global South cities.

This paper makes two contributions to urban infrastructure governance discourses. Firstly, it uses urban water infrastructure literature and observations about everyday practices and governance systems to propose a framework for analysing heterogeneous infrastructures. Secondly, it applies this framework to an empirical case, detailing: (i) water infrastructures, (ii) actors and modes of interactions, (iii) powers and regulatory mechanisms, and (iv) governance modalities of the varied non-utility-networked water infrastructures beyond a utility network. The paper is structured as follows: Section 2 reviews urban water governance in the Global South; Section 3 proposes an analytical framework on governance in heterogeneous infrastructures beyond utilities; Section 4 describes the study setting and data collection; Section 5 presents the findings on governance modalities facilitating water supply to urbanites; and Section 6 concludes with a demonstration of the hybrid governance arrangements and their impact on water supply beyond utilities.

3.2 Governance of urban water supply beyond the utility in global South cities

In urban (water) studies, research on water infrastructure heterogeneity has grown, often referencing the waterscapes of Global South cities (Lawhon et al., 2018; Truelove 2019; Smiley, 2020; Alba and Bruns, 2021). These studies show how cities in the Global South are typically the geographies where heterogeneous infrastructures pervade (Lawhon et al., 2018; Alba et al., 2019). Lawhon et al. (2018) introduce the Heterogenous Infrastructure Configuration (HIC), drawing on sanitation and waste infrastructural experiences from Kampala, Uganda, to demonstrate the varied constellations/ assemblages of actors, technologies, and practices that co-exist in cities of the Global South. Truelove (2019) introduces the "gray zone" as a heuristic perspective that furthers debate on HICs, broadening scholarly understanding about the ways in which urbanites source water from varied configurated infrastructures beyond the utility network.

Moreover, considering the evolving debates on infrastructure heterogeneity, a systematic categorisation of the varied infrastructures, actors, and interactions surrounding heterogeneous infrastructures could provide an analytical ordering and a holistic comprehension of those infrastructures' governance arrangements. This paper contributes to these debates by drawing on urban water infrastructure literature and observations of everyday practices and governance systems in Dar es Salaam to holistically explore and analyse the governance arrangements of heterogeneous infrastructures beyond utility networks. In this study, infrastructures beyond utility networks entail the varied small-scale, (in)formal, off-grid water systems such as protected/tube wells, drilled mechanised boreholes, tanker trucks, rainwater harvesting systems, boreholes fitted with hand-pumps, and community-based water systems that supply water to urbanites (McDonald et al., 2011; Chakava et al., 2014; Truelove, 2019). Through these infrastructures, water is either produced outside

the utility or collected from the utility network (Truelove, 2019). Water scholars stress the importance of studying the governance arrangements of heterogeneous water infrastructures for understanding water production, distribution, and consumption, as well as effects on human health (Alba et al., 2019; Sultana, 2014). Governance entails "those that determine *who gets what water* outside the utility *when* and *how,* and *who* has the right to be served with water" (Grönwall, 2016; Lim et al., 2022; Dakyaga et al., 2020). In urban water studies, governance occurs beyond the state domain and is studied through the ordinary practices of the actors involved in urban water supply (Cornea et al., 2017). Everyday governance refers to ordinary relationships between state and non-state actors and the processes that govern water beyond the utility network. However, the lens of "everyday practices and governance" is limited in analysing multiple infrastructures and their governance modalities. This paper proposes a new framework to analyse governance arrangements of heterogeneous water infrastructures beyond utility networks, contributing to the discourse on urban water infrastructure heterogeneity and governance. This is important for expanding our understanding of the actors and interactions involved in water production and distribution outside of utility networks in cities of the Global South.

Hoque (2021) demonstrates that although alternative water infrastructures complement utilities' efforts, formal regulations and mechanisms like monitoring and coordination of non-state actors are vital for improved water delivery and adherence. In the absence of formal regulations, non-state actors establish and regulate water infrastructure outside of formal processes (Chakava et al., 2014; Grönwall and Danert, 2020; Dakyaga et al., 2022). Even where formal regulatory measures exist, enforcement of regulations becomes necessary when non-state infrastructures produce unintended effects or threaten human health (Sultana 2013; Cain and Baptista, 2020). Regulatory mechanisms and their enforcement vary across cities in the Global South. Truelove's study in Delhi (2019), demonstrates how groundwater regulatory officials act as watchdogs to promote compliance through monitoring and coordinating tube wells in non-utility-networked areas. Truelove (2019) reveals how operators use their financial power to bribe a police task force and prevent their illegal tube wells from being labelled as unauthorised water sources. This shows how actors can influence existing formal procedures through power and interactions, even when such procedures are present. The urban water poor usually must rely on an unimproved water supply outside of a utility's service (Beard and Mitlin, 2021; Dakyaga et al., 2018b).

The multiplicity of infrastructures beyond a utility is made possible by people and material artefacts. Bodies act as infrastructures providing information, networking, and maintaining collaboration (Simone, 2015; Peloso and Morinville, 2014; Truelove and Ruszczyk, 2022). Water supply beyond the utility serves as a medium in which diverse relationships are built (Keough and Saidou, 2021). Scholars consider canals, pumps, treatment plants, and various technologies – such as plastics, pipes, and barrels – as crucial for storing, filtering, and transporting water to end users beyond utility networks (Meehan, 2014; Wutich et al., 2018; Meehan et al., 2020; Adeniran, 2022; Kasper and Schramm, 2022). Studies highlight the impact of environmental conditions, power relations, and socio-material factors on water production and distribution beyond utility networks (Sultana, 2013;

Schramm and Ibrahim, 2019). These interactions differentiate water supply through the inclusion and exclusion of neighbourhoods and households within cities (Truelove, 2019; Dakyaga et al., 2022).

Furthermore, the involvement of community volunteers and organisations, NGOs, individuals, state political actors, and private individuals has been shown in providing water beyond utility networks (Moretto et al., 2018; Alba et al., 2019). Plumbers/technicians, engineers/water experts, government employees, public health workers, environmental resource managers, social entrepreneurs, and policymakers are (non)professional agents that offer socio-technical knowledge, as well as financial and material support, to enable water supply beyond utilities (Cleaver et al., 2005; Sultana, 2013; Moglia et al., 2011). Linking these actors with the water infrastructure they create and distribute is useful for understanding the complexities of water supply in the Global South. Examining water governance in Buguruni (a suburb of Dar es Salaam), Bourque (2010), and Smiley (2020) reveal how uneven relations manifest among water supply actors. Residents tend to cooperate more with local water providers than with utility and government authorities. Although the utility holds 'reinforcive' powers, urbanites lack trust in the utility due to unequal distribution of network water. Social hierarchies, resource capacities, and local leadership empower control over non-utility water systems. These determine in/exclusion of non-powerful residents from the utility's water connectivity (Truelove, 2019). Scholars have researched diverse aspects of governance in relation to water production and distribution beyond utility networks (Wamuchiru, 2017a; Truelove, 2020; Alba et al., 2019; Dakyaga et al., 2020). However, holistic analysis of governance arrangements for heterogeneous infrastructures, including modalities, actors, and interactions, remains challenging. This is essential to broadening conceptions of governance modalities that mediate water flow beyond utility networks. The following section presents a framework to analyse the multiple infrastructures, actors, and interactions in the production and distribution of water beyond utility networks.

3.3 Analytical framework: governance modalities and actors' interactions in heterogeneous infrastructures beyond the utility

The paper draws on urban water infrastructure literature, observations of everyday practices, and analysis of governance systems to propose a framework of governance modalities and actors' interactions within heterogeneous infrastructure landscapes. Since the 2000s, studies have evolved on everyday practices and governance as an approach for theorizing urban water infrastructure provision (Cornea et al., 2017; Truelove, 2019). This lens has been used in various studies to demonstrate the ordinary ways in which people relate with, and regulate, land (Le Meur and Lund, 2001); how local leaders interact with waste and regulate their subjects (Øyvind, 2011; Zimmer, 2012); how people interact with, and regulate, the natural environment (Cornea et al., 2017); and largely how water infrastructure provision and operation works (Cornea, 2020; Truelove, 2020; Kundu and Chatterjee, 2021). Perspectives on everyday practices and governance offer the possibility for urban scholars to engage with diverse logics, rationalities, and artefacts through (in)direct interaction with the state's actors (Plio, 2019). Although this lens has been instrumental for understanding the practices, powers, regulations, and actor interactions in infrastructure provision (Velzeboer et al.,

2017; Zhen et al., 2019; MacAfee, 2023), it is inherently incapable of categorizing the varied infrastructures *vis-à-vis* their governance modalities. Moreover, it is useful for analysing the governance of diverse infrastructures and showcasing the interconnected socio-technical arrangements involved in producing and distributing water beyond a utility network.

Infrastructure categorisation entails the compartmentalisation of the multiple infrastructures that co-exist in supplying water beyond utilities. These infrastructures differ in sizes, legality, ownership, regulation, and technicalities. Infrastructures are classified in several ways: by size – either large-scale/centralised or small-scale/decentralised (Domènech, 2011; Sesan et al., 2021); by legality – as formal or informal (Maryati et al., 2018); by ownership and regulation – as individually or communally owned and regulated; and as rudimentary technologies and techniques as opposed to standardized and sophisticated technologies for water production and distribution (Maryati et al., 2018). They may be owned and regulated by states, private groups, or individuals for mutual and collective benefits (Adams et al., 2018; Maryati et al., 2018). For example, community-based and self-supply infrastructures are independently controlled, monitored, and regulated for household and community use (Stoler et al., 2019; Wutich et al., 2018). Gifting and sharing of water are practices embodied in these water infrastructures (Allen et al., 2006; Allen et al., 2016). Private networked infrastructures also produce and distribute groundwater to residents (un)served by a utility (Bakker, 2003). These infrastructures are (in)directly connected to a utility as they draw electricity for water distribution (Dakyaga et al., 2022). Additionally, "hydro-mobile infrastructures" work to facilitate the distribution of water to end users beyond a utility's pipes. These infrastructures are non-static but mobile. "People may act as infrastructures" by mediating information provision and networking to collect water (Simone, 2021; Andueza et al., 2021). In this context, hydro-mobile infrastructures refer to infrastructures whose water distributions are mediated by the socio-material and bodily work of people. These include pushcart owners, tanker truck drivers, and tricycles/bicycle riders that distribute water to end users (Wutich et al., 2016; Alba et al., 2019; Truelove and Ruszczyk, 2022). Residents may chase for water to be delivered (Peloso and Morinville, 2014). Central to such arrangements are the material technologies such as storage artefacts, plastics, and metallic containers through which water is stored for onward distribution and use (Kasper and Schramm, 2022).

Modes of governance define actors and their roles and interactions in producing and distributing water beyond a utility network. The modes of governance define the powers and regulatory mechanisms for a given infrastructure (See Table 1). These may include co-production, co-management, co-governance, self-governance, network governance, and market-oriented governance. C*o-production* is a mode of governance characterised by an (in)formal working relationship between a state water utility and non-state actors/residents. Recipients of the service equally perform key roles or make substantial contributions towards the provision of the service (Moretto et al., 2018). Non-state actors may encompass volunteers, community groups, NGOs, Community-based Organisations (CBOs), private individuals, and organisations. They may participate as (co)producers or negotiators in water provision and delivery. Heterogeneous infrastructure may be self-governed, where non-state actors interact to address water-related issues

by setting goals, exchanging resources, and negotiating common purposes based on their differential capacities (Stoker, 2018). Self-governance also involves self-help and associations formed by individuals to provide and operate water supply systems, which may be exclusively owned by the actors involved, with non-members having no rights (Nederhand et al., 2019). Market-oriented governance involves local entrepreneurs actively participating in water production and distribution (O'Keefe et al., 2015). Infrastructures may be collaboratively governed by involving state and non-state actors in power sharing, formal institutional decision making, and consensus building based on trust and social capital (Yu et al., 2012; Ansell and Gash, 2008).

Actors and modes of interaction refer to the individuals, groups, organisations, and institutions that facilitate water production and distribution beyond a utility, including formal and informal, state and non-state actors, users, producers, distributors, plumbers, and technicians. Formal actors comprise defined organisations, governmental departments, and agencies such as officials of the state utility and water policymakers. Non-state actors include individuals and groups, as well as associations such as CBOs, Civil Society Organisations (CSOs), and development partners. Private sector actors with technical knowledge, innovation, and resource capacities also participate in providing and managing water systems (Dakyaga et al., 2020). Technicians/plumbers and (co)producers of water can act as formal or informal state or non-state actors, regulating the provision of water infrastructure (Truelove, 2020). Their interactions are mediated by factors such as resource capacity, rules, and interdependency in the water supply chain (Pakizer and Lieberherr, 2018). Different types of infrastructure may involve various forms of collaboration, such as civic cooperation, alliance-building, coalition, collaboration, participation, and networking, to facilitate water supply beyond the utility (Ansell and Gash, 2008; Dakyaga et al., 2020). The interactions of actors may differ depending on the governance modalities of the infrastructures (Cornea et al., 2017). These interactions enable (non)state actors to structure processes and mechanisms for water service provision in their neighbourhoods (Pilo', 2019; Dakyaga et al., 2020). See Table 1.

Powers and regulatory mechanisms are the ways in which rules and regulations are established, both within and outside formal stipulations, and followed by actors involved in water supply beyond a utility network. They include existing interests, how they're pursued/challenged/undermined, and how powers are exercised (Alba et al., 2019; Truelove, 2020). Powers and regulatory mechanisms include (in)formal and market-based instruments – such as rules, regulations, legislation, and sanctions – that are legally binding and enforceable to ensure water quality and operational standards. The informal mechanisms consist of informal rules – such as social norms and values, local laws, and sanctions – that define authority and shape actor's relations (Pilo, 2017). Regulatory mechanisms direct actors, define ownership and decision-making, and establish protocols for water provision. Policy mechanisms enforce regulations and legislation, rewarding conformity and punishing non-conformity (Pakizer and Lieberherr, 2018). Institutional processes and procedures, such as licensing, registration, permitting, and enforcement, may encourage compliance with water extraction regulations. Regulations are central to practices but vary across infrastructures. See Table 3.1.

Table 3.1 Categorisation of water governance models, actors, and modes of interactions within heterogeneous infrastructures

Models	Major actors involved		Roles & Modes of interactions	References
	State	Non-state		
Co-production	- Agency /Utility officials etc.	- Civil-Society, - NGOs - Clients/service users - Self-supply residents	- (In)formal partnership, Coalition - (In)formal collaborative - (In)formal participation - May involve defined responsibilities	Loeffler & Bovaird, 2016; Sorrentino et al., 2018; Turnhout et al., 2020; Otsuki, 2016; Rosati et al., 2020; Chatterjee & Kundu, 2020
Co-management	- Utility/state water Agencies	- Small-scale individual/private provider/groups - NGOs & residents.	- Mostly formal partnerships, - Utility formally assists - Defined responsibilities	Pomeroy, 1996; Alipour & Arefipour, 2020.
Co-governance	- Utility/state agencies	- Water user's Associations/Committee - Local/community leaders - NGOs	- Formal collaborative decision-making - Formal partnership & Participation - Cooperation/interdependence - Responsibilities/Arrangements defined. -	Ansell & Gash, 2008; Ansell et al., 2020
Self-governance	- With(out) state actors	- Residents, Community-based self-help groups, - Individuals/private/ water entrepreneurs etc.	- Informal participations - Informal collaboration - Indirect interactions with the state - Alliance/coalition	Rauws et al.,2020; Dakyaga et al., 2020
Network governance	- State utility/agencies	- Private individuals /NGOs/Water experts/ Civil society with specialized knowledge/Utility kiosks	- Consulting - Contract service - Defined arrangements/responsibilities	Graversgaard et al., 2018; Batory & Svensson, 2019
Market-oriented Governance	- With(out) state utility as regulator	- (in)formal local entrepreneurs, users, associations/groups	- Responsible for infrastructure and service provision, contract service - Collection of user fees, marketing,	Dakyaga et al., 2022; O'Keefe et al., 2015; Sakijege, 2019; Bakker, 2010

They are caveats to power, including *innovative power* – the ability to mobilise resources for water supply (Velzeboer et al., 2017); '*Reinforcive' power* – top-down power exercised to enact and enforce rules towards water supply; and *transformative power* – the power to influence the production and distribution of water (Ayodele-Olajire, 2022). Operators may be accountable to political or non-political administrative units or directly to water users. However, Pakizer and Lieberherr (2018) note that water operators tend to be accountable to their consumers, rather than political-administrative actors. State actors ensure that water quality standards are met in commercial and domestic water provision by assessing, standardizing, monitoring, and evaluating water quality.

3.4 Study setting and methods

Dar es Salaam, one of the largest and fastest-growing cities in Africa, is rapidly urbanising amidst less coordinated expansion and coverage of network water (Bender, 2021). The utility network has not kept pace with the city's expansion over the years (Sweya et al., 2021). Despite its multiple water sources, including boreholes and three different rivers (the Lower Ruvu, Upper Ruvu, and Mtoni), the city is still unable to meet its demand for water. About 80% of the city's residents, especially those in the fringes (Sakijege, 2019; Hofmann, 2020), lack adequate access to piped water connections from the utility (Bender, 2021). Most residents rely on heterogeneous infrastructures that supply water beyond the utility (Smiley, 2020). Rugemalila and Gibbs (2015) consider the uneven ways in which water is supplied within the city an issue of governance. This study builds on existing literature on urban water infrastructure, everyday practices, and governance to propose a framework for analysing the governance arrangements that mediate water flow from varied water infrastructures beyond the utility.

The study commenced in July 2021 with the review of policy documents, reports, and articles concerning water supply beyond the utility network. The goal was to understand the regulatory mechanisms and policies governing water supply beyond the utility and build a framework to analyse the governance arrangements of various infrastructures. The review offered a preliminary understanding of (non)state actors engaged in the water supply. A qualitative case study method was used to explore the various typologies of infrastructure that supply water beyond the utility and their governance modalities. Snowballing and Maximum Variation Purposive (MVP) sampling techniques, also known as heterogeneous sampling techniques, were used to select diverse participants for face-to-face interviews. Whilst the snowballing technique enabled the selection of participants engaged in similar water supply arrangements, like tanker drivers, the MVP enabled the identification of participants across diverse organisations within the city, such as experts and technicians. Thirty-six participants were interviewed, comprising utility officials, policymakers, residents engaged in water supply, plumbers/technicians, experts, advisors to the utility, and households as consumers. Expert interviews were conducted with water resources managers and scientists, the advisor to the utility and the off-grid director of the utility, and planning and monitoring officials. These participants were purposefully selected due to their in-depth knowledge and experiences with the water supply in the city. Participants were asked about the various ways in which water was sourced and distributed by residents beyond the utility. Questions were also asked

about the existing (in)formal rules and regulations guiding residents engaged in the water supply; the power relations and modes of interaction between the utility and non-state actors; the governance approach(es) mediating urban water supply beyond the utility; and how utility officials generally regard non-state water providers in the waterscape.

Using a semi-structured interview guide, data were collected on the non-utility-networked infrastructure across the city. These infrastructures were found to dominate in the peripheral areas where water network connectivity was lacking. As a result, three peripheral settlements, namely Kivule, Magogoni, and Goba, were selected and data collected. Goba Ward is in Ubungo Municipality, with about 54,630 people and uneven utility connections. Kivule Ward is in Temeke Municipality, with about 72,032 people and no utility connection. Magogoni is a sub-ward of Kigamboni, with about 36,701 people and no utility network. Semi-structured interviews were conducted in these settlements with three Ward *Mtaa*, leaders who monitor spatial and infrastructure development. They were asked about water supply, production, and distribution, as well as the types of water infrastructure and the rules governing water supply. Data were also collected on governance arrangements and the actors' roles in mediating such water supply. This also involved providing an elaborate description of different governance modalities, such as self-governance and co-production. Participants were asked to select the governance model(s) that best described how water is produced and distributed beyond the utility. Data were also collected on the mode of interaction between water providers, local government authorities, and the utility. In addition, six face-to-face household case studies were conducted, coupled with observations of materials used for water storage and collection processes. This involved developing a good rapport with selected households and asking different household members the arrangements through which water was collected.

Key Informant Interviews (KIIs), alongside observations and photography, were conducted with 23 purposely selected non-state water providers located in the three selected settlements. These included six water kiosk owners and resellers, three protected well caretakers, eight bore well owners, and four private water network providers. KIIs were also conducted with plumbers and pump technicians to ascertain the innovative ways in which urbanites facilitate water supply beyond the utility network. Interviews were conducted with borehole owners/caretakers at household and community levels. Water pumping, storage and distribution, and related technological artefacts were observed. Transect walks were conducted within the catchment areas of privately owned mechanized bore wells that provided in-house water connections to residents. Data were collected on water sourcing, distribution, regulations, interactions among actors, and governance modalities. In addition, four (un)registered water tanker drivers and pushcart operators were purposefully sampled and interviewed based on their experiences with water distribution in the city. Tanker truck drivers registered with the utility were interviewed at the various utility kiosks where they were stationed to collect water for onward distribution. Data were collected on the practices, the existing regulatory actors, rules and regulations. See Figure 3.1.

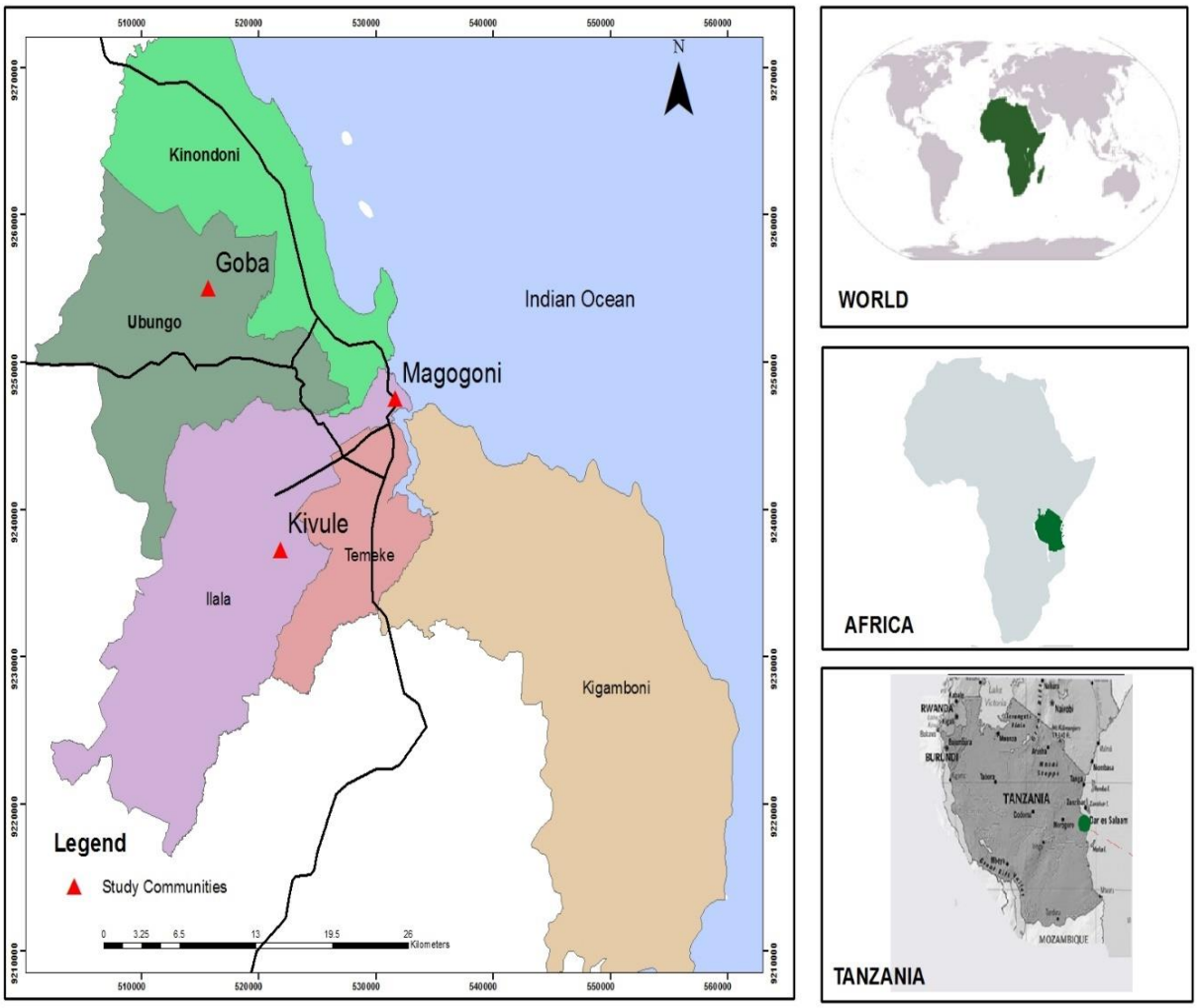

Figure 3.1 Map of Dar es Salaam showing study areas

Interviews with tanker drivers were validated through the conduct of a focus group discussion with private tanker truck drivers registered with the utility. Interviews were conducted in Swahili and English. Consent was sought and the discussion was recorded. Thematic analysis was conducted – data transcribed were edited, grouped and analysed. Themes were defined and substantiated using field evidence. Through thematic analysis, the paper presents water infrastructure, actors, and governance models beyond the utility, described in words and tables.

3.5 GOVERNANCE MODALITIES, ACTORS AND MODES OF INTERACTIONS WITHIN HETEROGENEOUS INFRASTRUCTURES BEYOND THE UTILITY

3.5.1 Categorization of water supply infrastructures beyond the utility

The field interviews revealed four varied and interrelated sets of water supply infrastructure types in Dar es Salaam. These included community-owned water infrastructures (CWI), hydro-mobile

infrastructures, independent household self-supply, and privately networked water, which operated collectively as interconnected infrastructures (Massey & Gunter, 2020). Despite their interrelatedness, the usage of water, sources, ownership and how water was produced and distributed delineated these infrastructures from one another. CWI comprised boreholes fitted with hand pumps and mechanized boreholes. These infrastructures were financed by religious bodies, Development agencies and NGOs. Ownership and regulatory powers were exercised by either the residents, the utility, or the Local Government Authorities as observed by previous studies (Allen et al., 2017). CWIs were people-centred and their operations were shaped more by mutuality and/or mechanics of common understanding among water users. Interviews showed that boreholes were popular due to the depletion of water sources such as rivers and shallow wells, which were commonly used in the outskirts of Dar es Salaam in the past, the 1990s and 2000s. This was influenced by residential expansion and development (Andreasen & Møller-Jensen, 2016). Before modern hydrological technologies, bore wells were constructed through communal self-digging or by hiring artisans. With modern drilling equipment and private drilling companies, boreholes became the typical water system for urbanites unserved by the utility.

Independent self-supply infrastructures provided individual and household-specific water supply needs. These comprised households with rainwater harvesting facilities and mechanized boreholes. Experts opined that the high cost of storage facilities limited the large-scale collection of rainwater through rainwater harvesting among residents in Dar es Salaam. Individual households in Dar es Salaam engaged in need driven-practices via petty collection and storage of rainwater. This was mediated by the use of ordinary technologies such as buckets, plastic storage tanks/cans and barrels (Meehan et al. 2020). However, the high salinity of water in many parts of the city limited the usage of water from bore wells, especially for drinking. Except in *Kivule,* where the utility network did not also exist, bore wells were the typical water infrastructure. This type of infrastructure enabled a sufficient supply of water to satisfy end-users in terms of meeting their everyday water needs (cf. Uitermark and Tieleman 2021); see Figure 3.2).

Figure 3.2 Private mechanized boreholes networked water system

As a 64 year old owner of a self-supply water infrastructure revealed: "...I have a borehole where I get water for everything (...), so anytime, I hear announcement that DAWASA [the utility] is shutting-down for repairs or doing maintenance at the Upper Ruvu pumping station which is the main source of water supply for the city, and that for three days or more, the city will be dried (...) Am just tired of hearing this kind of information always, because, it does not matter, whether they do maintenance or not (...) it does not affect me. Am so sure of reliable water supply within the 365 days per year from my boreholes, but the rest of the residents in Dar es Salaam are subjected to this kind of calls or attention from the utility, like please tomorrow, we will have no water for the city..." [KII, 23 March 2022].

The findings suggest that water supplied beyond the utility in turn provides a fined-grain remedy, as it enabled residents to adapt to the utility's absence and failures. Although network water is the ideal for many residents (Smiley, 2020), long-term socio-natural interactions (between residents and boreholes) can contribute to the lack of interest in formal utility connections. A resident confirmed this; "Am saving a lot of water from the borehole, I don't think DAWASA [the utility] water could have been enough for me, I could have not afforded their water supply with all the functions, I have in the plot. Because, the remaining acre or hectare of my house is committed for gardening/horticulture, very intensive" [KII, 23/03/2022]. In continuation, he acclaimed, "no! I don't need a utility connection, whatever diameter size the pipe will be for me it doesn't mean anything, I don't need them, I am very self-reliant on that, on the contrary, I could help them, I could supplement their water, like I am doing free for my neighbours" [KII, 23/03/2022]. This reinforces Keough and Saidou's (2021) observations that off-grid water infrastructures not only structure supply, but also

serve as the medium through which hydro-social relations are built. In this context, neighbourhood-based social relations were developed and deepened through the act of supplying free water to neighbours living beyond the utility network. This partly reinforces Uitermark and Tieleman's (2021) observations that owners of mechanized boreholes rejected or disconnected themselves from the utility network. But for some residents, relying on heterogeneous infrastructures represents a safeguard measure (Lawhon et al., 2018).

Figure 3.3 Hydro-mobile reseller of utility water

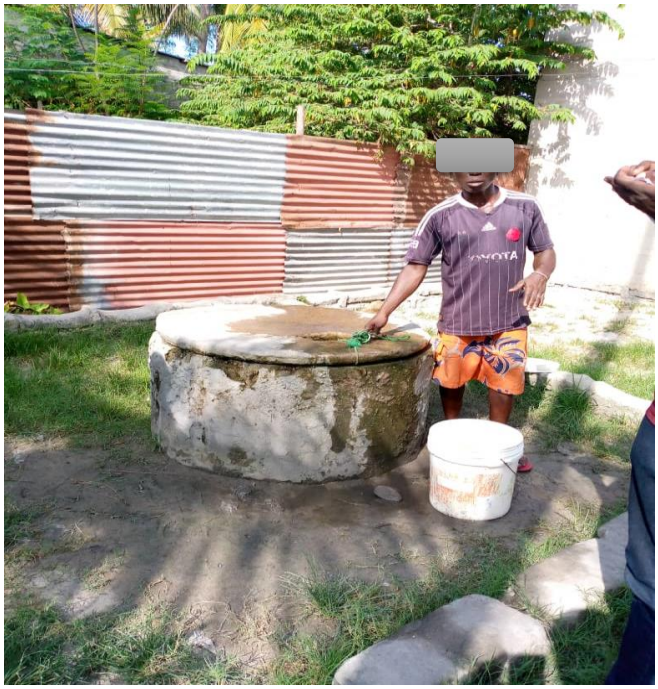

Figure 3.4 Protected bore well

Figure 3.5 Standalone kiosk reseller of utility water

As a private network water provider disclosed: "...Even when I get connectivity to utility network, when it reaches me, I will still like to operate my own supply. If I disconnect my bore-well and the utility's network gets problem, what will I do?" (KII, 17th March, 2022). However, disparities were found across the city in terms of perceived sufficiency of groundwater use. Unlike Kivule where groundwater satisfied households' water needs, such was not the case in *Goba* and *Magogoni*. In the latter, ordinary innovations and creativities (Martínez-Santos et al., 2020), such as boiling of

groundwater, helped reduce salinity and enabled residents to attain multiple-use. However, boiling of water for drinking was a peculiar practice not limited to groundwater, but also water sourced from the utility for doubt of quality.

In addition, the private networked infrastructure provided hydraulic connections to neighbours, serving about 3 to 100 households. The practice of drilling was interceded by varied material technologies, such as plastic storage tanks (Kasper & Schramm, 2022), the installation of pipelines, and the construction of the elevated tower for water storage and distribution (See Figure. 3.3). Groundwater was collected from artisanal dug-wells for domestic use, using rubber gallons tied with ropes as a routine practice (Figure 3.5). In rare cases, submerged water pumps were used as material artefacts to facilitate the circulation of water into elevated storage tanks of about 14-15 meters in height for onward distribution by gravity. This routine practice ensured the continual collection and use of water from bore wells by residents. The higher the elevation, the higher the possibility of delivering water to connected households. Water from communal/shared water infrastructure was circulated through the ordinary practice of collecting and transporting by residents. Through selective pumping and distribution of water, private networked water providers enabled the regular flow of water to houses located in highly elevated areas. Although operating beyond the water utility, these infrastructures were connected to utility infrastructures and other systems. Some water providers constructed, 32,000-litre storage dams as backup storage infrastructures in case of electricity failure.

Hydro-mobile infrastructures such as tanker trucks (un)registered with the utility, tricycles, bicycles, or pushcarts were found as the fourth infrastructural category. They provided residents with virtually connected water service (See Figure 3.4). Bodies and material artefacts enabled the transportation of water for household use, based on request and purchase (Peloso & Morinville, 2014; Simone, 2021; 2014; Truelove & Ruszczyk, 2022). Road networks and mobile phones facilitated interactions as mediatory infrastructures. Storage tanks and water pump machines powered by petrol enabled the collection and discharge of water. Agents of hydro-mobile infrastructures responded to the challenge of uneven topographic spaces by delivering water across highly elevated areas beyond the pressure/reach of the pipes. Overall, although these water infrastructures co-existed as varied systems within the city, they were largely interconnected in terms of the sources and the technologies used for water distribution

3.5.2 Modes of governance of water supply beyond the utility

The interviews showed that hybrid governance modalities mediated water supplied beyond the utility network in Dar es Salaam. Mechanized boreholes, tankers and pushcarts co-produced, co-governed, and self-governed water distribution. Co-production and self-governance arrangements were the dominant models that facilitated water production/extraction and distribution. Community-shared/owned water infrastructures, private network water infrastructures, and self-supply households were informally co-produced and self-regulated. Non-state water actors such as community shared/owned water providers, and water resellers/distributors informally engaged, extracted and distributed groundwater to other residents. These actors configured material

technologies such as pipelines, and tanker trucks to collect and distribute water. As observed by previous studies (e.g., Pakizer & Lieberherr, 2018; Truelove, 2020; Dakyaga, 2022), these acts challenged the mono-centric ways in which water was supplied by the utility (residents supplied water based on their self-will and abilities). As revealed by a private networked water provider: "...When you are starting the drilling process, you don't ask for permission, you look for the people/companies into water drilling and you wake up in the morning and start drilling. You just tell the private companies with the expertise that you want to drill water, they come to you and you show them the locations, then you negotiate the price/cost then they start the drilling processes. When you get the water drilled then you now start to follow the procedures that is if you want to supply to people..." (KII, Goba, 07/03/2022). Deep wells ranging from 50 to 70 meters in depth and boreholes ranging from 136 to 150 meters were discovered to have been constructed as a result of this arrangement. These informal ways in which non-utility infrastructures were produced defied the ability of the utility to govern their operations. As observed by previous studies (Sultana, 2013), monitoring became necessary only upon speculation of outbreaks of water-borne diseases such as cholera. In such occasions, monitoring and regulations were limited to commercial water producers and distributors to the neglect of self-supply households, The owners of gated homes restricted self-supply water infrastructures to maintain their privacy and indirectly assert their own power (Dakyaga et al., 2022).

The interviews also uncovered how the mediating roles of collaborative governance modalities influenced the supply of water outside of the utility (Ansell & Gash, 2008). The utility partnered with private tankers to distribute water to unserved areas, including elevated locations like Goba and Mbezi, beyond the reach of its pipes. "Utility water kiosks gate-keepers" coordinated water supplied enabling registered tankers and pushcarts to collect water from the utility kiosks for onward distribution. The gatekeepers of the utility's water kiosks oversaw, managed, organized, and assisted registered tankers in collecting water. Tanker drivers showed coupons as proof of payment to the utility and collected water for onward distribution. Tanker operators partnered with the utility based on their self-interest in co-distributing the utility's water (Doberstein et al., 2020). Utility's "water kiosks gate-keepers" acted as mediators with interface interactions by maintaining relations between the tankers/water distributors and the utility at the designated utility kiosks. Private water providers, unregistered tankers, tricycles, and motorbikes operated outside of official regulations to produce and distribute water with the aim of providing a social service to residents. These actors drilled boreholes informally, in the purview of self-supply and social agency, but in turn, operated as commercial entities. see Table 3.2.

Table 3.2 Typology of water infrastructure beyond the utility network and their governance modalities

Water infrastructures	Mediating actors	Governance modalities											
		Production/extraction						Distribution/Circulation of water					
		Self-governance	Co-governance	Co-management	Co-production	Market-oriented gov.	Network governance	Self-governance	Co-governance	Co-management	Co-production	MKT-oriented gov.	Network governance
Community-owned/shared infrastructure	Mosques water vendors	•			•			•			•		
	Community-based water vendors	•	•	•				•	•		•		
	Protected wells	•			•			•			•		
	Shared water networked actors	•			•	•		•			•	•	
Hydro-mobile infrastructures	Tanker drivers (non-registered)	•			•	•		•			•	•	
	Pushcarts/tricycle operators							•			•	•	
	Utility kiosks water resellers								•		•		•
	Tanker drivers (registered utility)								•		•	•	•
Private networked infrastructures	Bore-wells connected to residents	•			•	•		•			•		
	Private taps	•			•	•		•			•		•
Self-supply water infrastructure	Household with bore-wells for self-use	•			•			•			•		

Through partnerships between NGOs such as WaterAid, Local Government Authorities and the utility, boreholes were co-produced and co-managed for water distribution especially in the peri-urban areas (Sorrentino et al., 2018; Turnhout et al., 2020). In Goba, interviews revealed that beneficiaries' capacities were built on the aspects of maintenance and repairs of water infrastructures by NGOs. Residents exercised responsibilities in aspects of repairs and maintenance of water infrastructures for continual use of the water. Technicians/pump engineers interacted with NGOs and residents as well as the private networked water providers to provide technical and technological support such as repairs and maintenance. These interactions were mediated by networked governance modality and developed through the acts of consulting and contractual service provision (Graversgaard et al., 2018; Batory & Svensson, 2019). These offered a fine-grained arrangement through which bore wells and tankers with pumps were made functional and distributed water beyond the utility.

3.5.3 The actors and modes of interactions towards water supply beyond the utility

In peri-urban areas of Dar es Salaam, water was delivered largely by non-state actors. This was made possible through a complex web of institutional, intra- and inter-actor interactions among the actors. Such as co-producers and distributors, co-distributors, co-financiers and engineers/technicians, consumers and (in)direct regulatory agencies. Co-producers and distributors comprised privately networked water providers and independent self-supply households (that extracted groundwater mainly for domestic use) (Dakyaga et al., 2022). These actors produced and distributed water via civic cooperation and as voluntary participants. As revealed by a plumber; "We work with the hydrologist and the drilling companies sometimes. We go around mapping the water drilling point through the use of technological devices. I have worked for more than 200 customers on the issue of water connection..." (KII, Plumber). These relations existed between technicians, pump engineers, plumbers' hydrologists and residents interested in drilling boreholes for household self-use and commercialization. Technicians, plumbers, pump engineers and hydrologists with the technical know-how invented tailored-made/customer-centred water distribution innovations. To address irregular water flow in peri-urban areas at higher elevations, they linked valves, pipes, wires, and storage tanks, submerged water pumps to increase pressure. Through socio-technical interactions (Keough & Saidou, 2021), plumbers and engineers configured material artefacts by providing single pipeline connectivity from the elevated storage towers to clients' homes. Secondly, Pump technicians provided customers in higher elevated areas with a dedicated pump machine, and distributed water utilizing the "Off" and "On" switch control system. The interview revealed that NGOs financed the drilling of mechanized water systems through the relations of civic cooperation, partnership, collaboration and voluntary participation (Turnhout et al. 2020; Otsuki, 2016). In Kivule and Goba (peri-urban areas), earlier settlers financed the drilling of bore-well water systems through which newcomers collected water (Grönwall, 2016). This was enabled through the relationship of gifting and sharing of water as observed by previous studies (e.g., Wutich et al., 2018; Keough & Saidou, 2021). The findings also suggest that water infrastructures are not only artefacts that deliver water but the medium through which varied socio-cultural relationships emerge and are deepened. In both

cases, the mechanization of water infrastructures enabled the delivery of running water for neighbours. Private network water providers without automatic switch pump technology hired workers to manually coordinate water pumping into storage tanks for distribution. The provision of these water infrastructures manifested through civic cooperation between the utility, local Government Authorities and NGOs.

Technicians/engineers acted as mediators between the utility and non-state water actors, extending water systems, in addition to providing technical support. Plumbers assisted in drilling wells, connected PVC pipes, installed water pumps, and monitored household water systems. Sole distributors of water include (un)registered private water tanker drivers, so-called "water boosers", pushcarts, tricycles, and bicycle, or motorbike operators. Some tanker truck drivers were found to engage in formal partnerships with the utility (DAWASA). These actors collected and delivered water from the utility. Except for the utility tankers, most water distributors had neither formal union nor registered, but configured and distributed water via self-regulated leadership. As disclosed: "Everywhere there is a leader, without the leader you know we are all matured, the leader manages our affairs, but he is not here now..." [FGD tanker drivers, 02/03/2021]. Local norms structured interactions among non-state actors, especially tanker drivers engaged in water distribution. Unregistered tanker trucks collected water from private bore wells/holes for onward distribution. However, the relationships between the utility and non-state water providers were cordial interdependence, and (in)formal collaboration. As the utility advisor revealed: I think there is a positive interaction, there is a supportive environment for non-state actors, and the utility is not fighting them. To me, I don't see DAWASA [utility] fighting them, because the utility knows that if non-state actors are not there, they are in problems". DAWASA/utility, Ministry of Water, and Local Government Authorities (LGA) exercised legal mandate as water providers and regulators (See Table 3.3).

Table 3.3 Categories of actors and modes of interactions towards water supply beyond the utility network

Categories	Actors' specification	Modes of interaction															
		Among non-state actors								With state actors (Utility, WoW)							
		Civic cooperation	Partnership	Alliance/coalition	Networking	Vol. participation	Collaboration	Contractual	Interdependence	Civic cooperation	Partnership	Alliance/coalition	Networking	Vol. participation	Collaboration	Contractual	Interdependence
Co-producers & distributors	Mosques water vendors	•				•				•				•			
	Self-supply households	•				•				•				•			
	Community-based water vendors	•				•				•				•			•
	Private taps	•				•				•				•			
	Private water kiosks' operators	•				•			•	•				•			
	Private networked water actors	•				•				•				•			
Co-distributors	Tanker drivers (non-registered)		•			•	•		•	•				•			
	Resellers of utility water	•	•			•	•			•	•			•		•	•
	Private water kiosks -groundwater	•				•				•				•			
	Pushcarts/tricycle operators	•				•			•	•				•			
	Utility kiosks operators	•				•			•	•	•			•	•	•	•
	Tanker drivers (registered utility)		•			•	•	•	•		•			•	•		•
Co-financiers & Technicians	NGOs/Dev.t Agencies		•						•	•	•		•	•	•		•
	Plumbers	•			•			•			•		•				
	Drilling companies	•		•				•				•				•	
	Water pump mechanics	•		•				•	•	•							
(In)direct regulatory actors	The utility, Basin water board	•					•		•								
	Ministry of water & of health						•		•								•
	Municipal water Engineers	•			•				•	•			•				•
	Local leaders (*Mtaa)*	•							•	•			•		•	•	•
Consumers	Households	•							•	•			•		•	•	•
	Businesses; salons, food vendors								•	•							•

Some bore-well drilling companies allied and collaborated with the Ministry of Water to facilitate the drilling of bore wells, often via contractual agreement. They indirectly monitored the extraction of groundwater by testing and analysing samples of drilled groundwater to certify the quality for domestic use. These actors (in)directly structured the production and distribution of water outside the utility. As Grönwall (2016) observed, non-state actors were the "governors" who engaged in routine monitoring of the production and distribution of water through which the "governees" collected water. As revealed: "...I usually walk around the pipelines to check leakages, the first sign of detecting leakages is the source, and the subsequent indicators are the patched of leakages..." (KII, private networked provider, 07/03/2022). This demonstrates the hydro-socio-technological interactions that mediate water distribution (Keough and Saidou 2021). The next section demonstrates the various powers and mechanisms that mediate water supply.

3.5.4 Powers and regulatory mechanisms governing water supply beyond the utility

In Dar es Salaam, multiple actors (in)directly regulated the drilling of mechanized boreholes, water kiosks, water tanker drivers and pushcarts. These comprised the Ministry of Health, the Ministry of Water, EWURA, DAWASA (Utility), Mtaa, Basin Water Board (BWB), and Waterworks units at the Municipal Councils. The Ministry of Health (MoH) and Ministry of Water (MoW) played leading roles, in the provision of policy guidelines to the Energy and Water Utility Regulatory Authority (EWURA). The interviews showed that EWURA held direct reinforcing power to (dis)empower utilities in terms of licensing, and tariffing. EWURA has the mandate to review and monitor the performance of utilities towards safe water and electricity services delivery. In reality, in the aspect of water, EWURA regulated formal service providers, particularly DAWASA. DAWASA has the legal mandate to regulate mechanized boreholes, tanker truck operators and other non-state actors in its service areas. It exercises the power to monitor and ensure compliance of non-state actors to regulatory mechanisms such as the registration, permitting and licenses for water supply. As disclosed "...there are procedures, you see you need to have first of all a drilling permit from the Basin Water Board, for any borehole, that is the procedures, of course, the control is a challenge because of so many people, sometimes some might not follow, but the procedure is there..." (Utility official, 02/03/2021). Overall, the utility exercised the power to mobilize material, financial and human resources. The power to determine the inclusion and exclusion of non-state actors engaged in water distribution. Despite these regulatory mechanisms, water supplied by non-utility-networked water providers was less monitored and coordinated by the utility/DAWASA. In the case of Magogoni (Kigamboni), inspections and confirmation by the *Mtaa* leaders paved the way for residents to engage in groundwater extraction for self-supply.

Although the utility has the power to cease, own and manage operational assets of non-state actors upon network extension in areas served by non-state actors, the utility has been vulnerable. This is due to the inability of utility to attain even coverage of networked extension. Even in peri-urban areas with utility networks such as Goba, the utility's policy of 50 meters distance extension from transmission pipes restricted its efforts to attain wider coverage. In light of its incapacity, the utility recognized non-state water suppliers as informal collaborators, temporal alternatives and enablers.

Consequently, non-state actors engaged, interacted, configured and structured water supply to their advantage in the purview of filling service gaps. This further suggests that the utility is not only vulnerable to changing ecological conditions (Gibbs, 2015) but also to its institutional inabilities. The utility lacked the ability to identify and monitor the activities of non-state actors and enforce regulations for compliance (Grönwall, 2016). As an expert revealed: "...Compliance requires enforcement, compliance does not come automatically(...), and if you talk of enforcement, you are now referring to the capacity of DAWASA (Utility), the capacity of DAWASA is very limited if at all, because itself has not been able to meet even the service requirement in terms of network extension, a capacity in terms of tools, instruments and staffs to ensure compliance..." Despite limited enforcement, non-utility-networked water suppliers were allowed to register when identified during monitoring; See Fig. 3.6.

Figure 3.6 Registered tanker trucks stationed at utility kiosk to collect water for distribution

Monitoring was conducted sporadically during an outbreak of waterborne disease (Sultana, 2013; Cain & Baptista, 2020). Licensing and monitoring selectively targeted privately networked water providers who extracted groundwater and extended connections to neighbourhoods. Beyond conformity to legal regulations, ownership of permits and licenses for water supply represented a kind of power to non-state water actors, especially tanker water distributors. Firstly, it signified the power of legality, and inclusion through which registered tankers collected water from the utility and served residents bypassed by the utility. Secondly, regulatory power and partnership enabled the utility to differentiate, regulate and collect fees from registered private tankers. Through formal registration, tanker drivers were able to organize a protest and resisted the utility's decision to close down water kiosks in the past. Tankers with formal partnership and collaborative arrangements were restricted from using registered vehicles for the collection of wastewater, stones and sand.

Despite the formal partnership, quality water distribution was sometimes compromised. Some registered tankers collect groundwater instead of utility water kiosk water. This happened during water scarcity when the demand for water is high due to the inconsistent flow from the utility. Beyond the utility-defined rules and regulations, informal norms mediated the collection of water by tankers at the various utility kiosks. Tanker truck drivers queued at the water kiosks to collect water, only when they got a request from clients to deliver water. While regulatory mechanisms represented mediating powers, their enforcement was hampered by the fragmented regulatory actors with overlapping, conflicting roles and responsibilities. Whereas the Basin Water Board (BWB) held the power to provide permits for the drilling of bore wells, registered actors interviewed obtained permits from the Ministry of Water. This contradicted the formal instituted arrangement, challenged the enforcement of regulations, and served as an impetus through which water was supplied beyond the utility. It suggests that the roles of state agencies, such as the Ministry of Water, produced, empowered and facilitated the proliferation of non-state actors that engaged in water supply beyond the utility network. This showed how state regulatory structures created loopholes for non-state actors to exercise agency. State agencies were indirectly connected to the evolution of non-utility-networked water providers. MoW enabled non-state actors by verifying and certifying groundwater quality extracted by private mechanized household water providers. Private water drilling companies allied to the MoW facilitated the drilling, collecting, testing and analysing of groundwater water samples for self-supply.

3.6 Conclusion and implications for improving urban water supply beyond the utility

Previous studies typified cities in the global South as peculiar geographies where infrastructural heterogeneity prevails (Jaglin, 2014; Lawhon et al., 2018). Categorizing these infrastructures, actors and their interactions can enhance understanding of heterogenous infrastructures. However, it is still a challenging task to develop a framework for studying the governance of these infrastructures. This study builds on literature on urban water infrastructure, everyday practices and governance to propose a comprehensive framework of governance modalities, and actors' interactions within heterogeneous infrastructures. The proposed framework articulates governance modalities, actors and interactions, powers and regulatory mechanisms. By situating the framework in Dar es Salaam's diverse infrastructure landscape, this study adds to discussions on urban water governance. The study showed that multiple categories of water infrastructure beyond the utility network co-exist supplying water to residents in Dar es Salaam. These comprised privately networked water, self-supply water infrastructure, communal/shared water infrastructure and hydro-mobile infrastructure. Water pump machines, vehicles, generators, pipes, and equipment were material technologies that enabled the storage and distribution of water. The interconnected and interdepending nature of these infrastructures fostered the configuration and delivery of water to meet place-specific conditions. Water production and distribution were mediated by diverse governance modalities, including informal and formal co-production, self-governance, co-governance, market-oriented governance, and networked governance. (In)formal co-production and self-governance arrangements were dominant governance modes facilitating water supply beyond the utility network in Dar es Salaam. These worked to challenge and exposed the vulnerability of the

hierarchical water supply approach of the utility, as they supplied water to most areas beyond the pressures of the utility pipes.

Except for formal tanker truck drivers registered with the utility, regulatory agencies did not regulate informal actors like pushcart/tricycle/motorbike/bicycle water vendors and distributors, protected wells, private tankers, water kiosks, private water taps, mosques/church water vendors, self-supply households, and resellers of utility water due to their informal ways of producing and distributing water to urbanites. The utility's inability to achieve coverage of networked water and regulate non-state actors challenged its power to (in)exclude actors in the waterscape. If formally monitored and regulated, non-utility-networked water actors could be valuable assets for improving urban water supply, given the vulnerability of the utility.

In conclusion, the study contributes to urban water infrastructure configuration, infrastructure heterogeneity, everyday practices and governance debates by revealing that multiple governance modalities, such as co-production, self-governance, market-oriented governance, co-governance and networked governance, shaped how water is produced and distributed beyond the utility network in cities of the global South. Moreover, (in)formal co-production and self-governance arrangements represent the dominant modes facilitating the production and distribution of water. Diverse actors, powers, conflicting responsibilities, and (in)formal regulatory mechanisms are embodied in these modalities. The multiplicity of governance modalities shaped the modes of interactions and powers of the various actors through which they (re)produce varied arrangements for water distribution across infrastructural categories. These arrangements and the infrastructures served as the medium through which hydro-social and technological relations were built and deepened. They are equally influenced by (in)informal norms/mechanisms and power relations. These have consequences for (un)even water distribution among urbanites and across urban spaces. The study recommends that future research pays attention to how residents navigate and manage trade-offs within heterogeneous infrastructures to collect water.

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CHAPTER FOUR

Governing ourselves for sustainability: Everyday ingenuities in the governance of water infrastructure in the informal settlements of Dar es Salaam

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4.0 Introduction

The chapter presents an exploration of the practices that mediate water infrastructure provision beyond the utility network, detailing how such water supply infrastructures are sustained for water supply. In so doing, the chapter draws an analytical perceptive from governance sustainability alongside the everyday practices of non-state actors. These perspectives aided the exploration of the mundane ingenuities of non-state actors about how water infrastructures are developed and sustained for supply beyond the utility network. Additionally, it highlights the key actors/agents involved in the practice, the resources, and where and how the engaged actors, source (non)material resources to develop the infrastructures such as boreholes, purchase tanker trucks for water supply and protected wells. The Chapter also highlights the discourses concerning water supply, the activities undertaken by the actors towards the infrastructure development and the rules and mechanisms that shape the sustainability of the infrastructures for water provision.

Abstract

Everyday ingenuities have gained hegemony in urban governance scholarship in the Global South, especially regarding the informal settlements of sub-Saharan Africa, where public water services are limited. Within the global commitment to sustainability, through the Sustainable Development Goals (SDGs), this article explores how non-state actors (water service providers) develop and sustain water infrastructure (provide, and manage water systems for continued availability) in informal settlements, through the lens of the everyday ingenuities and governance for sustainability framework, and a qualitative research approach. The study realized the involvement of individuals and groups of actors in water infrastructure governance. The actors self-mobilized resources and develop low-cost water infrastructure systems. The actors engaged in a gamut of actions, transactions, clientelist (broker and clients' relationships), and interactions (buying and selling of water, networking, production, cooperation, partnerships) to manage water infrastructure, the practices were guided by unwritten rules and regulations, and not independent of state actors' interactions, but formed and developed through the relations between state and non-state water service providers. The findings suggest that water infrastructures in the informal settlements are developed and sustained through the everyday act of inventing, repetitive self-actions, ordering and

disordering of the rules and mechanisms, among the inter-depending actors (producers and resellers of water), and their interactional relationship with the state water utility provider (DAWASA).

4.1 Introduction

The global development agenda "Leaving no one behind" entrenched in the United Nations Sustainable Development Goals (SDGs) paradigm raises significant concerns and pathways towards inclusive growth along with defined developmental priorities (UNESCO 2019; Ramutsindela and Mickler 2020). Fundamental to the global development priorities epitomized in the SDGs is to "ensure the availability and sustainable management of water and sanitation for all" (SDG 6) (United Nations 2016). Consistent with the drive to "ensure the availability and sustainable management of water and sanitation for all" is the call for collective action—collaborative governance of water infrastructure by the public and private water service providers (Alfaro d'Alençon, et al. 2016; United Nations (Habitat III) 2017).

Unfortunately, over the years, both the public and the private water service providers have been unable to meet the water needs in the informal settlements (Dagdeviren and Robertson 2011; Adams et al. 2020; McFarlane et al. 2014), where about 50–80% of the population in sub-Saharan African cities live (Corburn and Karanja 2016, p. 259). Though states have the legal right to serve the citizenry, residents in the informal settlements inclusive, public utility, preferably served the planned settlements, for the reason of low production capacity and the fear of water service cost recovery from residents in the informal settlements, among others (Wamuchiru 2017; Dakyaga et al. 2018b). Studies also criticize the adoption of global North planning principles for public utility segregation. It is argued that Western planning strategies dictate spatial inclusion and exclusion through the segmentation and segregation of cities into "planned" and "unplanned settlement" This perpetuated in services inclusion even in present-day African cities (Monstadt and Schramm 2017; Wamuchiru 2017; Truelove 2019). As a result, residents in the informal settlements engage in everyday practices to access services by undertaking self-initiative (Nhamo et al. 2019; Aleixo et al. 2019). In Dar es Salaam, most residents in the fringes undertake self-initiatives towards water provision due to the failures of conventional water networks (Kyessi 2005; Wamuchiru 2017). Gibbs (2015) also observes that the roles of public water authority in water provision are gradually transferred to the citizenry, due to the perceived potential of the citizenry.

It is within this context (state failures and the potential of the citizenry) that some urban scholars recommend the need to re-examine the everyday governing practices and perhaps adopt them to limit the burden of the centralized water system in the Global South cities (see Kyessi 2005; Alfaro d'Alençon et al. 2016; McGranahan et al. 2016). Some scholars called for the need to localize global development indicators, especially the SDGs and the New Urban Agenda (NUA) for universal applicability and local adaptability, and to gain the contribution of non-state actors (e.g., individuals, community-based organizations (CBOs) (Leach 2016; Patel et al. 2017). These are also in response to the inability of globalized solutions to meet local challenges (Gibbs 2015; Croese et

al. 2016). Although studies flourish on the everyday ingenuities/practices, little is known about how the residents/citizens develop and sustain water infrastructure (provide, and manage water systems for continued availability). Rather, related studies on everyday governance practices are engrossed in how the citizenry access urban water service, the power and urban politics in water access, and how state relations shape everyday governance practices in the Global South (see Bénit-Gbaffou and Oldfield 2011; Velzeboer et al. 2017; Zhen et al. 2019; Neves Alves 2019; Pihljak et al. 2019). This study acknowledges the valuable contributions of the aforementioned studies in shaping this present study. However, considering the global commitment to sustainability, through the SDGs, this study argues that how water infrastructures are developed and sustained (provided, managed for continued availability) is imperative in improving water access in low-income settlements.

The study explores how residents/citizens in informal settlements develop and sustain water infrastructure. The study draws from the everyday ingenuities and governance for sustainability framework to understand how the non-state water service providers pursue self-actions towards developing and sustaining water supply. To do this, the study starts by first synthesizing the literature in the "Governance of Urban Water Infrastructure in Sub-Saharan Africa" section. The "Methodology" section presents the study areas and methods used for data collection and analysis. The "Results and Discussion" section presents the results and the discussions. While the last section "Conclusion and Policy Implications" presents the conclusions, policy implications, and directions for future research.

4.2 Governance of Urban Water Infrastructure in Sub-Saharan Africa

4.2.1 Everyday Ingenuities/Practices of Urban Water Infrastructure Governance

The everyday ingenuities have gained consideration in urban water infrastructure, governance, and scholarship, especially in the Global South. Due to the failure of the conventional water networks in even water distribution, residents in the fringes access water through everyday practices—the mundane (ordinary), day-to-day self-actions/ activities, and arrangements (Peloso and Morinville 2014; Velzeboer et al. 2017; Pihljak et al. 2019). Such practices are often repetitive, conscious or unconscious, and dynamic in response to the prevailing situations and may contribute to or challenge prevailing procedures and rules (Alba et al. 2019). Governance refers to the ordered ways in which water infrastructure and services are provided, how interests are pursued and refuted, and how authority/power is exercised and institutionalized (Cornea et al. 2017). Governance follows explicit logic, and a set of norms, guided by specifying authority (Olivier de Sardan 2011).

Correspondingly, the everyday practices of governance are "loosely bundled" actions "trivial" but essential to the daily lives of the involved actors (Strengers 2010). The practices demonstrate "situated power relations" and determine how services are provided and accessed (Hackenbroch and Hossain 2012). Everyday governance practices are driven by practical knowledge/consciousness, common social understanding, rules, material infrastructure, performance, reproduction, and dynamism (Strengers 2010). Truelove describes everyday practices as "gray zone"—characterized by political assemblage, contests dualism, and blurs the borders between what is termed public-private, legal-illegal, and formal-informal practices (Truelove 2019).

The practices evolve through intricate interactional relations between state and non-state actors/ society, and social relations with differential sources of power (Neves Alves 2019). The sources of power, the social relations, the act of negotiation, and the norms, rules, and regulations determine the inclusion and exclusion of non-involved persons in governance practices (Velzeboer et al. 2017). Everyday governance practices are driven by "groups" and "individuals" (Strengers 2010). Olivier de Sardan (2011) indicates that the group-based actors comprise the state, the municipalities, non-government organizations (NGOs), and the associations, who govern through the bureaucratic power (state), decentralized (municipalities), development project-based (NGOs/community-based organizations), and associational power (cooperatives, faith-based groups). The individualized actors comprise the local leaders (chiefs—commonly found in West Africa), "big men" (rich individuals), the private operators, and the religious groups, who govern either through chiefly power (as local leaders); sponsorship-based (sponsors by financially capable individuals); the merchants (private operators engaged in public service delivery); and religious groups (churches, mosques).

The concept of "practices" in everyday governance involves interrelated actions, sets of interactions, regulations, negotiation, and the act of adapting and producing among others (Cornea et al. 2017). Practices are characterized by the logic of the sedimented antiquity of everyday "doings" associated with the desires of the actors and their knowledge (Alda-Vidal et al. 2018; Pihljak et al. 2019). They are created by the actors through routine interactions, internalized rules, and social norms and sustained through the multiplicities, repetition, and the ordering and disordering of the actions (Peloso and Morinville 2014). The ordering and disordering foster co-existence among the actors and prone the practices to transformation/change (Furlong et al. 2019). Accordingly, in societies characterized by everyday practices of governance; the less powerful residents may access services through social-relational sources of power. Hackenbroch and Hossain (2012) used the phrase "organized encroachment of the powerful" to describe how unbalanced power structures and inequalities in society may favour the powerful groups and individuals (local political leaders) to the detriment of the less privileged/powerful citizens.

4.2.2 Analytical framework: Governance for Sustainability

The study adapted the governance for sustainability framework to understand how non-state actors (water service providers) develop and sustain water infrastructure in informal settlements. In his book, Governance for Sustainability, Elkington (2006) suggests that covenants are central to fostering governance for sustainability. He notes that "when communities, groups govern themselves, covenantal relationships are often obvious" and are more likely to result in the sustainability of the objects and spaces being governed (Elkington 2006, p. xv). Self-governance is a network approach of governance, which involves an autonomous governing network, in which non-state actors (citizens, non-government organizations, groups, and peoples) interact with one another or with other organizations by exchanging resources, negotiating common purposes, due

to different capacities to realize a defined goal (Van de Meene et al. 2011; Stoker 2018). In self-governance, non-state actors lead the governing processes (Rauws 2016). The role of the state is not excluded but may determine the conditions and structures (Rauws 2016). Governance for

sustainability involves the set of written and unwritten rules, regulations, and interactions that link ecological citizenship with the institutions and norms towards the sustainability of the spaces and objects being governed (Elkington 2006). The institutions and norms that determine sustainable governance include the actors, resources, rules and mechanisms, activities, and discourses (Arts and Leroy 2006; Sørensen and Triantafillou 2009; Cleaver and Hamada 2010). The actors comprise of individuals and groups that influence resource mobilization and allocation, determine power, and decide who to involve in governing (Cleaver et al.2005; Asaduzzaman 2020). Governing involves the act of directing and controlling affairs and activities of an organization, groups, and people (Cornea et al. 2017). The bond between "those who govern and those being governed" is central to the continuity of governing (Elkington 2006), (see Table 4.1).

Table 4.1 Governance for sustainability framework

Key variables	*Criteria*	*Details descriptions*
Actors	Persons involved	Individuals, groups involved and their roles in the water service provision and supply
Resources	Inputs required	Technological, technical skills, material infrastructure, financial inputs, human resources required for production
Discourses	Objectives	Self-defined purpose, norms, problems and the approach
Rules	Procedures	The formal and informal procedures of making decisions, interaction
Activities	Actions are taken	Self-defined forms of actions undertaken by the actors towards the defined objectives

Source: Adapted and modified from Elkington, (2006) and Sorensen and Triantafillou (2009)

The *discourses* are the objectives, norms, values, problems, and approaches. The norms are comprised of official rules and unwritten codes of conduct that evolve through the interaction of the actors and serve as guides (Cornea et al. 2017). The *rules* of the game are the formal or informal rules and procedures that guide decision-making. They are neither institutional forces nor externally imposed, but evolve through the practices, and can lead to the reconfiguration of the practices (Strengers 2010). The *resources* comprise the materials, financial and skilled labour required to achieve success. The *activities* are the actions undertaken by the actors to realize the set objectives (Cleaver and Hamada 2010; Cleaver and Whaley 2018). To develop and sustain spaces and objects being governed, the actors must introduce a new system of rules and material infrastructure (e.g., technologies) and ensure that the rules and mechanisms are routinely recreated/reproduced (Strengers 2010).

4.3 Methodology

4.3.1 Study areas

Informal settlements are unplanned residential areas characterized by inadequate or lack improved water and sanitation infrastructure and basic services, insecure land tenure, poor housing/structural quality, and overcrowding/high density of dwellings (McFarlane et al. 2017). The applicability of these characteristics may vary from informal settlements across the globe, due to variations in settlements' make-up and also from country-specific contexts (Rasmussen 2013). The study was conducted in three informal settlements of Dar es Salaam—Goba-Chaurembo, Goba-Kibululu, and Goba-Kunguru—located in the Goba ward of the Ubungo municipality. These informal settlements are located in the periphery of Dar es Salaam, approximately 23 km away from the centre of the city, and were headed by Mtaa (ward) leaders. They share borders with Kunduchi, Mbezi beach to the east and urbanizing rapidly. In 2012, the population Goba-Kibululu was 5181 of 1594 households. The population of Kunguru was 6097 of 1186 households, while the population of Goba-Chaurembo was 5213 of 1185 households (URT 2017), (see Table 4.2).

Table 4.2 Basic information and characteristics of the study population

Study areas	Basic information		Selected actors interviewed per settlement				
	Population	No. of households	Mechanized household Water distributors	Water kiosks Actors	Well water actors	Private taps actors	Total
Kibululu	5,181	1,594	1	5	1	3	10
Kunguru	6,097	1,186	1	6	0	4	11
Chaurembo	5, 213	1,185	2	9	0	3	14
Total	16,491	3,965	4	17	1	10	35

Source; (URT, 2016).

These settlements are selected as information-rich cases: firstly, due to the dominant of non-state water service providers and secondly, as informal settlements (unplanned settlements - housing development did not comply with planning regulations) located at the fringe of the city. Though attempts were made to formalize (formally recognized as part of the city, through the extension of water services), inadequate access to residential water supply from the Dar es Salaam Water and Sewerage Authority (DAWASA) led to the proliferation of non-state water service providers (Dakyaga et al. 2018a), In the study settlements, about 53% of the residents were low-income earners. The estimated average household disposable income of the high-income households in these settlements was at 3,250,000 TZS or $1432.32 per month, 399,999 TZS or $ 176.29 of the middle-income households, and 109,999 TZS or $ 48.48 of that of the low-income households (Dakyaga et al. 2018b), see Table 4.2 and Figure 4.1).

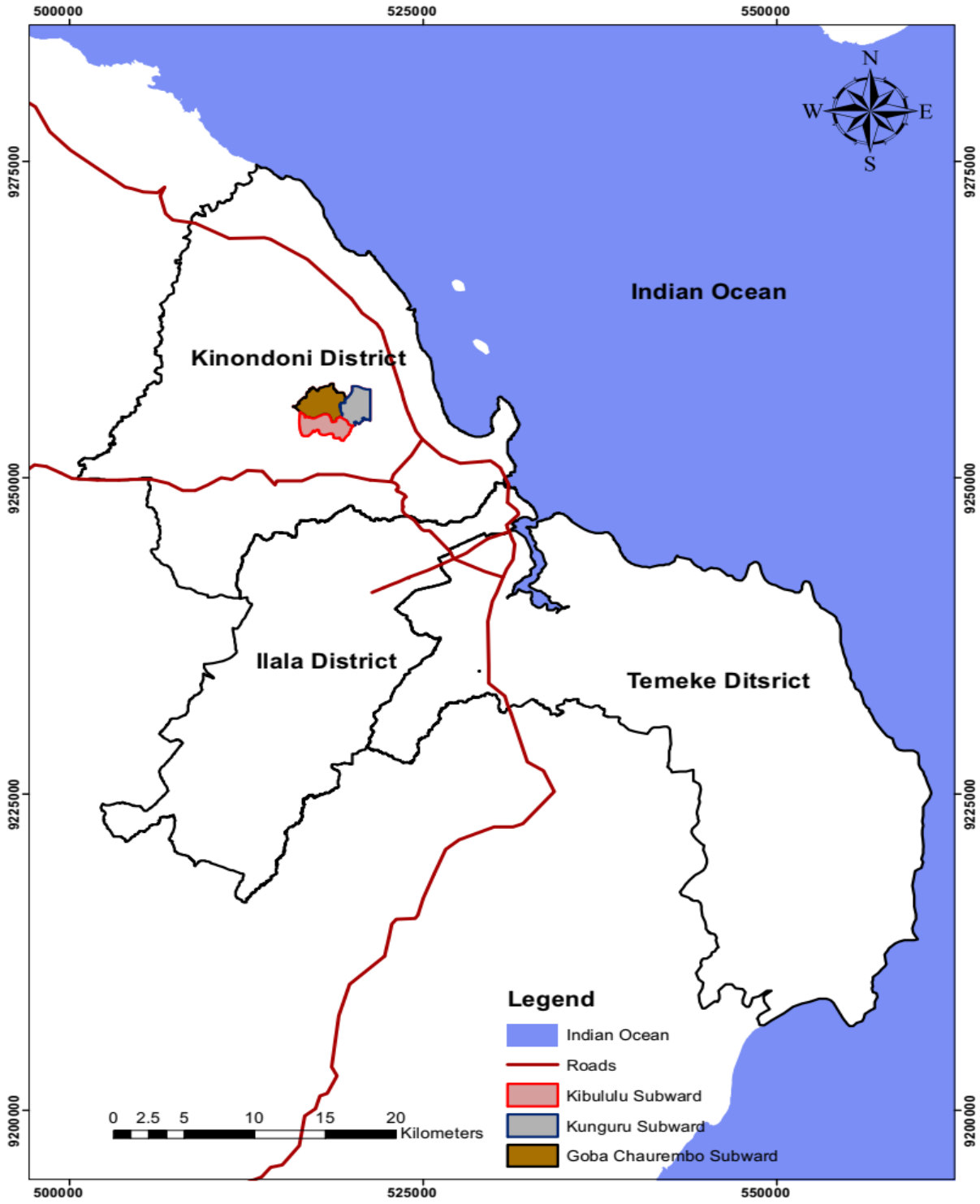

Figure 4.1 Map of Dar es Salaam showing the study areas

Considering that water infrastructure development and sustainability equally require huge financial resources investment (Wamuchiru 2017), it is uncertain how these residents develop and sustain water infrastructure.

4.3.2 Data collection and analysis

The study used a qualitative research method. This method was suitable for a comprehensive analysis of the everyday practices of governance. The method contributed to an in-depth exploration of everyday practices and provided a deeper understanding and clearer insight into the categories of actors involved, the resources used and their sources, the discourses, the activities and the rules, and the mechanisms the actors institute towards sustaining the water supply. Interviews were conducted with the *Ubungo* municipal water engineer and two *Mtaa* (ward leaders), the ward health officer and non-state water service providers, through face-to-face conversation. The interviews were conducted using open-ended questions, which enable probing, clarification and elaboration. The data was collected on the rules and regulations guiding the operations of non-state water service providers and whether they were registered operators. The interviews contributed to a preliminary understanding of the kind of actors involved (residents, groups, and individuals) in the water service provision. The interviewees had direct relations with the study settlements through their official responsibilities (municipal water engineer) or as residents in the study settlements (*Mtaa* leaders, ward health officers). The respondents interviewed have lived/stayed in the study settlements for decades and with adequate knowledge of how water infrastructure is governed.

It was not possible to survey non-state water service providers, due to the lack of knowledge of their number and locations in the study settlements. Instead, an initial reconnaissance observation was conducted through transect trips in July 2017 with the use of two motorbikes to take a preliminary record of the number of non-state water service operators and their locations. The reconnaissance observation was led by the *Mtaa* leaders and residents are familiar with the locations of the various water service providers. However, in the event that the *Mtaa* leaders could not locate non-state water service providers, a snowballing technique was used to ensure that the water service operators refer us to others involved. The reconnaissance observation and counting of the water service providers were done until saturation (a point where no water service provider could be located). The process led to the observation of their activities and the identification of thirty-five (35) water service providers. This number was assumed in almost all the water service providers in the three study settlements.

The data were then collected from thirty-five (35) non-water service providers through face-to-face interviews using open-ended questions. They comprised mechanized borehole water operators, water kiosks, standpipe, well water operators, tanker trucks, and pushcart water operators. The data were collected on the resources for water infrastructure development (kind of technology, technical skills, financial and human resources), and how they mobilise the resources. The discourses (the objectives, the norms and values), the activities, and the rules and mechanisms used to regulate and sustain infrastructure. Consent was sought from the interviewees, and the interview sessions were recorded for accuracy and to facilitate the process. The interviews were conducted by three (3) enumerators who were native speakers of Swahili, the dominant language spoken by the research participants. Ethical clearance was obtained from the *Ubungo* municipal council and the

Goba ward. The records/audios of the various interviews were transcribed, edited, and grouped along with the major themes/research questions that guided the interviews. The data were processed and codes are generated using MAXQDA, a software program used for qualitative data processing.

4.4 Results and Discussion

4.4.1 The actors involved and their roles in the urban water provision

The actors (water service providers) are comprised of groups (mechanized boreholes, water service providers, tanker truck operators) and individuals (water kiosks, protected wells, standpipes, pushcart water service providers). These actors governed the water supply through the act of networking (interconnecting, interacting, and supporting one another). The roles of the various actors varied; mechanized borehole water service providers played dual roles as producers and distributors—by drilling groundwater with the support of hired hydrologists—and as distributors by providing water to two categories of water consumers in the studied settlements: firstly, residential water supply through networked polymerizing vinyl chloride (PVC) pipes mostly to residents who could afford the cost of networked water extension (Wamuchiru 2017), and secondly, serving other residents who could not afford the metered water connection, through the everyday operations and selling of the water. The owners of the water facilities set and regulated the prices per connection (Pihljak et al. 2019). Service fees were based on the cost of the water extension materials (PVC pipes) in the market, the demand for water, and electricity tariffs (operators of the mechanized water facilities used electricity for pumping and distributing groundwater to residents). The fees collected from clients were used for both the maintenance of the facility and the payment of workers/operators of the water facilities, as well as to recover the cost of financial investment.

Both the standpipe and water kiosk operators were either producers of drilled groundwater or indirect distributors of DAWASA water through tanker truck operators. Standpipe and water kiosk operators distributed water through everyday operations and sold it to residents. Residents fetched water from the standpipes and kiosks and transported themselves to their homes. The tanker truck water service providers were in two categories: registered tanker trucks of DAWASA and non-registered trucks). Unlike Truelove's (2020) observation in Delhi (India), no restriction was placed on state-owned tankers from serving unplanned settlements. However, both state- and privately owned water tankers were not directly involved in water production but played pivotal roles as distributors of water produced by other water service providers (Truelove 2020). Through a partnership with the public water authority (Adams and Zulu 2015), the registered tanker trucks fetched water from the public water system and sold it to residents less served by the public water network. While non-registered tanker truck operators fetched or bought water from mechanized borehole water systems and distributed or sold it to residents, the partnerships offered monetary benefits to both the public water utility and the tanker truck operators registered with the public water utility.

Pushcart water operators (actors who utilized carts for water distribution) were absolute water distributors and resellers. They fetched water from the public water utility system into jerry cans and pushed them around in carts. Moreover, water from protected wells was open to all residents for access, especially when located outside the premises. In terms of gender, females were commonly engaged in the management of water kiosks and standpipe water systems, while males were involved in almost all the water supply systems (mechanized water systems, water kiosks, wells, and standpipes). Some tanker truck operators were registered with the Dar es Salaam Water and Sewerage Authority (DAWASA). Water kiosks, wells, pushcarts, and standpipe water operators were not registered but engaged in water production and distribution through self-decisions and practices (Alfaro d'Alençon et al. 2016; Neves Alves 2019). Consistent with earlier findings in cities of the Global South, the actors' involvement in the practice of water governance was necessitated by the unreliability of public water service and the challenges of accessing water services (Furlong et al. 2019; Truelove 2019). Access to adequate water service from the public utility was limited due to the low capacity of DAWASA to extend adequate water networks to all peripheral communities. The Mtaa (ward) leader shared his observation of the situation and the evolution of the everyday practices of governance as follows:

Our population is too much now, so water has been an issue. DAWASA's water is not frequent here we depend on our water providers. More than half of the people here get water from the wells or the kiosks actors, getting water from tankers in the dry season is 50-50, the tankers buy the water from DAWASA and supply us, this water is so expensive, so in the raining season, we normally supplement the cost by depending on the rainwater. (Kunguru-Mtaa leader, 02/05/2017, 12:34).

Through the act of self-initiative, the actors recognized water access in two dimensions: as a problem in their neighbourhood and equally as an economic activity. The residents involved in water provision devised entrepreneurial tactics to partly address the problem (Chien 2018) by financing the construction of water supply infrastructure and obtaining income by managing its operations for everyday water access.

4.4.2 Resources for urban water infrastructure provision

The actors mobilized and utilized diverse resources for water provision in their respective neighbourhoods (Kudva 2009). The resources comprised of financial, material, technological, and technical expertise. The actors mobilized financial and material resources through social networks and human agencies for the development of the water infrastructure. For example, all actors (water service providers) mobilized funding either through personal savings, family contributions, or a collective group (Dietz et al. 2003; Tummers 2015). The diversities of the actors' resources and their sources were influenced by the scale of activities, the mode of operations, the type of water supply infrastructure, and the segment of the population served.

For instance, mechanized borehole water service providers financed the cost of drilling and construction of water infrastructure. The actors secured materials such as cement, iron rocks, sea

sand, water storage tanks, and polymerizing vinyl chloride (PVC) pipelines. The actors secured standby generators as an alternative technology to the conventional grid, for pumping and distributing water. The actors sourced funding and other support through family savings or collective groups with an estimated cost of 20,970,000 TZS ($9000) to construct and provide water to their residents in their neighbourhoods. In the same way as the modernist infrastructure ideal, the actors recovered costs of investment and services, through monthly billings, utilizing meters to determine client-based consumptions. In terms of human capabilities/resources, mechanized borehole water systems were managed either by hired labour or family members. In the case of hired labour, the operators were paid through service fees obtained from clients. The operation and sustainability of mechanized borehole water facilities were dependent on the availability and stability of groundwater and the water storage capacities of the poly-tanks. The system of monthly billing (when extended via PVC pipes to residents) could not permit access by all residents, due to the inability of low-income residents to finance the cost of networked water extension. This suggests that citizenry self-governance is not a flawless approach to the urban water supply. It has the possibility of perpetuating inequality, "organized encroachment" by the financially powerful residents (Hackenbroch and Hossain 2012), who may act as the "governors" and the low-income residents as "those being governed" (Elkington 2006).

In the case of water kiosk service providers, resources such as a bag of cement, sea sand for molding blocks, and money for the construction and purchase of storage tanks were used for the construction of the infrastructure, demonstrating the capacities and power of citizenry self-governance (Mossberger and Stoker 2001; Orum and Lukas 2019). However, this was found to vary between water kiosk actors who relied on groundwater and the others who depended on other actors for water. Kiosk operators who relied on other water service providers for water required fewer resources and spent less on the construction of water supply infrastructure, approximately 10,000 TZS ($ 4.29) as the average cost of purchasing water from tanker trucks, but not the overall cost of the water supply infrastructure. Also, water kiosks were managed by family members or the owners of the facility. As indicated earlier, most operators and owners of water kiosks were women. The assigned family member, engaged in the management of the water system, cleans around the water facilities. Poly-tanks were used for water storage and distribution. Residents fetched water supply through gravity.

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4.4.3 Discourses in water provision and supply

From the findings, two main purposes instigated the everyday practices of governance practices: firstly, to reduce the burden of searching for water for domestic purposes, especially in the dry season (Colin-Castillo and Woodward 2015), and secondly, to earn income through the sales of water within their neighbourhoods. The governance of water infrastructure evolved in the neighbourhoods due to water scarcity and the location of residents beyond the formal utility networks (Andreasen and Møller-Jensen 2016). While households were able to access improved water by harvesting rainwater in the rainy season, in the dry season, residents spent more time searching for improved water, which affected engagement in petty trading and other livelihood activities (Sarkar 2020). To realize the above self-defined objectives, individuals and groups approached the problem by adopting a low-cost water servicing model—drilling and

mechanizing water systems in the case of mechanized water actors (Wamuchiru 2017), while others served as water redistributors through partnership. Pushcarts and trucks acted as "mobile water infrastructures by transporting or moving water to interested residents. Beyond the networking and partnership with one another, the actors developed an indirect engagement with the state water utility provider, serving as resellers of the public water utility. Although not all the actors (individuals and groups) had direct contact with the public water utility for water supply, the partnership and network among the actors enabled other non-state water service providers without direct cooperation with the public utility to act as public water utility resellers. For example, the kiosk water actors (individuals) had no direct partnership with the public water utility as they were non-registered operators; however, through their relations and partnerships with tanker truck operators registered with the state water utility provider, they accessed water from the state water utility and acted as water redistributors for the public water utility. Unlike Drivdal (2016) and Vivier and Sanchez-Betancourt's (2020) observations in Cape Town (South Africa), where residents in the informal settlement reconfigured the public utility network to their merit, the residents, in this case, devised self-initiatives towards water provision without tempering with the state utility network in their neighbourhoods. As a 29-year-old mechanized borehole water operator revealed:

… I hope to have all these houses around me get connected to my water infrastructure through the extension of the PVC pipelines, I am making efforts to see how that can be done, though I have not completed the construction of the water supply infrastructure. (07/0/2017, Goba-Chaurembo).

Though this demonstrates attributes of active citizenship (Wamuchiru 2017), the inability of the residents to configure the formal water network illegally, as in some informal settlements observed, was due to the residents' knowledge of the scant pressure and erratic flow of water of the formal water utility network in their neighbourhoods (McGranahan et al. 2016; Truelove 2019). However,

though the initiative evolved from individuals and groups, the actors formed the Water Committee Members and Council (WCM/C) informally. The WCM/C oversees the operations of the actors involved, regulating activities, especially the cleanliness of the water supply infrastructure. The actors liaised with one another in their daily operations, especially less resourceful actors (non-producers of water/resellers) who depended on resourceful water service providers (direct producers) for water redistribution. As a 34-year-old water kiosk actor revealed in Goba-Kibululu:

… Through my initiative, my neighbourhoods do not have to go far to look for water; I buy water from the tanker truck operators to supply. If the water is available, the business becomes good and profitable, but when it is unreliable, the business becomes difficult and expensive to operate. (07/06/2017: 14:50, Goba-Kibululu).

Consistent with Cain's (2018) observations in Angola, water kiosk actors in the informal settlements of Dar es Salaam allied with tanker truck operators registered by DAWASA for water supply. However, unlike Angola, not all tanker trucks supplying water in the informal settlements were registered. Interested non-registered tanker operators access public utility water through negotiation and alliance with registered tanker operators. In most instances, non-registered tanker operators depended on mechanized borehole water service providers and acted as redistributors. While Cunningham and Kwakkel (2009) regard negotiation among actors as a basis for maximizing and securing value in their activities, such negotiation and cooperation were valuable in sustaining the infrastructure (Stoker 2018). Water kiosk operators drilled groundwater supplies as their main source of water provision, while standpipe operators depended on groundwater or tanker truck operators for water in more of a partnership. The pushcart water operators relied on DAWASA and groundwater. Overall, through the system of partnership and alliance, the residents jointly governed the water supply in their neighbourhoods with limited municipal regulations.

4.4.4 Activities undertaken towards influencing change and sustaining infrastructure

The actors undertook several activities towards improving and sustaining the urban water supply. The activities varied from one actor to another, based on the kind of water supply infrastructure and the delivery model. The activities included the drilling of water supply sources by hydrologists; the construction and installation of equipment, water storage tanks as back-up; and the digging and extension of PVC pipelines to interested neighbours in the case of mechanized borehole water distributors. All actors cleaned around their water supply infrastructure, selling, and delivery of water to households. For most mechanized borehole water service providers, their daily activities revolved around the extension of water networks for households that can afford the cost. As a practice, the owners of mechanized boreholes continuously negotiated with plumbers for water network extension for residential water supply. Operators with vehicles also transported water to residents at their homes:

… I always clean around the poly-tank, I halt water from tanker trucks and DAWASA taps and put it into the poly-tanks for sale. I do not test the quality of the water in the poly-tank so I cannot tell

the quality of the water, but the business is good when the tanker truck water supply is reliable… (Goba-Chaurembo, 6/06/2017, 14:34)

Though quarterly chlorination of the water is necessary for maintaining and sustaining the quality of water, chlorination was done occasionally only by mechanized borehole water distributors. According to the Ubungo municipal water engineer, the following formal procedures are required before engaging in the water supply: First, residents are required to register with the municipal council before water supply; secondly, obtain permission from DAWASA; and third, obtain an operation permit from the Ministry of Health (MoH). Unfortunately, only the public tanker trucks were registered. However, the municipal water engineer described the actions of the non-registered operators as a "survival strategy" but not as a "criminal or illegal act." This corroborates Truelove's (2019) assertion of the blurriness of everyday practices of governance between "formal and informal" "and legal and illegal" and how state actors may "turn a blind eye" to such practices. It also suggests that formal institutions are often unable to regulate street-level governance, though heedful of their existence.

4.4.5 Rules and mechanisms to sustain infrastructure and water access

According to the study, two major rules governed water supply and access in the informal settlements: internal and external rules and regulations. The internal rules regulated the operations of the actors in their relationships with one another. They included trustworthiness, proper maintenance of the water infrastructure, responsiveness among actors, and willingness to routinely pay for the cost of water supply (Stoker 2018). Besides, water producers involved in the partnerships or contractual arrangements were expected to be responsive to redistributors. The rule of "cash and carry"1 characterized the transaction between water producers and resellers (Dakyaga et al. 2018b). This rule was observed among all water redistributors and their respective partners, especially, between water kiosk operators and some standpipe operators who depended on the tanker truck actors for water. Interactional relations and conduct were guided by unwritten rules and regulations (Cornea et al. 2017) and without a formal leadership structure (Kyessi 2005). In the case of external rules, the following was observed:

All people must pay the same price for water per liter… No person shall clean or wash the dirty bucket on the surface of the water infrastructure, especially in water kiosks. Except for men, elders, physically challenged persons and mothers with children younger than a year, all clients/customers must join the appropriate queue to fetch water in the days of long queues… Water should be sold only for domestic activities, especially in terms of scarcity, and children under the age of 10 were not allowed to fetch water…, continuous default in payment of water service charges results in denial of water, and overall, everyone should be polite in his or her interaction with others at the water sources (Goba-Chaurembo, Kibululu, Kunguru, 6/06/2017).

The above-mentioned rules steered the relationships between water actors and their clients or customers. The operation of mechanized boreholes water systems was governed by the rules of monthly billing based on the metered records of the water consumed. The conditional rule of the

cash and carry system governed water access and the maintenance of the water infrastructure. While clients were allowed to water on credit on the occasion of a lack of cash at hand grounded in social relations (as neighbours or relatives), continuous default in payment of water service charges was liable for refusal or denial of water services by the concerned actor (Cain 2018). In the case of tanker trucks and pushcart clients, appointments were made for water service delivery in their respective neighbourhoods. Both internal and external rules were undocumented but were built and routinely altered through their daily interactions with one another (Furlong et al. 2019). The rules and mechanisms were not fixed but subjected to negotiations in their mundane interactions. The negotiation inherent in the rules and mechanisms fostered their transformation and enabled the actors to develop rules and mechanisms suitable to the circumstances. The water service providers adhered to these rules and mechanisms, consciously and unconsciously, in their everyday practices of water management (Cleaver and Hamada 2010). This perhaps demonstrates the flexibility of the everyday practices of governance.

4.5 Conclusion and policy Implications

This study explored how non-state actors develop and sustained water infrastructure in informal settlements. This was in response to the limited number of studies carried out, especially in the context of how non-state water actors undertake initiatives towards urban water supply. By drawing from the theoretical perspective of governance for sustainability and the everyday practices of governance, the study identified how non-state water actors pursued self-actions/undertook activities, mobilized resources and instituted rules and mechanisms to develop and sustain urban water infrastructure.

It was found that a diverse range of non-state actors exists in the water supply, landscape, and structuring infrastructure within the informal urban water space. The resources were mobilized by groups and individuals and engaged in activities guided by undocumented operational rules and regulations in more everyday practices (Strengers 2010). Actors mobilized their resources through social networks and human agencies and operated based on their capacities and interests. The discourses that instigated the everyday governance practices were based on their lived experiences of difficulties in water access in the informal settlements, and the urgent desire to fill the water services gap and generate income from the failure of the public water governance arrangements. The rules guiding their practices were structured to guide internal and external interactions and operations and developed informally. However, the self-actions of residents observed were not without state actors' interactions and relationships (Neves Alves 2019). The few non-state actors with a formal contractual relationship with the public water utility enable other non-state water actors to act indirectly as associates of the public water utility, confirming Bénit-Gbaffou and Oldfield's (2011) perspective of the centrality of the state in everyday governance practices. The findings indicate the need to support the everyday ingenuities of local/nonstate actors involved in water provision through co-management (where non-state actors share state water utility provision power in their localities). In this case, only the registered tanker truck operators acted as legal co-

managers of the state water service. With the global drive for sustainability and universal and equitable access to safe and affordable drinking water for all, co-management may foster access to water for all. It may substitute access through the formalized arrangements between state and non-state water actors. However, further studies are required to examine whether the everyday practices of governance shape water service access in informal settlements.

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CHAPTER FIVE

Charging the non-networked: Water pricing governance of the heterogeneous infrastructure beyond the utility network in Dar es Salaam

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5.0 Introduction

Having explored the practices in which water infrastructures are developed beyond the utility network. This chapter explores the practice of pricing water beyond the utility network. The chapter draws perspective from heterogeneous water infrastructures beyond the utility network alongside everyday practice of pricing water, to explore the mechanisms that determine the pricing of water in such urban waterscape. It highlights the prices, water distribution and payment modalities of the varied non-utility-networked water infrastructures. Also, it presents the practices that determine the prices of water per cubic meter among the various water providers and infrastructural systems that supply water outside of the utility network. It also demonstrates the ways in which prices of water were regulated. Especially those who regulate the prices of water and how such regulatory efforts manifest in reality. In conclusion, the chapter returns to the debates on heterogeneous water infrastructure alongside the everyday practice of pricing water beyond the utility and discussed, the implications of the ways in which water is priced in improving urban water supply beyond utility network.

Abstract

Though urban scholars have drawn our attention to the multiple water infrastructures serving urbanites in cities of the global South, studies rarely explored the practice through which prices are produced and governed within the heterogeneous infrastructures that supply water beyond the utility. Drawing perspectives from everyday pricing practice and heterogeneous water infrastructure, we show how multiple infrastructural systems, such as hydro-mobile and private network water providers produced prices. Prices were established based on the cost of electricity, fuel, repairs and maintenance, location and/or distance, nature of road connectivity to clients' residences, and providers' expected profit margins. Water providers' discretions and learning by doing, enabled the continuity of pricing practices beyond the utility. The conventional practice of non-collective negotiation and bargaining produced specific prices between water providers and end-users. These manifested via reflectivity, creativity, practical knowledge and experiences of the actors acquired overtime. When prices were established, they remained subject to ordinary modification. We argue that the focus on pricing sheds light on an important aspect of heterogeneous infrastructure provision and governance: where varied prices are established outside

formal regulation, they reflect, shape and exacerbate fine-grained socio-spatial differences between individuals within single neighbourhoods.

5.1 Introduction

Dar es Salaam, like many Sub-African cities is characterized by uneven coverage of networked water, due to low water production capacity, leakages, and uncontrolled spatial expansion (Olivier, 2004; Monstadt and Schramm, 2017; Sweya et al., 2019; Bender, 2021). Urban and peri-urban residents collect and store water from varied non-utility-networked water infrastructures (tube wells, boreholes fitted with hand pumps, tankers, pushcarts etc.) for domestic use. These water infrastructures serve diverse categories of urbanites in Sub-Saharan African cities: residents located beyond the network; residents who are by-passed by the network due to inability to afford the cost of utility connection; and residents connected to the utility networked but experience an erratic and uneven flow of water (Peloso & Morinville, 2014; Nganyanyuka et al., 2015; Allen et al., 2016; Mapunda et al., 2018). Water collection within these infrastructures manifests in an interactional manner, where residents beyond and/or passed by the utility legitimize access, via out-of-pocket payments or "cash payments" for a given quantity of water (Simone, 2015; Tutu & Stoler, 2016; Sarkar, 2020a; Alba & Bruns, 2021).

Moreover, studies considering the socio-economic inequalities and the unequal negotiation and bargaining powers of urbanites, especially in global South cities advocate for the need to pay attention to the ordinary ways in which water is priced, distributed and collected (Pihljak et al., 2019; Adams, 2018a; Sesan et al., 2021; Dakyaga et al., 2022) beyond the utility network. This is crucial as pricing or commodification of water represents a double edge sword (Meehan, 2014; Bakker, 2003; Alba et al., 2019). While prices may regulate water use, limit wastage of water, they may also foster the exploitation and exclusion of disadvantaged residents (Pihljak et al., 2021; Alfonso et al., 2022). Secondly, prices may facilitate access and manage water scarcity, but may also restrict and (re)produce unequal access in heterogeneous socio-economic settings (Fuente et. al., 2016; Zetland, 2021). Critical urban scholars further show how spatial diversity and income shape water access in heterogeneous ways, often allowing residents located in the inner city and who can afford the cost of piped network water connection (Alba et al., 2020; Smiley 2020; Dakyaga 2022), while peripheral dwellers and low-income residents by-passed by the utility network remain dependent on manifold non-utility-networked water infrastructures. While we acknowledge the usefulness of the aforementioned observations, that water pricing is a strategy capable of fostering inequality and exclusion in the daily water collection chain, we distinct our aim from studying how pricing produces inequalities, towards understanding the practice of pricing itself, and how pricing practices beyond the utility network are governed. This is imperative because urban scholars barely explored the ways in which water prices are produced, especially the mechanisms that determine the setting of water prices and how they are regulated towards improving urban water supply. A nuanced understanding of such mechanisms and governance can provide initial insight for further research into how water pricing in the non-utility-networked produce inequality and exclusion in everyday water access beyond the utility network.

In urban Sub-Saharan Africa, where water collection beyond the utility is common, research on urban water pricing practices is yet at the infant stage (see Alba et. al., 2019; Alba et al., 2020). The existing few studies have been more focused on the sustainability of the utility's water tariffs and subsidies, and the everyday practice of setting prices within the utility-community collaboration in network water provision (e.g., Pihljak et al., 2021). Within these areas, scholars reveal the distributive inequity that characterizes the network water distribution in the global South cities, where tariffs are formally set (Fuente, 2019; Favre & Montginoul, 2018; Favre & Montginoul, 2018; Mercadier & Brenner, 2020). Similarly, in Dar es Salaam, research has showcased the proliferation of, and reliance on, the varied non-utility-networked water infrastructures (Allen et al. 2017; Nganyanyuka et al., 2015; Dakyaga et. al., 2022). Some urbanites leverage their owned resources to co-produce water for self-supply, while others rely on water systems owned by neighbours to cope and adapt to water access complexities (Dakyaga et al., 2018; Andreasen & Møller-Jensen, 2016). In this study, we attempt to further question perspectives on urban residents as non-passive actors in urban development issues (Schramm and Wright-Contreras, 2017; Wamuchiru, 2017), by demonstrating how urban residents influence price setting to supply water. Pricing is a central mediator of the production and distribution of water to end-users. Therefore, by engaging literature on water infrastructure heterogeneity and everyday practice of pricing, the study contributes to the growing debate on urban infrastructure governance, especially the governance of heterogeneous non-utility-networked urban water supply in the global South. The study offers an overview of the varied actors, prices and the ordinary ways in which water prices are produced to mediate water collection for domestic use.

The aim of this paper is to explore the practice through which prices are produced and governed within the heterogeneous infrastructures beyond the utility network, and the implications for improving water supply in global South cities. In doing so, we bring to light the various ways in which urbanites in Dar es Salaam engage with non-utility-networked water infrastructures beyond the utility, structure water distribution, and determine the monetary value of water. We first situate our exploration of water pricing practices within the perspective of heterogeneous water infrastructure and everyday practice of pricing water to demonstrate the ways in which water pricing manifests in practice. We unravel (i) the prices, paying and water distribution practices; (ii) the mechanisms through which water prices are produced, and (iii) how they are regulated. The paper is organized as follows; Section 2: reviews literature on heterogeneous non-utility-networked water infrastructures. Section 3: presents our framework for analyzing everyday practices of pricing water. Section 4: explains the research methods, and Section 5; presents the results and discussions. In section 6, we conclude by demonstrating the implications of the ways in which water was priced and regulated for improving urban water supply.

5.2 Heterogeneous non-utility-networked water infrastructure in global South cities

In nearly half a decade, literature in urban studies has grown tremendously on urban water infrastructure heterogeneity (Lawhon et al., 2018; Truelove, 2019; Smiley, 2020; Alba & Bruns, 2021). This growing body of knowledge demonstrates how the waterscape of cities in the global South is characterized by an assemblage of diverse actors, technologies that coexist distributing water beyond the utility water network (Schramm & Wright-Contreras, 2017; Monstadt & Schramm, 2017; Graham & Marvin, 2022). While utility connection may exist, it bypasses some residents, producing the need for alternative water infrastructures. Therefore, such bypass, or the inability of some residents to gain networked water connection, often produce two or more co-existing urban waterscapes within cities: One where high-income residents receive regular water via the utility networked water infrastructure; another, where high-income residents receive regular utility water, but ought out for self-supply or co-produce water by drilling groundwater due to unreliable supply (Furlong & Kooy, 2017; Healy, 2019; Uitermark & Tieleman, 2021). The third urban waterscape, is where extremely marginalized residents, are excluded, but lack the ability to self-supply, and remain subservient to manifolds water solutions and providers (Grönwall, 2016; Alba & Bruns, 2021). The failure of the utilities in terms of even coverage, and regular follow of water contributes to the insurgence of domestic boreholes in African cities (Dakyaga et al., 2023). These non-utility-networked water infrastructures augment water collection, and simultaneously provide economic benefits to their owners (independent self-help and market-oriented actors) through the sale of the water (Healy, 2019; Dakyaga et. al., 2022).

Some scholars (e.g., Dill & Crow, 2014; Adams, 2018), broaden our understanding as they reveal how historical intra-inequalities and heterogeneity of water supply especially in Sub-Saharan African cities produce uneven distribution of the utility networked water. They show how (post)colonial neglect and restriction in the distribution of utility networked water to suburbs of the colonial officials instigated the proliferation of non-utility-networked water infrastructures. These produce socio-spatial differentiation in access to networked water (Dakyaga et. al., 2020; Smiley 2020 Truelove, 2019; Healy, 2019; Wamuchiru, 2017). In urban environments where water is produced and distributed beyond the utility network, urbanites collect water from varied water systems through procedural interactions, entangled within materials and socioeconomic conditions (Burt & Ray, 2014; Wutich et al., 2016). Residents navigate within socioeconomically complex situations often to collect water daily (Alba & Bruns, 2021). The collections of water beyond the utility networked is mediated by diverse actors, whose ingenuities are more or less informed by varied motives, transcend "profit-making, political legitimacy, patronage and petty corruption including solidarity, religious beliefs and pragmatic choices" (Alba et al., 2020. pp 1; Rusca & Cleaver, 2022).
The paper contributes to this evolving scholarly discussion by exploring the practice of pricing, questioning how water prices are set and governed in a context of non-utility-networked water supply. The concept "non-utility-networked water infrastructure" depicts the multiple off-the-utility-grid water systems that may be indirectly connected to the utility network and produce and/or distribute water. Through these water infrastructures, (in)formal transactions may manifest

to enable water collection for domestic use (Healy, 2019; Caprotti et al., 2022). In some cases, where water is sourced from the utility network for resale, this may be unknown to the utility (Alba et al., 2020; Smiley, 2020). Situating our exploration within water infrastructure heterogeneity enables us to associate and extend our deliberation beyond the actors engaged in the practices, community ownership, private ownership, and the (in)formal domain, towards how prices are produced and regulated. These together offer a holistic understanding of everyday urban life (McFarlane, Silver, & Truelove, 2017).

Understanding urban infrastructure heterogeneity, especially the practices associated with the ways in which water is collected can enables us to imagine, associate and place ourselves in the position of (un)served urban residents whose daily water collection experiences circle around varied infrastructures of which none is perhaps adequate to provide reliance water supply (Alba & Bruns, 2021). Such diverse infrastructures and urban service provision models coexist in the peripheral areas, and co-produced by urbanites due to utility network failure (Schramm and Wright-Contreras, 2017; Sesan et al., 2021). Truelove, (2019), uses the term "gray zone" to describe the continuum of formal and informal water supply in Delhi, and reveals how such a continuum accounts for the heterogeneity of water infrastructure, co-existing and shaping the daily water collection lives of urbanites. Amidst heterogeneity of water infrastructures, urban residents oscillate between sharing water with neighbours, buying water from vendors and sometimes drawing on utility networked water from the owners' plots (Wutich et al., 2018; Alba & Bruns, 2021). This also involves relying on multiple non-utility-networked water infrastructures such as domestic boreholes, private and public water kiosks, tanker trucks, pushcarts, and private taps, in addition to utility water kiosks (Wutich et al., 2016; Hofmann, 2020; Sarkar, 2020). Through a perspective on the multi-modality of water systems in Dar es Salaam Dakyaga et al., (2018), reveal how "*dual* and *multiple"* purchasing and storing water in varied material artefacts enables household to fulfil domestic water demands at the fringes. Residents may hold connectivity to both utility networks as well as drill mechanized water system, often by collecting and storing water differently for drinking and sanitary purposes (Grönwall, 2016; Dakyaga et. al., 2022). In heterogeneous water infrastructure systems, access to water is mediated by the locations of residents, and the available water systems at the time of oscillation (Tiwale et al., 2018; Dakyaga et al., 2022). Additionally, the oscillation across the varied water infrastructures for water, is often shaped by residents' defined water uses, and also by the income required to purchase water (Dakyaga et. al., 2018b; Truelove, 2020; Alba et al., 2020).

Moreover, studies referring to cities of the global South argue that the fragmentation or heterogeneity of infrastructure does not represent failure, but a vacuum and possibility for advancing water infrastructure delivery (McFarlane et. al., 2017; Monstadt and Schramm, 2017; Smiley, 2020). Additionally, they reveal how the co-existence of technologies, skills, knowledge and operational capacities of the actors serve as incentives for facilitating and improving water supply beyond the utility network (Lawhon et. al., 2018; Truelove, 2020). Water collection beyond the utility network is essential for shaping the confines of the completely private (high cost) and utility water supply (Bakker, 2003). But contrarily, while multiple water systems may contribute to

innovatively delivering water to urban residents, they may offer water at high and unequal cost (Tiwale et al., 2018). The unequal cost of collecting water from such water infrastructures may occur due to varied technological artefacts, used by the actors, material costs and electricity, especially when connected to facilitate the distribution of water (Schramm & Wright-Contreras, 2017). These varied infrastructures producing varied costs thus differentiate access within urban geographies (Dakyaga et al., 2018; Sarkar, 2020b).

5.3 Analytical perspective: Everyday practice of pricing water beyond the utility

Within conventional water infrastructure – a large-scale water network, tariff systems mediate the pricing of water towards equitable and affordable supply between end-users and the utility (Fuente, 2019; Pihljak et al., 2019). But how prices of water are set in urban geographies where multiple non-utility-networked water infrastructures produce and distribute water remains a lacuna in urban studies. Therefore, furthering our understanding of pricing mechanisms concerning multiple water systems that are indirectly connected to the utility networked is imperative, especially with the uneven coverage of the utility network. Over the years, studies use everyday practices as an alternative lens for situating and analyzing how residents relate with water infrastructure (Peloso & Morinville, 2014; Velzeboer et al., 2017; Kundu & Chatterjee, 2020; Sarkar, 2020a). Scholars draw the everyday practice lens to analyze the ordinary ways in which urban residents engage with infrastructure, provide and access service (Amankwaa & Gough, 2021), how non-state actors develop and sustain water infrastructures beyond the utility (Dakyaga et al., 2020), and contribute to water tariff setting of the utility (Pihljak et al., 2019). These scholars show how "everyday practice" in connection with practice theory is useful for showcasing practices associated with phenomenon in cities of the global South (Eledi et al., 2023). Its usefulness has also been highlighted for decentering Northern theories from the Southern context (Velzeboer et al., 2017). Everyday practice lens offers possibility to unravel and critique socio-economic inequalities and the differentiated power relations that prevail in, and reproduce, the chain to accessing water. Parnell and Robinson (2012), justify the relevance of everyday practice in urban studies by revealing its suitability for diagnosing and comprehending the connection between global processes and specific situations in a city-specific context. This perspective more or less advances everyday practice as a universally applicable approach for urban studies beyond the global South. But while urban studies have advanced on the everyday practice, studies connecting everyday practices with pricing of water of the non-utility-networked water infrastructures barely exist. This concerns specifically the ways in which prices of water are produced and governed. We contribute to this evolving discourse, by exploring pricing practices in the non-utility-networked infrastructures. Drawing on non-utility-networked water infrastructures such as boreholes, protected wells, tanker trucks and carts, we intend to demonstrate how such practice may represent alternative ways of understanding water access inequalities or segregation in urban areas.

Studies furthering practice theory analyze the practices associated with the production of water, and electricity and how they shape infrastructure configuration (Neves Alves, 2019; Eledi et al., 2023). These studies reveal how urban residents develop and sustain water infrastructure and

sanitation, engage with, provide, operate and access water and sanitation services beyond the state utility. Some scholars also reveal the socio-material artefacts and ordinary social relations that facilitate the production and distribution of non-utility-networked water infrastructure (Peloso & Morinville, 2014; Alda-Vidal et al., 2018; Dakyaga et. al., 2020). In the context of this study, everyday pricing practice entails the ordinary, but diverse, trivial, discrete activities through which actors – producers, consumers or both establish and institute price, to warrant payments for the distribution or collection of water. Price setting may manifest through long-term strategies, and revolving within more or less complex transactional processes, shaped by (non)monetary costs and commitments (Nganyanyuka et al., 2015). However, prices of water may vary among the actors who perceived water supply as a business or a service. Alba and Bartels (2016), note that water prices are relatively higher among providers who regard the act of supplying water to their neighbours as a business than among those who perceive it as "a service". These motives are essential in shaping pricing decisions with possibilities to (re)producing prices (Strengers, 2010).

Through ordinary practices, the actors involved in such water provision, create, sustain, transform and (re)produce prices. The act of setting prices may manifest through repetitive actions driven by the engaged actors or residents and somehow shaped by materials and relational factors (Peloso & Morinville, 2014). While prices may be ordinarily determined, they may be guided by defined rules or verbally expressed principles and instructions.

Practices reflect the act or manner of "doing" influenced by historical, sociocultural interactions, powers, practical knowledge or know-how, and everyday experiences of the actors and they are shaped by discursive knowledge (Strengers 2010). The interactions in turn produce common social understandings at a given location. In relation to water access and pricing they may be mediated by material infrastructures and/or configurations of technologies, that produce and distribute water to residents (Strengers 2010). Moreover, actors may hold knowledge of local water culture, through which they may determine prices and use practical knowledge (tacit knowledge) in terms of what water prices existed in the past and how they were determined. These then inform how much a unit of water should cost (Cleaver et. al., 2005; Strengers, 2010). Where prices may be determined, negotiation, and re-articulation may be used as mechanisms by end-users to (re)produce prices towards institutionalization (Velzeboer et al., 2017). The conduct of these practices tends to facilitate relations, shaped by how water is delivered beyond the utility network, particularly, the material infrastructures (buckets, barrels, poly-tank, in-house pipes) that facilitate the distribution of water beyond the utility. Prices may vary across cities' spaces shaped by diverse arrangements, sources of water, quality and location factors. With references to hydro-mobile infrastructures (Dakyaga et al., 2023), studies reveal that water prices of tankers may be affected by travel distance, waiting time to haul water from the utility source, costs of fuel and labour (Alba et al., 2019). These may be negotiated differently based on intended uses.

5.4 Research methods

5.4.1 Study Areas

The confluence of Dar es Salaam's rate of urbanization (5.6%) and sprawl challenges even coverage of utility networked water supply. As a result, some residents live beyond the utility network (Andreasen & Møller-Jensen, 2016). Water supply by the utility/DAWASA has been intermittent and insufficient due to low production capacity to meet the demand of the rising population in the city. Water production capacity is challenged by power outages and low voltage especially at the utility pumping station (EWURA, 2022). Consequently, utility water flows at an average of 14 hours per, woefully below the benchmark of 24 hours (EWURA, 2022). The extension of network water has been demand-driven, residents pay for the estimated cost of the utility's network extension. The cost of utility network extension varies based on locations, and relatively costly to residents residing at the peripheral of the city (Hofmann, 2023). Like most cities in the global South (e.g., Fuente, 2019; Pihljak et al., 2019), the volumetric tariff system mediate the price per unit of water of the utility/DAWASA towards equitable and affordable supply.

The Energy and Water Utility Regulatory Authority (EWURA) sets and regulates prices per unit of water of the utility network. This is aimed at protecting the interests of residents, as well as ensuring the availability of regulated services to all residents especially for low-income residents and disadvantaged groups (EWURA, 2022). Moreover, due to uneven coverage and low production capacity of the utility, residents in the peripheral and in the intermediary zones of the city live without direct utility network connection. These residents secure water outside the utility, often from the varied non-utility-networked water infrastructures that co-exist and supplying water (McGranahan et al., 2016). These comprised private tanker trucks water distribution, protected wells, pushcarts water delivery, mechanized boreholes for commercial, self-supply networked water and community-managed water systems (Dakyaga et al., 2023). Although these water infrastructures complement the utility (Mapunda et al., 2018), how prices of water are set and governed to mediate the distribution of water outside of the utility has been barely explored. See Table 5.1 and Figure 5.1.

Table 5.1 Basic descriptions of the selected case study settlements

	Goba	Kivule	Magogoni
Geographical location	Located in *Ubungo* Municipal, App. 7 Kilometres from the centre of Dar es Salaam	Located in *Ilala* Municipal Council, App. 27 kms from Dar es Salaam	Located in *Kigamboni,* App. 23 kilometres from Dar es Salaam
Population & density	Urban ward had pop. of about 54,630, density of App. 903.4/km²	Ward had pop. of about 72,032, density of App. 2,883/km²	Sub-ward of *Kigamboni* of App. 36,701 people.
Income levels	Mixed (low, middle & high)	Mixed (low, middle & high)	Mixed (low, middle & high)
Utility network status	Utility network exist in surrounding neighbourhoods, but not in the study settlement	Absence of utility of network	Absence of utility networks
Non-utility networked water infrastructures	Dominated by self-supply bore-wells with connectivity to residents. Water kiosks/resellers of utility water Private taps Tricycles/pushcarts water sellers Tanker trucks deliveries Rainwater harvesting	Highly concentrated by self-supply boreholes, private networked water distributors. Deep & shallow wells Residents' reliance on alternative water suppliers. Rainwater harvesting	Highly concentrated by Water kiosks/resellers of utility Households' self-supply deep/bore-wells Tanker trucks deliveries Rainwater harvesting.
Planned status	Unplanned settlement	Unplanned settlement	Unplanned settlement
Dominant building types	Single-family houses	Large single-family houses	Single-family houses
Elevation level	High: 2,743 m (8,999 ft)	Low: 41 m (135 ft)	Medium: 144m (472 feet)

Figure 5.1 Non-utility-networked water infrastructures; **(a)** non-registered private tanker trucks, **(b)** Bicycle utility water reseller, **(c)** Utility registered tanker, **(d)** Privately mechanized boreholes for in-house/pipe water connections, **(e)** pipelines and meters of private boreholes networked, **(f)** standalone reseller of utility's water to neighbours.

Drawing on a qualitative case study research method, we questioned how prices are produced and governed beyond the utility network in Dar es Salaam. In so doing, we focused on the heterogeneous non-utility-networked water infrastructures. These comprised of private tanker trucks water distribution, protected wells, pushcarts water delivery, mechanized boreholes for commercial and self-supply networked water and community-managed water systems. These water infrastructures are not all fixed in terms of location but produce and transport water to varied suburbs within the city. Therefore, to gain a nuance understanding of how these water infrastructure providers set and govern prices beyond the utility network in Dar es Salaam, we targeted the utility's officials and experts, Ward (*Mtaa)* leaders, hydro-mobile infrastructure providers such as tanker truck drivers and pushcart operators. Additionally, we targeted water kiosks operators, mechanized borehole water providers, self-supply households, protected wells, private tap operators, Community-shared water systems in three settlements (*Goba, Kivule and Magogoni*). These settlements were selected from three Municipalities (Ilala, Ubungo and Kigamboni) in Dar es Salaam.

5.4.2 Data collection and analysis

We used a qualitative case study research method to gather data from city officials, experts, and (non)utility officials to unravel how prices were produced and regulated in the context of non-utility-networked water supply. Data were collected from March 2021 to July 2022. The study

focused on how water prices were produced and water sold outside the utility for domestic use. Snowballing and maximum variation purposive sampling techniques were used to select participants within the city. This enables the study to capture a wide variety of perspectives concerning water pricing practices beyond the utility. Data was collected from Utility officials, Policy-makers, alternative water providers, Plumbers/technicians, Experts/Advisors to the utility, and end-users about the practice of pricing water beyond the utility network and how such prices were regulated. Face-to-face interviews with thirty-five (35) interviewees comprising expert interviews, Key Informant Interviews (KIIs), end-users at household levels (see Appendix A). Expert interviews were conducted with water resource managers in Dar es Salaam, the advisor to the utility and two officials of the utility. The first officer was purposefully selected based on in-depth knowledge of water supply in the city, while subsequent participants were selected through snowballing techniques/referral by the first expert interviewed. Through semi-structured interviews, questions were asked and data was collected on how prices of water were set and regulated, the cost per unit of water, factors that determined pricing per unit of water, payments modalities, and actors with power to determine and regulate prices of water supply beyond the utility network. The probing technique was used for further clarifications and elaboration. To deepen our empirical understanding of water price production and governance outside the utility network in Dar es Salaam, three (3) peri-urban settlements; *Kivule, Magogoni* and *Goba* were purposely selected as information-rich cases. These settlements were selected due to limited or lacking utility connections. In these settlements, face-to-face in-depth interviews were conducted with three (3) Ward (*Mtaa*) leaders, who acted as intermediaries between the local government officials, the utility (DAWASA), residents and alternative water providers. Through interviews data were gathered from the various non-utility-networked water operators, either the care-takers or the owners. Data were collected on how prices were determined, regulated and how payments were made for water collection. Also, six (6) household case studies were conducted. These comprised low- middle-income and high-income households in the peripheral of Dar es Salaam. The high-income households had self-supply water infrastructure. Some shared networked connections with neighbours. Some middle-income household had mechanized boreholes for self-supply water. The selected low-income households, lived in smaller un-gated houses and routinely collected water from tanker truck drivers and pushcarts. One low-income household connected to private networked, but routinely bought water from pushcarts to complement. The household case study also included three middle-income households without utility connections. These households installed rainwater harvesting technologies, but also relied on tanker truck drivers registered with the utility for water delivery in the dry season. These households were purposely selected. The goal was to ascertain the ways in which households secured water from actors who produce and distribute water beyond the utility network. See Appendix A, for details.

Key Informant Interviews (KIIs) alongside observations and photographs were conducted with purposely selected non-utility-networked water providers in the selected settlements. These comprised of water kiosk owners, or resellers of utility water (6); caretakers of protected wells (3); tricycle/carts operators (2) and privately mechanized in-house water providers (4), See Fig 1. KIIs

were also conducted with plumbers/pump technicians to ascertain the technologies and materials that facilitated water supply and how that influenced pricing. The goal was to understand the arrangements that mediated supply and price determination. Lastly, the first author conducted transect walks and took photos around the various water infrastructural systems.

During the transect walks, we asked questions about how prices per unit of water were set, payments made, and the key actors and factors shaping prices of water, particularly the roles of the utility in pricing. We also collected data on the various ways through which water was sourced or produced and distributed to end-users. Throughout the interviews, consent was sought from the participants and the conversation was recorded. The interviews were also validated through the conduct of a Focus Group Discussion (FGD) with private tanker trucks registered with the utility. Interviews were conducted in *Swahili* and English. Thematic analysis was conducted on the text of the transcribed audios. These involved editing and cross-validating transcribed text alongside a replay of the audio. Through the use of MAXQDA 2022, the transcribed text was grouped and codes were generated/constructed. Themes were defined alongside the objectives of the study, such as the prices and water distribution, paying for water, the practice of producing water prices, the actors, powers and water price regulations. A constructed narrative in a chronological sequence was developed along the themes such as prices, water distribution and paying for water, the practices of producing water prices, and water price regulations – actors, powers and water price regulations. The aforementioned themes were substantiated using field evidence.

5.5 The everyday production and regulation of prices beyond the utility

5.5.1 Prices, distributing and paying for water beyond the utility network

In urban areas of Dar es Salaam without or with limited access to the utility water network, water was varyingly priced, paid for, and collected from, community-owned water systems, hydro-mobile systems and privately mechanized in-house water networks. Hydro-mobile infrastructures such as carts and tankers truck drivers served as intermediaries distributing water to residents. These were the sources of water most preferred by some residents unserved by the utility. As observed in several global South cities (Wutich et al., 2016; Alba et al., 2019; Truelove, 2019), hydro-mobile water infrastructures such as tanker trucks, tricycles and pushcarts collected water from the utility, supplied to residents by-passed by the utility network, or those connected to the utility but facing interrupted water flows (e.g., Nganyanyuka et al., 2015; Mapunda et al., 2018). Water was distributed directly and indirectly. Privately mechanized in-house water network owners (PMIWNO), coexisted and provided direct pipe water to residents. Like the utility networked, socioeconomic power, such as the ability to pay for an estimated cost of water connection enabled interested residents to gain connectivity to the privately mechanized in-housed water connection (Andreasen & Moller, 2016; Truelove, 2019). Water from intermediaries such as tanker truck drivers, pushcarts/tricycles operators and standalone water kiosks was distributed indirectly via self-

collection and transportation by residents for domestic use. This was mediated by socio-material artefacts such as containers, barrels, buckets, jerry-cans and pipelines (Dakyaga et al., 2018a).

Payment modalities comprised "pay as you collect" – commonly associated with stand-alone kiosk and standpipes. "Pay as delivered" – associated with hydro-mobile infrastructures such as tankers, pushcarts/tricycles, and weekly or monthly payments — characterized water supply arrangements of privately mechanized in-house water networks, such as mechanized boreholes with pipe networked connections. As observed elsewhere, "Pay as you collect" via cash and carry was found as the dominant mode of payment (Simone, 2015; Tutu & Stoler, 2016; Sarkar, 2020a). The price per unit of water varied among resellers or intermediaries of the utility such as pushcarts, tankers, standalone water kiosks, motorbike/bicycle water distributors and across the neighbourhoods. These varied prices were shaped by varied conditions such as locations and sources from which intermediaries collected water for onward distribution (see also Alba et al., 2019). Prices per unit of water were rather stable over the past decades but differed across water providers beyond the utility network. As revealed; *I have been here for more than ten (10) years, and my price per unit of water has been the normal 3000TZS/$1.30, so we all know how much a tank of water should be sold for* [No. 22]. However, in the same location, some privately mechanized in-house water providers charged 5000TSZ/$2.16 per unit of water. As revealed by a resident during the households' case studies, "*…someone here has also drilled groundwater and is supplying us, 5000TSh per unit of water (1000L), and every month we pay for the cost of the water supply. The water provider comes to read the meter, and give us the bill based on the quantity of water I have consumed…"* [No. 28]. This produced unequal cost of accessing privately in-house networked water connection across neigbourhoods in the same settlement. While residents connected to privately mechanized in-house water network at the cost of 5000TSZ/$2.16 would opt for the alternative private connection at the cost of 3000TSZ/$1.30 per unit of water, their location beyond the coverage of alternative network such as above 500 meters curtailed connectivity to less costly private water network providers in the same settlement. Due to price variations within and across suburbs and among providers, common social knowledge (Strengers 2010) or, what residents perceived as the right or wrong price, guided the bargaining processes for water. As indicated by tanker truck drivers: "*…the customers know the price ranges in their areas. They know it is between 10,000TZS/$4.30 – 15,000TZS/$5.10, per unit of water. They also know the water which is salty is sold between 300TZS/ $ 0.17 -400TZS/$ 0.17 per 20L and 500TZS/$* 0.22 - *600 TZS/0.26* per 20L of utility water [No. 35]. Prices of utility water resellers and redistributors such as registered tankers, kiosks and pushcarts were relatively higher compared with groundwater distributors. These operators considered water distribution as a business for profit making (Alba et al., 2019). As indicated, tanker truck drivers supplied 1000L of utility's water at the cost of 10,000TSZ/$ 4.30 and 15,000 TSZ/$6.49. This price range was found as the commonly known price per unit of water of tanker trucks drivers formally registered with the utility (See Table 5.1).

Table 5.2 Water distribution, prices and payment modalities of water beyond the utility

Categories	Mediating water systems	Prices ranges per 1000L (TSZ & $)	Distribution modes	Payment modalities
Community-owned water infrastructure	Mosques water	10,000/$4.30 – 12,000/$5.10	Indirect via self-collection	Pay as you collect
	Community shared scheme (mechanized boreholes & boreholes fitted with hand-pumps)	10,000/$4.30 – 12,000/$5.10	Indirect and direct	Pay as you collect
	Protected deep/shallow wells	Non-priced water	Indirect via self-collection	Fetch for free
	Water kiosks (resellers of utility water)	15,000TSZ/$6.49 - 20,000TSZ/$8.7	Indirect via self-collection	Pay as you collect
Hydro-mobile infrastructure	Tanker drivers (Registered)	10,000TSZ/$4.30 –15,000TSZ/$6.49	Indirect via mobile	Pay as it is delivered
	Tankers (non-registered, groundwater)	10,000TSZ/$4.30 - 12,000TSZ/$5.10	Indirect	Pay as it is delivered
	Pushcarts/tricycles/motorbikes	15,000 TSZ/$6.49 –20,000TSZ/$8.70	Indirect via mobile delivery	Pay as it is delivered
Privately mechanized in-house water infrastructure	Mechanized boreholes connected to households via pipes	2000 TSZ/$0.86 – 7000TSZ/$3.02	Direct via pipe network	Weekly & monthly billing
	Self-supply households	Based on electricity cost	Direct via pipe network	Self-use
	Private taps (water resellers)	15,000TSZ/$6.49 – 20,000TSZ/$8.70	Indirect via self-collect	Pay as you collect
	Private taps (groundwater)	10,000TSZ/$4.30 – 20,000 TSZ/$8.70	Indirect via self-collection	Pay as you collect

Moreover, our interlocutors preferred tanker truck water services. This is because tanker truck drivers registered with the utility were believed to collect improved water from the utility's source. As disclosed by a resident: *"…I purchase water from the Tanker truck drivers registered with DAWASA. It is better to buy water from these tanker drivers registered with DAWASA than the salt water, because it has multiple purposes, you can drink, you can wash your clothes and other things…"* [No. 29]. Residents connected to private mechanized boreholes water networked, bought water from pushcart and tricycles and stored alternatively for drinking (Dakyaga et al., 2018a). As revealed: *I am connected to private owner pipeline, so I just buy little of DAWASA water, I just go to the tricycle operators purchase two galloons/jerry-cans of water to use when I want water from DAWASA, getting water from the tankers, is not also easy..*" [No. 28]. In this context, residents beyond the utility network practice the "dual and multiple" purchasing and storing water arrangements (Dakyaga et al., 2018b). The price per cubic charged by registered tanker truck drivers was established as 10,000 TZS/$4.30, as the lowest, determined by a short distance and 15000 TZS/$ 6.49 as the highest cost for water delivering in farther distance of travel. These prices per unit of tanker truck water were formally established between registered tanker truck drivers and the utility. In the context of tanker truck drivers, the existing price ranges were not adequate measures for addressing inequity and inequality in access to water especially among residents beyond the utility network. Although the price range of 10,000TZS//$4.30 – 15,000 TZS/$ 6.49 was established, no standard distance in terms of kilometers of travel was defined as short or far to warrant a particular price, for example of 10,000TZS/$4.30 or 15,000 TZS/$ 6.49. In this context, drivers determined proximity of locations based on their own discretions, and that warranted a given price per unit of water was charged. As disclosed by a tanker truck driver: *"…. each driver decides the price unit of water based on how far he travels to deliver water, even the customers do not know where and how far we are coming to their places …"* [No. 39].

However, gaining water from water providers outside the utility involved diverse piecemeal arrangements and practices. These included self-searching for water providers, contacting neighbours and gaining referral from relatives. This connects with previous observations in Accra, (see Peloso & Morinville, 2014) where residents chased, bought and transported water for self-use. In this process, the act of building rapport with water providers such as tanker truck drivers and pushcart water resellers enabled residents to gain access to improved water resellers. While residents may develop rapport with water providers, "preparing the providers" – thus notifying tanker truck drivers, pushcarts operators, and privately mechanized in-house water network operators in advance were key practices for gaining timely supply of water. Residents gained contacts with water providers often via neighbours' recommendations of water suppliers. As revealed by a middle-income household head*: I know a permanent water provider, who knows me and I trust him, there is no way he can bring me contaminated water. No, no, I got him from the street, from the other neighbour who is getting water from him also. So, I asked around and got his number. I pay him after delivery, [..] because we have a good relationship, I could be at the job and when the water is finished, I call him to supply me whilst I pay him afterwards because we know each other.* [No. 31]. However, these practices through which water was distributed were less applied to standalone kiosks reselling utility water.

5.5.2 Practices of water price production beyond the utility network

Prices per unit of water were ordinarily produced through non-unionized and non-collaborative arrangements, but via negotiation and bargaining between provider and end-user. Generally, pricing of water supplied beyond the utility network was informed by multiple factors; (i) the source of water such as (utility water or groundwater); (ii) the mode of delivery (direct or indirect) to end-users, (iv) the kind of relations or social ties that existed between a given water provider and end-user (short to long-term provider-end-user relationships, relations as family or friendship), and (iii) the purchasing power (the quantity of litres a user can purchase at a given time, especially from hydro-mobile infrastructures). These factors produced varied prices outside formal regulation, they shaped and exacerbated fine-grained socio-spatial differences between residents within single neighbourhoods. For example, a case study of six households in Goba (low- and middle-income households interviewed) revealed variations in prices per unit cost of tanker truck water supply and privately mechanized in-house water connection. Though five of the case study households in the same neighbourhood, sought the services of tanker truck drivers for utility water, they paid different prices per unit of water in the past months. Four of the households revealed to have paid 15000TSZ/$ 6.49, while one paid 12000 TSZ/$ 5.10 per unit of water. Though the case study households were served water by different tanker truck drivers, they revealed that purchasing powers accounted for the disparities (Tiwale et al., 2018). As revealed: "*…I bargain sometimes for the price's reduction, with tanker truck drivers registered with the utility, they said, they can give me one-unit of water* [1000L] *for 10,000TSZ/$4.30 if I can buy 10,000 units of water. But I usually buy 3000 units of water at the cost of 15000TSZ* $6.49 per unit of water, *because my water storage tank can only store 7000 units of water. Even if I can purchase the 10,000 units of water at a reduced price, I cannot store it….*" [No. 32]. However, from the experiences of a low-income households, price negotiation and bargaining with tanker truck drivers has been impossible. As revealed; "*… when they* [tanker truck drivers] *set the price of water, there is no negotiation, it is 15,000TZS/$6.49, you agree and they bring you the water or not…*" [No. 29]. The confluence of higher purchasing power, storage capacity work to enable some residents beyond the utility collect larger amount of water at a reduced cost per unit of water. Besides that, the ordinary market arrangement of demand and supply shaped price variations (Wutich et al., 2016). As revealed: "*…so what I will say is like market-driven, so they look at the willingness and ability of the people to pay, then they charge…"* [No. 3]. The aforementioned factors shaped prices loosely ultimately not binding the various providers. In these arrangements, common social understandings of the price expected by residents and distributors enabled water supply (Strengers 2010). A resident explained the existing social understanding as follows: "*Yes, you know here (Dar es Salaam), we have different prices for the different water, the water which is salty is cheaper than the utility water. In my area, they are supplying salty water, but I don't buy salty water, I have not connected, there is a private company that is supplying the water, not the government. Everyone knows the prices, the private operator in the area supplies residents with the salty water…"* [No. 31]. He continued: - *There was a time I wanted the operator to connect me to the salty water, but the water is expensive. People quarrel with him, the other day he saw me and said "he is sorry I want to connect you to the water" then I said no, I don't want to be connected to your water system"* [No. 31]. These common social understanding (Strengers 2010), of the prices

of different waters and providers [utility and groundwater], and their respective distributors enabled residents, water distributors and producers to collectively reach consensus of the price per unit of water distributed. This also implies that peri-urban residents located farther away from the utility water kiosks, gained access to utility water via tanker truck drivers, but at a higher cost of about 15,000 TSZ/$6.49 (Pihljak et al., 2021). Residents incurred higher expenses on water in February and March, not due to rise in price per unit of water, but due to increased demand for water at household levels. People bath two-three times per day because of high temperature.

Moreover, some mechanisms were found more specific to certain non-utility-networked water infrastructures and providers. For example, the price per unit of water of hydro-mobile infrastructures such as tanker trucks was shaped by distance, cost of fuel, repairs and maintenance of vehicles and the nature of the road network to clients' residences. A 20L of water (gallon) was priced 500 TZS/$ 2.17 by pushcarts/tricycles operators based on the distance to water source and expected profit margins of the operators. As revealed: *It depends on the place you go, if you do not go farther places, the price is low, but if you go farther places the price is high*. For another*; It is the distance, and the fuel (..), so we charge based on the fuel, now one-litre of petrol is about 2400 – 2500 TZS/$1.04 – 1.08, which is too high. Each driver decides the price based on how far he travels to deliver water, even the customers do not know where and how far we are coming to their places …"* [No. 36]. As a practice, new drivers and cart operators acquainted themselves with pricing practices, by learning from experienced operators (Cleaver et. al., 2005; Strengers, 2010). These served as logics and meanings in which consensus can be reached and water collected by residents beyond the utility network (Rusca & Cleaver, 2022).

Moreover, ownership of the means (truck/carts) for water distribution affected pricing. Care-takers such as drivers of tanker trucks were obliged to meet the daily monetary targets of 60,000TSZ/$25.95 or of their respective truck owners. As revealed: *When it is not up to 60,000TZS*/$25.95 *our bosses* [owners of the trucks] *sometimes ask us today you are giving this amount how is the business now?* [No. 36].

Table 5.3 Mechanisms determining pricing of water beyond the utility network

Categories	Descriptions	Mechanisms determining pricing of water														
		Cost of fuel	Distance covered	Cost of repairs & maintenance	Nature of road network	Ownership of carts/trucks	Source of water (utility/ground)	Mode of distribution	Demand & supply	Social ties (friend, relative etc.)	Purchasing power	Anticipated profit margin	Electricity tariffs	Utility (DAWASA) tariffs	Cost of materials (valves etc.)
Community-Owned water infrastructure	Mechanized boreholes fitted with hand-pumps			•											•
	Protected deep/shallow wells	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Water kiosks (resellers of utility water)						•			•		•		•	
Hydro-mobile infrastructure	Tanker drivers (Registered)	•	•	•	•	•	•			•	•	•		•	
	Tankers (non-registered, groundwater)	•	•	•	•	•	•			•	•	•		•	
	Pushcarts/tricycles/motorbikes						•							•	
	Mechanized boreholes connected to households via pipes			•			•		•			•	•	•	•
Privately networked water infrastructure	Self-supply households	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Private taps (water resellers)						•			•		•		•	
	Private taps (groundwater)						•			•		•		•	

While prices may be established based on common knowledge, the practice of bargaining and negotiation can be used by both end-users and operators to (re)set prices of water especially with tanker trucks. As disclosed: *"…they* [clients] *bargain, some will call you and say in my area, they bring water to me at this price, they want it at this and that price, if it is good, we agree on the price before we deliver. If you go and they don't agree you send it to a different person* [No. 36]. In these processes, drivers yet had the power to influence prices to reflect their daily targets and profits. Truck owners monitored, and set targets through the daily records [in books] of water distribution trips of drivers. Also, competition among water providers (re)produced price per unit of water, between an end-user, a tanker driver, and a pushcart. However, prices of water of Community-based water infrastructures and private networked water infrastructures were stable and less subjected to negotiation and bargaining processes. For tanker trucks water, potential customers suggested prices per unit of water of interest, and tanker truck drivers choose to accept or not. It is through this process, that price per unit of water was negotiated and bargained between tanker truck drivers and clients.

Moreover, among privately mechanized in-house water networks and communal shared water systems, prices per unit of water were determined by owners based on the recurrent cost of electricity, technologies such as pipelines, valves, pump machines, repairs and maintenance, bills for plumbers, care-takers of the facility and less by competition. Generally, the electricity bill was the dominant factor shaping the price per unit of water provided via a private mechanized in-house water network. This implies that utility's actions such as increase or decrease of electricity tend to shape the price per unit of non-utility water systems. As revealed: "*…the cost of power/electricity, maintenance cost, emergency cost, when you sometime get problem with the distribution, you should have money to address it, this cost should not affect the anticipated profit of 700,000 – 800,000 TZS/$302.76 – 346.02, per month from the sale of the water…"* [No. 24]. Varied prices were found per unit of water within neighbourhoods due to the non-collective ways in which prices were produced. As revealed: *It is my own decision about the cost of the unit of water, I could make it 1000TSZ/$0.43 per unit, but what I think is the cost of the electricity. Also, the repairs and maintenance of the pumps, pumps can break down at any time and we need to call for repairs* [No. 22]. Also, the motive or perception of actors, of their operations; either as a service or a business shaped prices in varied ways. Private mechanized water providers who perceived in-house water distribution as a "service to the community" were found to charge lower prices per cubic meter, compared with owners who regarded such as a "business for profit making" (see also Alba et al., 2019). Nonetheless, in order to gain connectivity, potential clients must be able to pay for the estimated cost of materials required for private networked water connectivity.

For standalone kiosks' water resellers who purchased bulk water from registered tankers, the distance travelled by tankers, and the cost of fuel indirectly shaped the price per 20L/gallon of water. Prices were determined by water resellers of utility's water such as standalone kiosks and private taps. Price ranged from 400 – 500TZS/$ 0.17 – 0.22 per bucket of water (20L). For some standalone kiosk water resellers, prices were determined by the tanker truck drivers from which they collected water for onward distribution. As disclosed; *"Those* [drivers] *who sell water to me, are the ones who determine price for me to buy and to sell out"* [No. 11]. For others, the practice of self-

calculating how much a bulk quantity of water was purchased vis a vis the anticipated profit margins justified the price per bucket/gallon of water within neighbourhoods. The calculative strategy represented a practice of determining the quantity of water purchased from tanker trucks drivers and the amount to be sold per 20L of water to attain the total amount invested and profit. In so doing, water resellers divided the bulk quantity of water purchased by 20L (1000L divided by 20L equivalent to gallon or buckets), and multiplied by 500TSZ/$0.22, the anticipated price per bucket of water. Through these processes, prices by 20L of water were either adjusted to suit the anticipated profit margins of the resellers. Additionally, new resellers of utility water, such as standalone water kiosks determined prices based on price information provided by tankers from whom utility water was collected for resale.

5.5.3 Water price regulation of the non-utility-networked infrastructures

In Dar es Salaam, prices of water of non-utility-networked water providers were (in)directly regulated by state and non-state actors. The state actors included the Energy and Water Utilities Regulatory Authorities (EWURA), the Dar es Salaam Water Supply and Sanitation Authority (DAWASA), and the Tanzania Electricity Supply Company Limited (TANESCOs). While the non-state actors are comprised of consumers, caretakers and owners of water systems, distributors such as tanker drivers, owners of tanker trucks, pushcarts/tricycle operators, standalone water kiosks, religious bodies (Allen et al., 2017). Through the (in)direct actions of the aforementioned actors (Burt & Ray, 2014), prices per unit of water were structured in manifold ways. EWURA exercised the legal mandate to regulate utility services in Tanzania such as water, electricity and petroleum. EWURA directly regulated the prices and services of DAWASA and TANESCO. The regulatory roles of EWURA directly influenced the service and prices of formal utility service providers and indirectly shaped the prices and service of water provided by intermediaries such as private tankers registered with the utility, and kiosk resellers of utility water. These state agencies by legal mandate are expected to regulate the prices of intermediaries, especially non-state actors engaged in water and electricity service provision. The interview revealed that though DAWASA (utility) exercised legal mandate to directly regulate prices of the non-utility-networked water providers. However, the utility has been unable to directly regulate prices per unit of water produced and distributed beyond the utility, due to the informal arrangements that characterized such water supply. As disclosed: "*…The capacity of DAWASA to enforce regulation is very limited if at all…"* [No. 1]. From another; "*Regulating the other operators has been difficult, we tried registering them but they resisted for fear that they may be asked to pay taxes…"* [No. 2]. Therefore, the utility navigated these challenges by equally playing a role as an indirect regulator of the prices of water produced and distributed beyond the utility. For example, the utility/DAWASA engaged, and built partnerships with, private water tanker drivers (Dakyaga et al., 2023b), to collaboratively establish price ranges per unit of water.

As recounted by an old tanker truck driver: *In some years ago, we had a water shortage in Dar es salaam, we struggled a lot to collect water, clean water was very expensive, it cost 25000TZS/$10.81 per 1000 liters, the drivers together with DAWASA then DAWASCO agreed to set the minimum standard that it should start from 10,000TZS/$4.33 per 1000litres, but distributing water to various*

areas it depends on the distance, fuel used, hills and roughness of the road. So, if you travel a long distance to supply water the price will increase from 10,000TZS/$4.33, to 12,000TZS/$5.19, 13,000TZS/$ 5.62, 14,000TZS/$ 6.06 up to 15,000TZS/$ 6.49 depending on the factors mentioned" [No. 36]. Drivers justified their mediatory roles and the powers of vehicle owners as follows; *So, we have two bosses, DAWASA and the owners of the vehicles, but for the case of DAWASA not so necessary. It is the owner of the cars/trucks that is very important because when you burst the tyre; it is the boss/owner you have to call immediately* [No. 36].

Additionally, the utility acquired and introduced hydro-mobile infrastructures such as tanker trucks that collected water from the utility for onward distribution, at the cost of 1663 TZS/$0.72 per unit of water as observed elsewhere (Dakyaga 2022). This served as an alternative to residents located beyond the network to either collect water from the utility's owned tanker truck drivers or the private owned tanker trucks registered by the utility. This represented an indirect way in which the utility regulated the prices per unit of water of hydro-mobile infrastructures such as tanker trucks water delivery. As lamented: "*…Mmmh, basically those water operators do not have formal tariffs (…) but of course, they compare with the tariffs of those that are regulated by DAWASA, somehow they charge more, they charge more because, when for example our tariffs are 1663TZS/$0.72 is a unit price per cubic meter (1000L), private tankers may sell at 10,000TSH or more than…"* [No. 3]. Though this price range existed, known by residents, the study realized that enforcement of the regulation has been problematic. As the utility officials revealed: *"…but we don't have any formal means of saying we are setting prices for the others…"* [No. 2].

Due to lack of formal regulations, (un)registered water providers exercised greater power over prices determination and regulation. Prices were regulated by individual water providers outside the utility. As revealed: "*DAWASA has nothing to do with me, once I receive water in my tanker truck, I am the one who controls everything."* [No. 35]. Registration of private tanker truck drivers by the utility for water distribution does not necessarily contribute to affordable water supply. While bargaining and negotiation could influence prices, it was fluid. Residents could not identify the respective utility kiosks from which tanker truck drivers collected water for onward distribution. This limited the ability of residents to determine the distance traveled by drivers for the appropriate price per unit of water. In this case, drivers' profit motives, and the cost of a litre of fuel indirectly served as regulatory mechanisms that mediated how much customers paid per unit of water. This suggests that the (in)direct actions of EWURA, TANESCO and DAWASA, changes in petrol prices, and unit of water of the utility in turn influence the prices per unit of water sold across non-utility-networked water providers in the city. The interviews revealed that residents used the price of the unit of utility water as the terms of reference when bargaining and negotiating prices per cubic meter of water outside the utility network. As disclosed by a middle-income household. "*…I have ordered for water from the tankers today, and am waiting for them. I bargain sometimes for the price's reduction from tanker truck drivers registered with the utility, they said, they can give me 1 unit of water for 10,000TZS/$4.30 if I can buy 10,000 units of water…"* [No. 32]. This implies that urban spaces where non-utility-networked co-exist, inequality in terms of access to water may be (re)produced. This may widen the gap in terms of who gets what water, when, how and from whom (Adams et al., 2018). For example, private tanker trucks' drivers registered with the utility constituted the

major distributors of water beyond the utility. However, these water distributors were mainly monitored to pay fees to collect water from the utility's kiosks for onward distribution., see Figure 5.2.

Figure 5.2 Water meters of private network water system

Also, prices of privately networked in-house water systems and water intermediaries such as resellers of utility water (standalone kiosks), pushcarts/tricycle vendors, mosques water vendors and community-based water vendors, were neither determined nor regulated by the utility, but more directly regulated by the owners and care-takers. Except for private mechanized in-house water network systems that provided connectivity, water intermediaries had neither formal registration, permits nor a license for water distribution. This connotes to the situation in global South cities (Bakker, 2003; Alba et al., 2019; Kundu and Chatterjee 2020), where non-networked water systems remained unregulated in terms of operations and water prices. Lack of direct regulations, possessions or ownership of water infrastructure signified power (Rusca & Cleaver, 2022), especially in areas beyond and bypassed by the utility. As revealed: *When you have water, it is the people who come to you. The need and demand for water drives people to you so you become the lord "governor" because you have water* [Privately networked water provider, No. 22]. The household case studies revealed how ownership of in-housed networked water providers signifies the power of lordship or "water governors" in such waterscape. As revealed: *My house has no connectivity to DAWASA water, there is a private operator here who supplies water to other households not connected to the utility. There was a time I wanted the operator to connect me to the salty water, but the connector is too greedy, he talks badly, and charged me 400,000TZS/$173.01 as the cost of the connectivity to the network. it is expensive, I told him to reduce some money for me*

because my storage system is about 2,400Liters capacity, and even the tankers charge 15,000TZS/$6.49 per unit of water supplied…" [No. 32]. In this context, the owner of the infrastructure held the power to either reduce or maintain the cost of connectivity based on his discretion.

Though the utility ordinarily established 5000TZS/$2.16 as the maximum standard price per cubic meter of water for privately mechanized in-house water connections, interviews revealed that some privately mechanized in-house water providers charged more than the standard price. Whilst this represented a peculiar water urbanism with non-utility-networked water infrastructural systems, the uneven coverage of networked challenged the utility's efforts towards attaining equitable and affordable water distribution beyond the utility network. The lack of direct regulation of the water providers instigated high cost of water, especially from intermediaries of the utility (Rusca & Cleaver, 2022). This was found common especially among standalone kiosks and pushcarts/tricycles' operators reselling utility's water. However, for private mechanized in-house water networks, the price per unit of water was indirectly regulated by the utility. Artefacts such as pipelines, and meters regulated the price per unit of water. Pipelines mediated the flow and the distribution of water to end-users. Water meters did not only regulate water flow but also acted as intermediaries by preventing conflicting discourses and building transparency between water providers and end-users, justifying cost to warrant payment. As revealed by private mechanized in-house water network owner: "*…At any time, they come to ask me, how much do I owe you? Then I read the meter, and tell them the quantity they have consumed, and then they pay me. I have meters installed that regulate the consumption of the water* [No. 22]. This demonstrates the role, of pipelines, water pump machines, robes, water meters and storage systems. These non-material actors indirectly determined the quantity of water consumed through which payment was warranted and user fees collected by the providers.

5.6 Conclusion and implications for improving urban water supply beyond the utility

In many cities of the global South, studies demonstrate the heterogeneous ways in which water is produced and distributed beyond the utility network (Lawhon et al., 2018; Truelove, 2019; Alba & Bruns, 2021). This growing body of knowledge shows how diverse infrastructural arrangements and technologies co-exist and serve residents in cities of the global South. In light of the multiple ways through which people produce, distribute and access water beyond the utility network, scholars considering the socio-economic inequalities in cities of the global South have argued for the need to pay attention to the ways in which prices are produced and regulated beyond utility networks (Adams, 2018a; Truelove, 2019b). However, studies have to date rarely explored the ways through which prices are established and governed in such uneven waterscapes and what this means for improving urban water supply. Drawing from literature on everyday pricing practices and urban water infrastructure heterogeneity, we contribute to urban water governance scholarships especially in the global South about the ways in which water prices are produced and governed, in urban geographies characterized by uneven utility networked coverage. Through a qualitative case study of the non-utility-networked in Dar es Salaam, we showed how water prices are set and

governed, especially the mechanisms that determined pricing in the non-utility-networked waterscape. These provide an overview of the diverse ways and factors that exacerbate urban water supply and access challenges in cities of the global South.

We showed that the pricing of drinking water in non-utility-networked urban spaces was shaped by the presence of multiple infrastructural systems and actors such as hydro-mobile infrastructures (pushcarts/tricycles, (non)utility tankers and households' own water networks. In these spaces, prices were established in a place-specific way, less by pre-determined tariffs, unionized or collaborative arrangements, but rather by everyday learning by doing. The involved actors utilized self-discretions to determine prices per unit of water. Largely, the cost of electricity, fuel, repairs and maintenance, location and/or distance, nature of the road network to clients' residences, as well as providers' expected profit margins guided pricing determination.

These practices present diverse implications for improving urban water supply through non-utility-networked water infrastructures that prevail in global South cities. While they enabled water access via the mediating roles of diverse actors, skills, technologies and creativities (McFarlane et. al., 2017; Monstadt and Schramm, 2017), such practices also hold the possibility for widening water access inequities. This can be attributed to limited regulations of the varied actors engaged in water production and distributions outside the utility network. With the exception of registered tanker truck drivers, prices per unit of water of the other water providers were determined by their owners. Again, the conventional practice such as using spatial distance to establish prices for water collection in the case of tanker trucks water distribution, were processes fostering exclusion and inclusion in the waterscape. Because in the absence of a defined specific kilometric distance, short and long distances can be subjective. Tanker truck drivers decided which distance was short or long to merit price per unit of water to clients. The institution of a defined kilometric distances for a given price may enable tanker truck drivers equitably price the utility's water. Also, bargaining and negotiation were virtual spaces where socio-economic powers were exercised, as well as where relational powers, such as one's ability to gain bulk quantities of water based on storage abilities was made possible. Moreover, considering the plaguing socio-economic inequalities in cities of the global South, water access challenges of the predominantly low-income residents may heighten exclusion, insecurity and exploitation (Pihljak et al., 2021). The study concludes that focusing on the varied ways in which pricing is determined sheds light on an important aspect of heterogeneous infrastructure provision especially in urban spaces: where varied prices are established outside formal regulation, they reflect, shape and exacerbate fine-grained socio-spatial differences between individuals within single neighbourhoods. We suggest that further studies pay attention to how water pricing practices in the non-utility-networked waterscape produces inequality and exclusion.

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CHAPTER SIX

Between self-help and emerging water markets: Self-Governance, everyday practices and the spatiality of water access in Dar es Salaam

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6.0 Introduction

Having analysed the governance arrangement of heterogeneous non-utility-networked water infrastructures, the practices through non-utility-networked water infrastructures are developed and sustained for water supply as well as the mechanisms that determined prices of water beyond the utility network, this chapter brings together a reflection and evaluation of the practices detailed in Chapter 3, 4 and 5. In this context, it presents an evaluation of the limits and potentials of the ways in which non-utility-networked water infrastructures. Self-governance emerged as one of the dominant modes that facilitate the production and distribution of water beyond the utility network. This chapter, therefore, highlights the nature of varied practices and what the practices really achieve in terms of water access: quality, affordability, reliability and distance to water. This was done by drawing debates from everyday practices, and self-governance alongside the concept of water access.

Abstract

In many Sub-Saharan African cities, residents depend more or less on decentralized (off the utility grid) water infrastructures, often by engaging in diverse but ordinary daily acts through which water is supplied and collected beyond the utility. However, little is known about how these ordinary practices and governance arrangement shape water access in terms of distance of water sources, reliability, affordability and water quality. This study addresses this gap by exploring the potential and limits of the ordinary ways in which urban residents self-supply and collect water and how that shapes water access in peri-urban areas. Through in-depth interviews, observations and household surveys, we contribute to urban water infrastructure governance debates by showcasing how some residents self-financed and self-supplied water beyond the utility through which other residents collect water. These practices were shaped by the desires and needs of the governing actors (independent self-help and market-oriented actors) to simplify the water access situation, earn extra income and fulfil the basic water needs. The practices were characterised by informal relations, and financial powers to supply water and to restrict use. These (re)produced geographies of access advantage in favour of the suppliers and access disadvantages to residents who depended on off the utility grid water infrastructures in the absence of state utility. We conclude that although ordinary ways of supplying and regulating water systems hold some potential for fulfilling the water

access gaps, the uneven power relations, propertisation and commodification of water infrastructures limit their usefulness.

6.1 Introduction

Until the early nineteenth century, non-piped water such as surface water, rainwater, and groundwater were the main sources of water supply in cities across the globe (Domènech, 2011). However, in the wake of rapid urbanization and industrialization in the Global North; scientific and technological advancements in engineering, urban planning and epidemiology; as well as changing expectations and ideas of good urban living, a new ideal of urban planning and engineering emerged: the modern infrastructural ideal of the hydraulic, or networked city (Graham & Marvin, 2001, p. 22; Courtard & Rutherford, 2016). According to this ideal, state-regulated utilities provide standardized services to all urban citizens through large-scale infrastructure networks (ibid.). As scholars have discussed elsewhere, colonialism has contributed to the global travel of this ideal and the contradictions inherent to it, especially in cities of the global South (Schramm & Wright-Contreras, 2017; Monstadt & Schramm, 2017). While the modern ideal continues to influence urban planning education and practice, as well as urban policies across the globe, its various, place-specific appropriations have not led to the unification and standardization of infrastructures in cities of the global South (ibid). Rather, access to necessities, such as drinking water, has regularly remained fragmented, contested, and uneven during and after the end of colonial rule (Mcgranahan et al., 2016; Uitermark & Tieleman, 2021). In this light, a growing body of literature has been concerned with analyses of water infrastructural "heterogeneity", the "multi-modalities" of urban water systems (Dakyaga et al., 2018; Smiley, 2020), decentralized water systems, or with opening up new perspectives on "post-networked" infrastructures for water access (Cirolia & Rode, 2019). More specifically, scholars have paid attention to citizens' strategies/bottom-up self-initiatives and practices in accessing water beyond the erratic or incomplete centralized water networks in cities of the global South (e.g. Velzeboer, Hordijk, & Schwartz, 2017; Sara et al., 2017; Alba et al., 2019; Neves Alves, 2019; Zhen et al., 2019; Truelove, 2020). Although the diverse, mundane daily acts in which residents engage, to self-supply, self-regulate and collect water beyond the utility for domestic use have gained recognition within scholarship on urban water infrastructure in the global South (Grönwall & Danert, 2020; Dakyaga et al., 2020), little is known about how such practices and arrangements shape the intricacies of water access in terms of distance to water sources, reliability, affordability and quality of water.

In Dar es Salaam, rapid urban growth has manifested in an expansion of peri-urban settlements sprawling far into the hinterland of the city (Pastore & Pastore, 2016). Dar es Salaam's morphology together with financial restrictions makes the installation of centralized water networks that are managed by the utility and regulated by the state largely infeasible (McGranahan et al., 2016; Todd et al., 2019). Consequently, most residents of Dar es Salaam's sprawling peripheries are not served by the utility water network (Smiley, 2013). Instead, water supply is more or less characterized by off-grid, localized, private and decentralized systems (Sakijege, 2019; Hofmann, 2020). It is regularly self-governed through everyday practices - ordinary day-to-day actions and diverse arrangements of residents, more or less independently of the State (Kombe et al., 2015; Gibbs, 2015; Alen et al.,

2017; Mapunda et al., 2018). Research on water access and infrastructure provision in Dar es Salaam has extensively covered the complexities associated with urban water access, the inequality in water distribution and self-help strategies of citizens in accessing water (Nganyanyuka et al., 2015; Andreasen & Møller-Jensen, 2016; Smiley, 2017; 2018; 2020; Allen et al., 2016). Only a few studies have explored the ordinary ways in which residents provide and self-regulate off the utility grid water systems towards water access (Hofmann, 2020).

In this light, this study aims to provide a more nuanced picture of self-governance and everyday practices regarding decentralized water infrastructure provision and operations. We used the concept decentralized water infrastructure to refer to small-scale, off the utility grid water systems that serve a population of less than 500 – 10,000 (Dobbs, 2003). We explored in detail the actors, practices and arrangements of residents in water provision; and secondly, how such practices shape water access in terms of water reliability, proximity, affordability, and quality. To do so, we draw academic debates on everyday practices, self-governance, and water access in sections 2 and 3. In section 4, we explain our research methods; in section 5, we present results and discussions, and in section 6, we conclude by demonstrating the potential and limits of everyday practices and self-governance arrangements of residents.

6.2 Everyday practices and self-governance of urban water infrastructure in the global South cities

Since the early 2000s, everyday practices and self-governance received considerable attention as analytical lenses for studying the ordinary and fragmented practices that relate to natural resource management, urbanism and infrastructure in the global South (Gautam & Shivakoti, 2005; Colin-Castillo & Woodward, 2015; Rauws, 2016; Rauws, Cozzolino, & Moroni, 2020). The notion *everyday practices* entail the diverse, ordinary daily acts or arrangements which residents engage in, to supply or collect water beyond the utility (Dakyaga et al., 2020), while *self-governance* entails the act of "doing it yourself" such as self-regulation, self-supply and self-control of the provision/distribution of water by individuals or group beyond the utility (Rauws, 2016). Conversely, both manifest through undefined practices of varied actors, that are non-collective, but more shaped by the intention or motives of the actors invovled. The often oscilitate between self-help initiatives and market-driven practices (ibid). These lenses have commonly been used to demonstrate the ways in which residents supply and collect water in cities of the global South as a kind of urbanism. Related studies have applauded the instrumentality of ordinary practices in filling public service gaps in peripheral, marginalized and informalized areas of cities, and exclaim for the integration and modification of these water systems within the large-scale water infrastructure to enhance their performance (Ahlers, Schwartz, & Guida, 2013; Allen, Hofmann, Mukherjee, & Walnycki, 2017). However, following the perspective of Gramsci and Foucault, Ekers and Lofus (2008), urge scholars to pay attention to micropolitics and practices through which urban water is ordinarily provided, by revealing that providers exercise power through which other people are subjected, in order to collect water. In view of this, studies called for an expanded analysis of the everyday practices and governance arrangements in relation to the ways they shape urban life, especially in the global South (Lawhon et al., 2018; Truelove, 2020). More recently, Cleaver and

Rusca (2022) reveal that drawing on the everyday perspective helps scholars to appreciate the hybrid governance arrangements and constellations that characterize the waterscape of the global South cities. They further suggest that the hybrid arrangements are created via social practices as well as relationships with diverse logics and gist, which reflect and (re)produce forms of power and inequality. In order to reveal how they shape water access precisely, our study analyses everyday practices and governance arrangements of urban citizens that either occur outside formal laws, are entangled with the state, or operate through self-organization (cf. Ranganathan, 2014; Bénit-Gbaffou & Oldfield, 2011; Rauws, 2016). Bringing together these approaches helps to focus our study and offers a nuanced understanding of the micro-level practices of accessing water through drilled mechanized boreholes, protected wells, tanker trucks, private pipes, water kiosks etc.

Over the years, urban scholars have researched self-governance and everyday practices concerning urban water and sanitation infrastructure provision and access with increasing intensity (Peloso & Morinville, 2014; Pastore, 2015; Velzeboer et al., 2017; Wamuchiru, 2017; Dakyaga et al., 2020). These studies offer insights on how citizens' practices may be considered as more or less novel form of governance (e.g. Kooiman & van Vliet, 2000; Ubels, 2020). A range of studies demonstrate how citizens access resources through everyday practices (Hausermann, 2012): they reveal the uneven power relations inherent in state-citizen interactions and among residents in the provision and access to water from off the utility grid, informal water systems (Cornea et al., 2016; Alda-Vidal et al., 2018; Neves Alves, 2019). In Asian and African cities, Grönwall and Danert (2020) and Uitermark and Tieleman (2021) report how the upper strata households and political actors self-supply water to serve themselves and the low-income residents. Truelove (2020) reveals that these actors may swing their identities, roles and status between state and non-state to maintain their existence and maximize their own interests through the provision and regulation of water systems. The involvement of state actors and upper-class residents in informal water provision illustrates how such actors (mis)appropriate powers and sovereignty in their personal favour (ibid.). Grönwall and Danert (2020) and Sørensen and Triantafillouand (2009) add that such practices are often situated within place-specific power relations and self-governance (sovereignty, self-controlled, self-regulated provision and supply of water).

Some scholars argue that residents create, negotiate and adapt norms, rules, regulations and decision-making procedures to regulate water production and access (Cornea et al., 2017). Through such negotiations and adaptations, citizens may be able to realize the right to water in the absence of state utility (Sarkar, 2020). While the insurgence of self-supply and regulation of water signify sovereignty (Sørensen & Triantafillouand, 2009), it may widen socio-economic inequalities. This is because not all citizens are able to self-supply. Self-supply depends on particular resources' control and power to install and regulate water systems (Bakker, 2003; Andreasen & Møller-Jensen, 2016). Some scholars add that spaces of self-supply are not only shaped by the absence of state utilities to provide but also by the absence of a statutory regime to govern water provision and access (Cornea et al., 2016). The state's absence promotes the fragmentation of systems that in turn (re)produces uneven power relations and unequal terms of water access among end-users (Meehan et al., 2020).

Devlin makes an important contribution to the analysis of "bottom-up interventions of everyday citizens" by arguing that everyday practices of urban citizens occur in different places with varied ends – he distinguishes practices born out of "desire" and practices born out of "need" (Devlin, 2018, p. 33). Practices based on "desire" are bottom-up, mundane practices often undertaken by middle- and upper-class residents more or less as "wants" to simplify situations, contribute towards improving their living environments, and perhaps earn an extra income. However, such acts do not directly affect their survival. In contrast, practices born of "need" are ordinary practices undertaken by the urban poor (low-income class residents) to fulfil vital needs they otherwise have no access to (Devlin, 2018, p 7). In such situations, access to water is mediated by uneven power relations, socioeconomic status, individual social ties, and one's belongingness to local institutions such as clubs or groups and parties. These in turn re-produce uneven water access to further disadvantage marginalized residents (Cornea et al., 2016). Powerful actors may take advantage of the absence of the utility by providing water on their own terms, and may lack the prerequisite capital and capacities for a reliable, ubiquitous and affordable water supply (Meehan et al., 2020). These practices towards basic service access often reflect an in-deliberate transfer of responsibilities of public authorities to citizens in the global South (Gibbs, 2015; Okeyo Obosi, 2020). But for some scholars, self-governance of service provision enables communities to define, act in line with, and ultimately realize, their actual desires and needs (Sørensen & Triantafillouand, 2009, p. 158; Devlin, 2018). Habitually, the practices may evolve through citizen creativity driven by "technologies, power relations, capacities and operations with the progressive potential to shaping service provision" (cf. e.g. Lawhon et al., 2018, p. 1). However, as discussed here, such practices and modes of governance hold not only the potential for progressive change but also bear some risks, such as widening inequality and unequal power relations and discrimination in water access. The next section presents the conceptual perspective on everyday water access.

6.3 Conceptualizing everyday water access in urbanizing cities of the global South

As discussed above, an intense scholarly debate is ongoing around the multifaceted ways in which residents self-provide and self-govern water access and the implications of such practices for progressive change. However, in order to make a more precise statement on how such practices shape water access, a closer definition of everyday water access and how to measure it, is useful. The 2010 Resolution 64/292 –Human Right to Water and Sanitation provides an entry point for such a definition as it states that "everyone has the right to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic uses" (Roaf et al., 2019; United Nations & WHO, 2019; Bos, 2016; Antunes & Martins, 2020). Furthermore, national and global parameters exist in measuring water access. In Tanzania, the 1971 Julius Nyerere Rural Water and Sanitation program defines water access as a maximum of 400 meters distance from an improved water source and 30 minutes for a round trip. These standards have since been used on a national scale (URT, 2013). However, some scholars argue that these indicators are vague, because households may be close to water, yet constrained by unreliability of the source, poor quality or high cost of water (Obeng-Odoom, 2012; Smiley, 2013).

Table 6.1 Parameters of water access

Parameters	Definitions	Description of indicators
Access to water	Distance /proximity	Distance to improved water sources ≤ 1 km (WHO), and ≤ 400 meters (URT) from a dwelling unit
	Reliability	How reliability of water supply is (dis)enabled via ordinary practices
	Time spent	Procedures and time spent in water collections in relation to 30 minutes of round trip.
	Quality of water	How acceptability of water is (dis)enabled
	Affordability	How affordability is (dis)enabled via ordinary practices

Source: Authors' compilation

Perhaps in response to these critical voices, the Joint Monitory Report of the World Health Organization (WHO) and United Nations Children Fund (UNICEF) subsume the availability of water, the accessibility of water, the quality of water and related services in their definition of water access (UNICEF & WHO, 2017). Safely managed drinking water is "defined as the use of an improved drinking water source, located on-premises, available when needed, free from faecal matter and chemical contamination" (WHO & UNICEF, 2017, p. 24). Proximity is categorized into *basic services* – households having improved water sources located-off premises and within 30 minutes for a round-trip (Table 2). *Limited access* – implies that a household has access to improved water with a collection time beyond 30 minutes for the round-trip (ibid). The sufficiency of water is defined by its availability for 12 hours per day (WHO & UNICEF, 2017).

These precise national and global indicators ignore the ordinary practices and governance arrangements that may (dis)enable water access (Wutich et al., 2020). Scholars demonstrate how access to water is bonded with existing relations, processes and mechanisms that hinder, facilitate and differentiate access among socio-economic groups (Roy, 2005). As discussed above, uneven power relations, situated authority and legitimacy (dis)enable one's access to water in the absence of state governance (Cornea et al., 2017; Wutich et al., 2019; Truelove, 2020). Regularly, the informal relations, mechanisms and processes exclude and exploit marginalized and urban poor populations because financially and politically powerful individuals and groups may improve their status and accumulate wealth through the absence of state-governed water networks (Sultana, 2020). Truelove (2020) mobilizes the notion of "infrastructural power" to explain the varied negotiations that mediate water access and how vulnerable residents are regulated, deceived and exploited by the vocal and powerful actors who act as water providers (p. 7). Considering Accra, Ghana, Peloso and Morinville (2014) show the complex daily routines through which urban residents collect or "chase" water from decentralized water systems. Related studies reveal that these challenges are influenced

not only by the scarcity of water, but also by the politics of informal water operators, unequal water distribution, and the marginalization of unserved residents in cities' development plans (Roy, 2005; Crow & Odaba, 2010; Truelove, 2019). In Dar es Salaam, residents in the peripheral informal settlements are compelled to seek alternatives in order to cope with erratic water supply services due to low coverage of the state utility. These struggles tend to hinder households' ability to attain sufficient water (Herslund & Mguni, 2019).

6.4 Research Setting and Methods

6.4.1 Centralized water supply and self-governance of water in Dar es Salaam

Dar es Salaam is one of the fastest-growing cities ranked 3rd in Africa and 9th worldwide (McGranahan et al., 2016). It is the largest city of Tanzania bordered by the Indian Ocean. Like so many cities in the Global South, its infrastructure and service provision are unable to keep pace with the rapid outward growth (Todd et al., 2019). Between 1990 and 2014, the city expanded from 255.06 km² to 532.13 km² (Bhanjee & Zhang, 2018, p. 7). The city's rapid growth has manifested in informal development and peri-urban sprawl (Pastore & Pastore, 2016). Dar es Salaam's peri-urban sprawl makes networked water provision difficult and expensive (McGranahan et al., 2016). Indeed, only a fraction of residents have access to the city's utility network. Specifically, peri-urban areas are regularly disconnected from Dar es Salaam's utility network (Pastore & Pastore, 2016; Sakijege, 2019; Hofmann, 2020). Consequently, urban water provision works through a de-facto transfer of the state's responsibilities to urban residents and private informal water vendors (Smiley, 2013). In light of the lacking capacities of the state, it is argued that building on local initiatives and potential is perhaps the pathway to reduce the burden on the centralized water infrastructure (Dill, 2010).

6.4.2 Case study areas in Dar es Salaam

The study was conducted in three "ordinary" peri-urban settlements of Dar es Salaam to explore how everyday practices and self-governance of decentralized water systems shape water access. In this context, we define ordinary peri-urban settlements as unplanned and transitional areas of Dar es Salaam, characterized by diverse socio-economic groups (low, middle and high-income households, co-existing in geographical areas), living without networked water, by relying on diverse alternatives, based on their different abilities (Robinson, 2006). These settlements were selected as information-rich cases because of their location at the fringe of the city, The selected settlements included *Goba-Chaurembo, Goba-Kibululu* and *Goba-Kunguru* located in Goba ward, in the *Ubungo* Municipality approximately 23 kilometres from the city centre along the Mwenge-Bagamoyo major road. These settlements were headed by *Mtaa* (Ward) leaders and urbanized rapidly. In 2012, the population of the entire ward (Goba) stood at 42,669 and rose to 52,056 in 2016 (URT, 2017). See Table 6.2.

Table 6.2 Basic information and characteristics of the population

Study areas	Basic information		Sampled of respondents		
	Population	No. of households	No. of water systems mainly for households' use	No. of water systems for both household use/sale	Sampled households
Kibululu	5,181	1,594	4	11	128
Kunguru	6,097	1,186	3	10	81
Chaurembo	5, 213	1,185	3	14	83
Total	16,491	3,965	10	35	292

Source: Authors' compilation

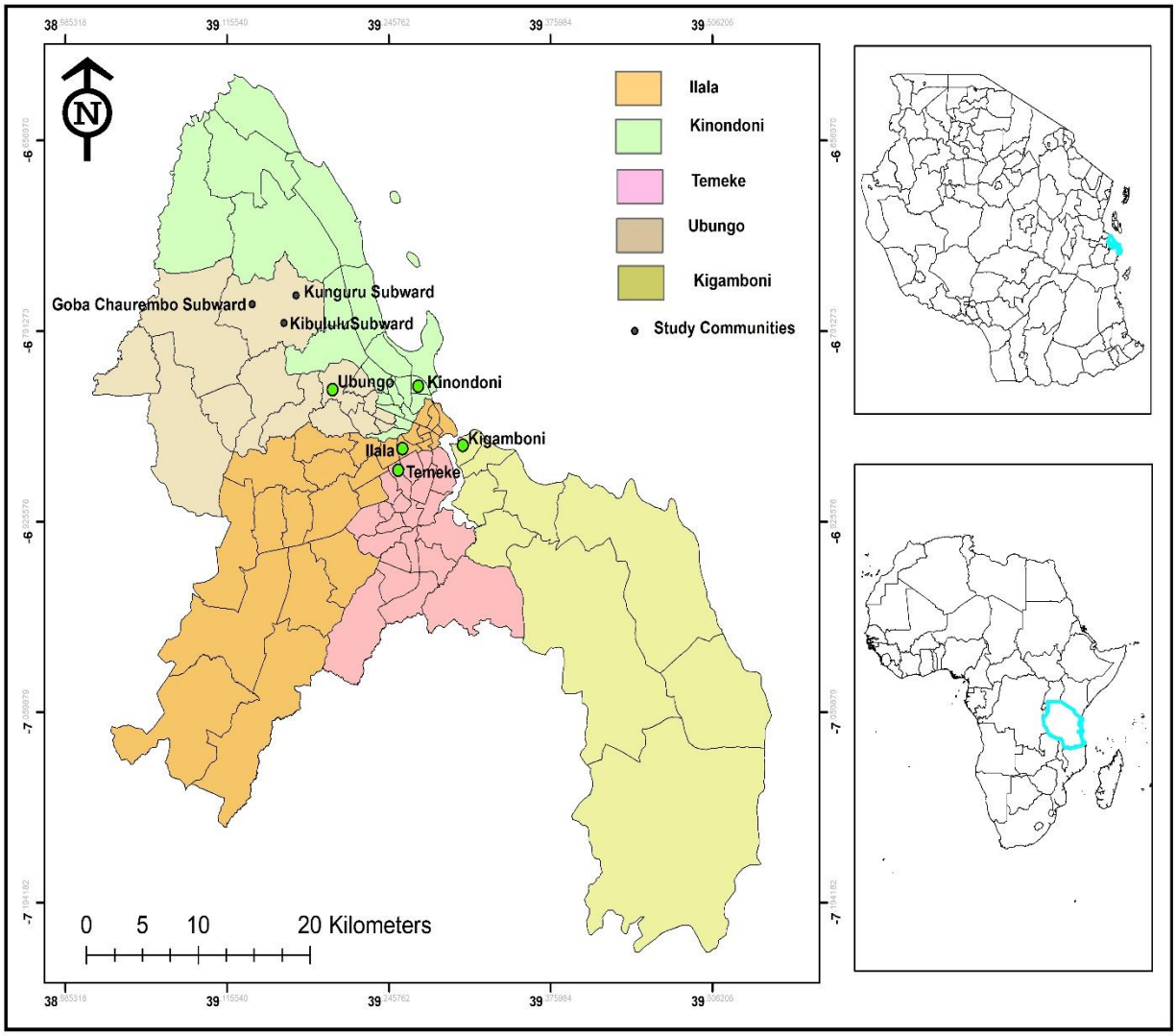

Figure 6.1 Map of Dar es Salaam showing Ubungo Municipality

6.4.3 Research methods

We used a case study approach with both qualitative and qualitative data to explore everyday practices and self-governance arrangements of residents in decentralized water provision and how they shape water access. Data were collected through observations and mapping, in-depth interviews and household surveys in three peripheral settlements of Dar es Salaam. The combination of these data enabled triangulation and synergy. The field study started with a preliminary observation and mapping to set the pace for the conduct of in-depth interviews and household surveys. Transect trips/walks were done through the use of a motorbike to observe and map the locations of the various water systems and their owners/operators with the guide of a checklist. The checklist contained questions about the location of the water systems (out-door/in-door), the type of water infrastructure (mechanized boreholes, water kiosks etc.), and their usage (domestic use/both domestic/commercial). Field trips and observations were led by *Mtaa (*local leaders) who had lived in the settlements for decades and had knowledge about the location of water infrastructures provided by the residents. This was necessary because most of the operators were unregistered both by the Ward and the Municipality. Through the transect trips/walks, the water infrastructures were observed and pictures taken and their location mapped with the use of GPS. Throughout the process, the snowballing/chain referral technique was used to enable known operators to refer the research team to other operators within the settlements. The observations enabled the identification of the types of water infrastructures, their operators, and locations for follow-up and the conduct of in-depth interviews.

The in-depth interviews were conducted with the Municipal Water Engineer (MWE), three *Mtaa* leaders, the Ward Health Officer, and heads of households connected to drilled mechanized boreholes. In-depth interviews were also conducted with a total of 45 owners/operators of water systems as the primary unit of analysis. Operators/caretakers of the water facilities were interviewed on the occasions when the owners of the water facilities were not available for the interview. Among the water facilities we studied were three drilled mechanized-boreholes connected to households, 28 owners/operators of water kiosks, two tanker truck operators, two pushcart operators, and ten households with in-house/in-door self-owned water system. Tanker truck and pushcart operators were selected accidentally and interviewed. The goal was to obtain detailed information about practices on water provision and operation of water systems, and to map the various actors involved. The interviews were conducted in the form of face-to-face interactions. In these interviews, questions were asked about the procedures involved in the provision and operations of decentralized water systems; the sources of water (DAWASA/groundwater); the source of funding/occupations of the owners; their registration status; are measures taken to ensure water quality; rules and regulations guiding water provision and operation; why residents engaged in decentralized water provision; and the payments and access modalities. The in-depth interviews were recorded only with respondents who consented to records of the discussions being recorded. The study also sought to conduct interviews with officials of DAWASA (state utility) to gain their opinions about the practices of the residents, particularly the existence of off-grid water operators. However, although several follow-ups were made, the

officials were not available for interviews. This represented a limitation of this study. The conduct of in-depth interviews provided a clear insight into the practices that guided the development of the survey questionnaires to collect data at the household level.

Household surveys were conducted among randomly selected households/consumers to obtain a community-wide perception of off-grid decentralized water systems provided by residents and how they shape water access in the three selected settlements. Given the homogeneity of the study settlements in terms of practices, governance and water access situation, data were collected from (*n = 292)* households. The representativeness of this sample was determined via the use of Yamane's mathematical formula for sample size determination. The household surveys targeted households' heads and persons aged 18 years and above who were directly involved in the households' water collection or financing of the cost of water collection. Interviews were conducted face-to-face. The random sampling technique complemented by area sampling was appropriate in giving equal probability for all households to be selected for the surveys. Households in the three selected settlements were randomly approached and the questionnaire was self-administered with the use of closed-ended questions. In the course of the random selections, only households whose heads or persons involved in water collection or financing were present were selected.

The survey questions covered the demographic characteristics of the respondents (age, sex, level of education, the main sources of water, estimated household income, how water was collected/distributed to their homes, the quality, cost, reliability and distances of the various water sources). The questionnaires were pre-tested in *Kinzudi,* one of the peripheral/informal settlements in the Goba ward. Responses gathered were evaluated and the questionnaires were restructured for more clarity to obtain the information required from the respondents. Thirteen enumerators who were native speakers of *Swahili* assisted the data collection. The household survey data were cleaned, edited for consistency, and processed using the Statistical Package for Social Scientists (SPSS) version 20. Cross-tabulations analysis was conducted to segregate and comprehend the water access level across the study settlements, the reliability of the water, the distance of water sources, affordability and the perceived quality of the water. The recorded qualitative interviews were transcribed, edited, grouped and codes generated using MAXQDA 2018. While the content and narratives of the respondents were thematically analysed. The combination of the data fostered triangulation and offered a nuanced understanding of the practices and governance arrangements with regard to the provision and operation of decentralized water systems.

6.5 Results and Discussions

6.5.1 Socioeconomic characteristics of the respondents

The surveyed households comprised 128 households in *Kibululu,* 81 in *Kunguru,* and 83 in *Goba/Chaurembo*. Most of the respondents interviewed were females 149 (51%). All the respondents had formal education, either primary, secondary or tertiary. About 23% of the respondents had a tertiary level of education. Most respondents in *Kibululu* attained a high level of education (51.6%)

compared with the other settlements (Table 3). About 29.1% of the respondents were between the ages of 26-31 years. The average size of the households was 5 persons. Most water kiosks were operated by females, see Table 6.3.

Table 6.3 Socioeconomic characteristics of the respondents

Socioeconomic characteristics	Study settlements			
	Chaurembo	*Kibululu*	*Kunguru*	N
Sex	N (%)	N (%)	N (%)	
Male	38 (26.6)	69 (48.3)	36 (25.2)	143
Female	45 (30.2)	59 (39.6)	45 (30.2)	149
Educational level				
Primary	50 (30.9)	64 (39.5)	48 (29.6)	162
Secondary	18 (26.5)	32 (29.8)	18 (26.5)	68
Tertiary	15 (24.2)	32 (51.6)	15 (24.2)	62
Sources of income				
Petty trading	36 (27.9)	57 (44.2)	36 (27.9)	129
Farming	11 (45.8)	4 (16.7)	9 (24.0)	24
Public sector workers	9 (18.4)	31 (63.3)	9 (18.4)	49
Medium/large scale business	15 (26.3)	27 (47.4)	15 (26.3)	57
Others	12 (36.4)	9 (27.3)	12 (36.4)	33
Estimated income level (monthly)				
High-income 3, 250,000 TSZ	17 (23.9)	38 (53.5)	16 (22.5)	71
Middle-income 399,999 TSZ	27 (40.3)	14 (20.9)	26 (38.8)	67
Low-income 109,999 TSZ	39 (25.3)	76 (49.4)	39 (25.3)	154

Source: Authors' compilation

Across all the settlements, varied income sources were found, including petty trading, public sector work, business and farming extenuating Mapunda et al. (2018) supposition of the different socioeconomic groups in Dar es Salaam's informal settlements. About 129 (44.2%) of the respondents were petty traders. The monthly household disposable incomes of the respondents were observed and classified as follows; high-income (3, 250,000 TSZ or $ 1432.35), middle-income (399,999 TSZ or $ 176.29) and low-income (109,999 TSZ or $ 48.48). Respondents within the low-income category constituted the majority with 154 (52.7%) cutting across all the case study areas but dominated in *Kibululu* settlement with 76 (49.4%). All the operators and owners of the decentralized water supply systems had operated the water supply for over three years.

6.5.2 Everyday practices and self-governance of non-utility-networked water infrastructure

In this section, the ordinary practices and governance arrangements of residents in *Kunguru, Kibululu, and Chaurembo* of Dar es Salaam's edges are presented. As observed elsewhere, the inability of the utility to extend water to peripheral areas led some residents to provide off the utility grid water systems for water collection (Sultana, 2020). In the absence of the utility, residents collected water through drilled mechanized boreholes, private standpipe pipes, tanker trucks, water kiosks, and un/protected wells. As a male resident disclosed, "…we do not have any choice as the utility service has not reached us" (Kibululu, 27/09/2020). The water systems were provided, operated, regulated and financed by households and individuals without the direct involvement of government. Our study revealed that these water infrastructures were governed by three major categories of actors: independent self-help actors; market-oriented water actors; and dependent actors.

Independent self-help actors comprised middle and high-income residents who self-supplied and operated drilled and mechanized water systems for self-use. About 13% of the households (middle and high-income residents) we surveyed were engaged in self-supply. The practices of this actor category imply that informal and ordinary practices in urban settings are not necessarily driven by the urban poor but more by the affluent (Devlin, 2018). Moreover, the provision and access to water were shaped by place-specific and uneven power relations (cf. Truelove, 2020). Financial power and the ability to acquire ownership or claim spaces enabled these actors to secure water as a basic human need in the absence of universal access through off the utility-grid water infrastructure. Even though these actors were not directly engaged in the drilling of groundwater, due to lack of technical skills, they were able to pay for the services of plumbers and hydrologists who had the skills to establish such infrastructures. These actors financed the costs sequentially. Self-supply of water systems enabled these actors to exercise absolute ownership and regulatory powers and to decide their own consumption. Self-supply therefore fostered propertization of water infrastructure through the exclusion of other citizens/residents. In so doing, it enabled independent self-help actors to exclusively limit water infrastructures to their gated yards for ease of water access, privacy, flexibility and convenience.

While it served as the medium through which residents collected water in the absence of utility (Grönwall, 2016), the propertization (claiming of ownership) of such water infrastructures limited universal access to water. Therefore, whereas lack of state utility provides freedom for self-supply, it also has the tendency to further deprive the already urban water poor who cannot finance the drilling of water systems on their premises (Rusca and Cleaver, 2022). As a male resident disclosed, "…it is not also easy to drill your own water you will spend a lot of money…". Even when drilled and mechanized, water availability and reliability was dependent on the household's ability to purchase electricity for pumping groundwater into storage tanks or the use of microgrid (generators) as an alternative source of energy. As a result, independent self-help actors oscillated between absolute self-use and commercialization of water to obtain income in seasons of water scarcity to augment the purchase of electricity for pumping water at the household levels. From in-depth interviews,

the market-oriented water actors used technologies such as mechanized boreholes, tanker trucks (owned and regulated by middle-income residents), standpipes, protected wells, water kiosks, and carts for water supply About 48% of the households secured water from tanker trucks, 20% from mechanized boreholes, 11% via water kiosks, 8% from private water taps, 6% by purchase carts, 6% by protected well and 3% from other sources of water supply (see Figure. 6.2).

Figure 6.2 Non-utility-networked water infrastructure connected to surrounding households

Source: Photo by Francis Dakyaga

These actors governed supply by determining the daily duration of water operations and prices in their respective locations. With reference to Devlin's (2018) perspective on "desire" and "need", the study found that the practices of market-oriented actors were driven both by the middle and high-income resident, and shaped by the need to secure water for themselves and the desire to simplify water access situation in their localities and earn extra income. The actions of these suppliers

enabled residents without water facilities (dependent actors, mostly low-income residents) to secure water. Contrary to Devlin's observations, the ordinary practices towards water access were not only undertaken by the urban poor but also the affluent. The provision of water to unserved residents enabled market-oriented actors (high- and middle-income residents) to earn extra income (Fig. 3). The act of self-control and regulation (Sørensen & Triantafillouand, 2009) enabled the actors to commodify water (Bakker, 2003). As EKers and Luftus (2008) observe, these powers transformed market-oriented actors beyond mere residents to more or less "governors" who determined who gets what water at what time, and at what price.

In addition, the functionalities and operationability of water supply beyond the utility were not completely independent of state the utility. For most mechanized boreholes connected to households, oscillations were found not in terms of identity and roles of the actors as in the case of Delhi, India (Truelove, 2020). But in terms of connectivity, these operators switched between electricity grid to off-grid energy systems to facilitate the pumping and distribution of water. The consumption and payments were regulated by the owners through installed meters. This resonates with findings of earlier studies, where ordinary practices and governance arrangements of citizens were entangled and operated within state formalized system of infrastructural arrangements (Ranganathan, 2014; Bénit-Gbaffou & Oldfield, 2011; Rauws, 2016). Overall, residents without water facilities were governed by market-oriented actors in the absence of state regulation. Access to privately networked water was determined by households' ability to negotiate supply, finance the cost of materials and routinely pay for the cost of water supply. As a 45-year-old male resident disclosed:

"… Yes, I contacted the supplier for the water connection when I heard about it, then I was asked to pay 200,000 TZS, ($ 86.96) as the cost of materials and extension, then, they started the excavation and laying of the pipelines to my house. You can see this electric pump (picture below), the water suppliers [market oriented actor, comment by the authors] do not network the water directly into your baths, kitchen and others, they operate partly like state utilities, they usually extend the water closer to your household in the form of a standpipe, then you the consumer have to bear the cost of networking the pipelines to your house, with the help of plumbers, that is if you want the water to flow through your kitchen and baths. For me, I bought a storage-tank, where the supplier pumps the water into, then through the use of an electric pump, I supply the water into my baths, kitchen and the others. Anytime the water finishes from my storage-tank, the supplier pumps the water into it again…" (In-depth interviews Kibululu, 27/09/2020, 09:30).

As revealed, water collection from market-oriented actors was also mediated by the financial powers of the dependent actors. It indirectly requires that clients bear an extra cost for adequate water supply; by purchasing water storage tanks for frequent storage of water as well as materials for connectivity. The study further revealed that networking, partnerships and alliances facilitated water supply among the actors. Some water kiosk actors depended on tanker trucks and mechanized boreholes for water supply (see Figure 6.3).

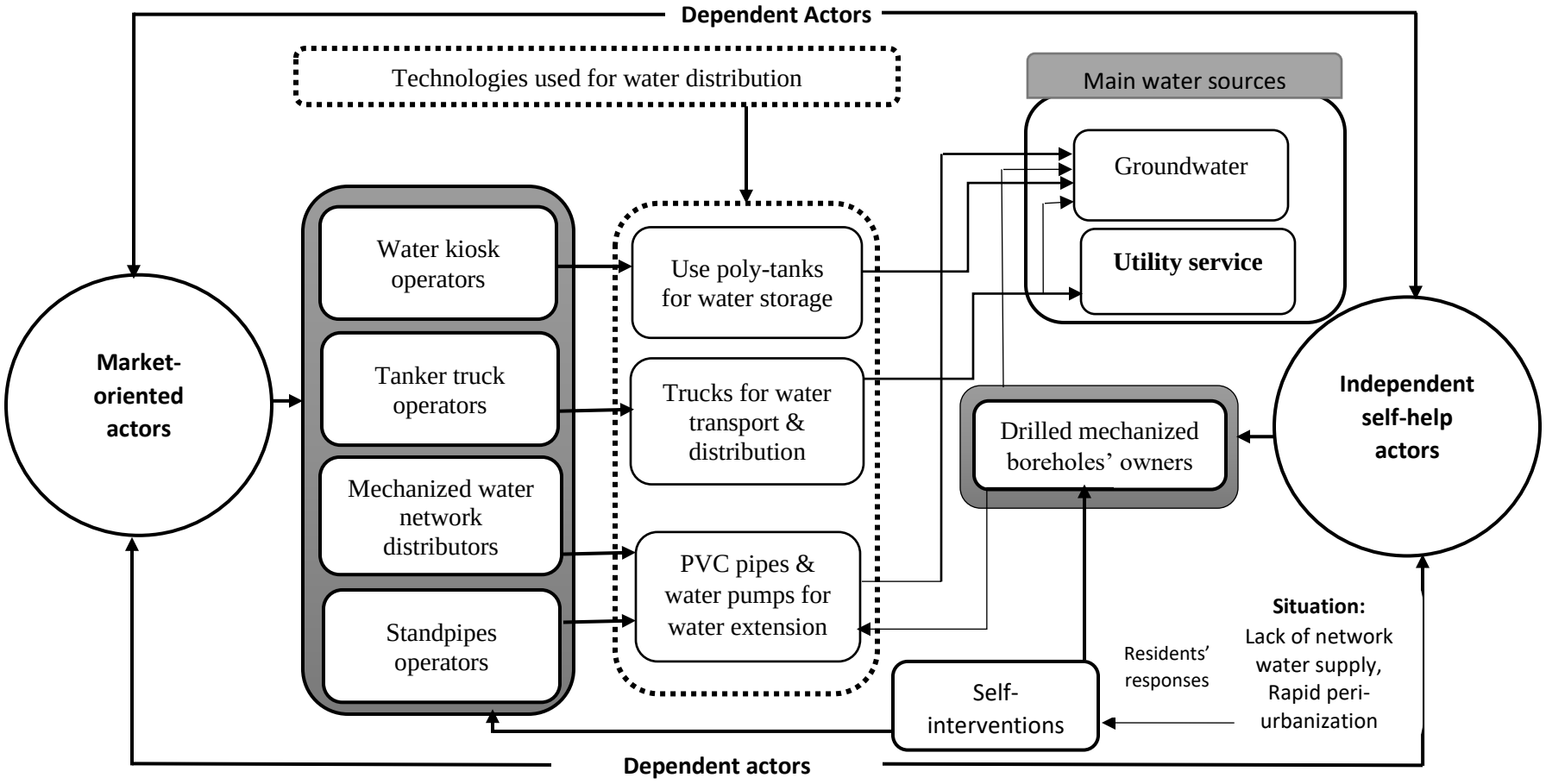

Figure 6.3 Framework on everyday practices and self-governance of non-utility-networked water infrastructure

As a 34-year-old female water kiosk operator revealed; "The water we get to sell is from the tankers, it is not reliable, if water is available supply becomes good and profitable, but when it is unreliable the business becomes difficult and expensive to operate" Protected wells and drilled mechanized water systems relied on groundwater, while other off the utility grid water systems, such as water kiosks, tanker trucks, and private taps, relied on both state utility and groundwater. As revealed earlier, these interdependencies among the market-oriented actors were necessitated by the unequal capacities and powers that stirred water provision.

Figure 6.4 Electric pumps for pumping water into storage tanks

The act of drilling groundwater was partly supported by Section 11 (3) of the *Water Resources Management Act,* 2009, which states that:

... Any person being the legal owner or occupier of any land may construct a shallow hand-dug well and use the water for domestic purposes without a Groundwater Permit issued under this Act, subject to any limitation on the depth of such wells in any area as may be prescribed in Regulations by the Minister (URT, 2009). Moreover, the Act mandates that residents interested in groundwater extraction for commercial purposes obtain a permit. However, market-oriented actors engaged in groundwater extraction without a permit (Sakijege, 2019). Although these formal regulations existed, they were less adhered to by the market-oriented actors engaged in decentralized water provision and operations.

6.5.3 Enabling reliable access to water within non-utility-networked water infrastructure

In the absence of state utility and regulation (Wutich et al., 2020), specific mechanisms mediated water supply and determined the reliability of water self-supply, such as seasonality shifts and one's bargaining power to purchase water from market-oriented actors. Interviews revealed that residents (dependent actors) negotiated their water supply from market-oriented actors via phone calls. While this medium often resulted in reliable access to water in the rainy seasons, it becomes less fruitful in enabling water collection in the dry season. As a resident revealed;

"In the rainy season we don't have problem, but in the dry season, we suffer for water, you have to arrange to purchase water from the sellers, sometimes you call suppliers and they do not come, then it affects your whole day, they will even tell you if you want water tomorrow, call today, before you get clean water from tanker trucks in the dry season, then your order should be there earlier before your name" This explanation demonstrates the complex but diverse arrangements that intercede and enable water collection across seasons. Similarly, our study revealed that in the midst of these complexities and seasons, uneven supply and access reliability is often (re)produced among dependent actors (Rusca and Cleaver, 2022) (See Table 6.4).

Table 6.4 Perceptions on water access reliability by neighbourhoods

Variables		Water access reliability			
		Intermitte nt access	*Reliable access*	*Minimal access*	Total
Location					
Chaurembo	Count	23	38	22	83
	Expected	(19.0)	(41.5)	(22.5)	
Kibululu	Count	28	64	36	128
	Expected	(29.4)	(64.0)	(34.6)	
Kunguru	Count	16	44	21	81
	Expected	(18.6)	(40.5)	(21.9)	
Total	Count	67	146	79	292
	Expected	(67.0)	(146.0)	(79.0)	
Income levels					
High-income	Count	25	30	16	71
	Expected	(16.3)	(35.5)	(19.2)	
Middle-income	Count	17	30	20	67
	Expected	(15.4)	(33.5)	(18.1)	
Low-income	Count	25	86	43	154
	Expected	(35.3)	(77.0)	(41.7)	
Total	Count	67	146	79	292
	Expected	(67.0)	(146.0)	(79.0)	

Source: Authors' compilation

As observed elsewhere, in situations where a statutory regime regulating supply is missing, one's financial powers were instrumental in determining reliable water supply in times of scarcity

Seasonality shifts did not only affect households' water collection times but also the security of water, especially of dependent actors through delays in water collection. These actors adapted to unreliable water supply through the storage of water. Interviews revealed that residents (dependent actors) with financial powers to purchase at less bulk quantity of water were preferred by tankers to other residents without these powers (Cornea et al. 2016). Moreover, for many independent self-help actors, reliable supply was guaranteed across seasons as they exercised absolute ownership and operation of their water systems. Reliable access in this context implies that residents had access to water for 24 hours per day with minimal closures and interruptions of the water systems (Dakyaga, 2018). Further analysis conducted on the reliability of water revealed no relationship between the location of residents and water access in a self-supplied water system.

6.5.4 Distance to water sources of the non-utility-networked water infrastructure

Our study also revealed that distance is not only a global indicator to measure access but also a socio-physical space that facilitates or impedes water provision and access in settings where ordinary practices serve as the major alternatives. Distance to water was redefined and shaped by profit motives, the power to self-provide, and location advantage among the actors (market-oriented actors, dependent and independent self-help actors). For instance, for independent self-help actors with self-owned systems, distance meant the practice and ability to facilitate the pumping of water in the absence or shortage of water in storage tanks or distance to seek alternative water such as bottled water. Therefore, distance was shaped by the availability of water within the premises of residents (households), who self-supplied water via owned water systems (Grönwall & Danert, 2020). Moreover, for many households (dependent actors) served by market-oriented actors, distance meant the physical space through which water was collected.

Table 6.5 Estimated average distances of water sources

Settlements	Estimated average distances (meters)					
		0 - 100 m	>100 - 200 m	>200 - 300 m	>300 – 400 m & above	Total
Chaurembo	Count	60	12	6	5	83
	Expected	56.3	10.8	8.7	7.2	
Kibululu	Count	76	14	19	19	128
	Expected	59.3	16.6	14.8	14.8	
Kunguru	Count	60	12	3	6	81
	Expected	74.3	14.8	5.0	7.4	
Total	Count	198	38	25	31	292
	Expected	67.8	13.0	8.6	10.6	100

Source: Authors' compilation

From the interviews and observations, some peripheral settlements with relatively high-density areas (Kunguru and Chaurembo) were served more by market-oriented actors (water kiosks, private taps and wells) due to their prevalence. In these settlements, about 86% of the residents collected water within a distance of 200 meters away from their dwelling units. The domination of the water systems in these settlements influenced their accessibility and was informed by the desires of the market-oriented actors to provide water and earn income. However, about 79% (231) of the households had access to water within a distance of 200 meters. Only 21% (61) of the households were found to access water from water sources located above 200 meters away.

Distance invariably differed among socio-economic groups (high-income, middle and low-income). The findings revealed spatially segregated supply, where most high-income residents (74%) had access to water in less than 10 meters from self-owned water systems, compared with 46% of the low-income (dependent actors) who accessed water from less than 10 meters due to the proximity of their dwellings to market-oriented water systems. These variations in terms of distance were influenced by the location advantage of dependent actors in the absence of the utility and the power of the market-oriented actors to self-finance. Our findings also revealed that while tanker trucks could serve about 48% of residents, locations and neighbourhoods' characteristics, such as steeply sloped areas and congestion due to informal development, in turn, limited the ability of tankers to navigate and to supply water (Smiley, 2020). These barriers produced uneven distance and access among residents and households. Moreover, when taking into consideration the 400 meters distance (United Republic of Tanzania indicator of water accessible water), about 91% (266) of the households had access to water.

6.5.5 Procedures and time spent on water collection from non-utility-networked water infrastructure

Time is both an indicator of spatial access to water and reveals the processes and practices associated with how and when water is collected by the unserved residents. As Sarkar (2020, p. 8) observes, in the absence of the state utility, substantial time is committed to water collection in practice, such as "commuting to the source, queuing, filling containers, and commuting back to dwellings". Except for independent self-help actors with self-connected water, footing and cash and carry (80%) were the means through which water was collected by the dependent actors. As the interviews revealed, time and the processes involved in water collection were more static in rainy seasons, but more dynamic in the dry seasons. While it was possible to negotiate and obtain water immediately in the rainy season, it became more complex in the dry season. As a resident disclosed, "…in the dry season, they will tell if you want water tomorrow call today…" This dynamic was shaped by the seasons, water scarcity and the actors involved, which in turn promoted the politics of everyday anticipation to collect water (Truelove, 2020, p. 6). However, it also created an opportunity for social ties, belongingness, neighbourliness and family relations to mediate water collection by residents (Cornea et al., 2016). Moreover, the operational hours of market-oriented actors were determined and regulated by their discretions, availability and readiness to sell; while that of independent self-help actors were self-defined. For most water kiosks, a signpost was found pasted on the storage tanks indicating a 10-hourly duration for daily water collection. From the surveys, 39% of households disclosed that water collection periods were limited to 10 hours per day

in the case of tanker trucks. The exception was found with mechanized boreholes, where supply and collection duration were limited to 24 hours. While mechanized boreholes and tanker trucks had a higher possibility of enabling timely supply and access to water, the middle and high-income residents were continuously served by these water systems due to their ability to pay for the cost of extension and supply. Using the World Health Organization definition of water source accessibility of 30 minutes for a round-trip, about 58% (169) of the households surveyed spent about 30-minute per round trip to water access.

Table 6.6 Time spent on the water access chain

Water access chain	*Time spent in the water access chain*								
	N	*< 5 minutes (%)*	*About 10 minutes (%)*	*About 15 minutes (%)*	*20 minutes & above (%)*	*Mean Time (Minutes)*	*Std. Dev.*	*Mini. Time*	*Maxi. Time*
Going to water source	292	57.9 (169)	6.2 (18)	17.9 (52)	18.0 (53)	2.08	1.44	1	10
Fetching the water	292	47.6 (139)	11.4 (33)	13.0 (38)	28.0 (82)	2.42	1.60	1	10
Transporting water	292	39.7 (116)	11.7 (39)	19.9 (58)	28.7 (84)	2.47	1.41	1	10

Source: Authors' compilation

Most households (52%) spent 6 minutes, and 47 seconds in the entire water access chain, while 48% (140) of the households spent less than 5 minutes; this encompassed the trip to the water source, time spent fetching water at the source, and the time spent transporting water to their dwelling units. Comparatively, residents spent lesser time walking to water sources (2 minutes, 8 seconds) than collecting and transporting water to their dwellings (2 minutes, 47 seconds). Most of the households either collected water closer to their dwelling units from the mechanized household water systems or water kiosks. About 63% (184) of the households revealed that time spent in daily water access chain did not affect other equally important household activities.

6.5.6 Water affordability of the non-utility-networked water infrastructure

From the surveys, about 87% of households collected water from market-oriented water actors (tanker owners, kiosk operators, standpipes, and mechanized borehole water systems). As Perreault (2014) reports, social relations and power, which (un)shape water flow, quality, and quantity, in turn, intercept governance towards equity. In reference to the findings, the practices produced provider-client relationships and informal interactional relations between market-oriented actors (middle and high-income residents) and dependent actors (low-income residents) through which water was secured (Roy, 2005). In these interactional relations, the former determined prices and

sold water to the latter. This inter-depending relationship promoted disparities by creating a vacuum of inter-exploitation, where middle- and high-income residents (market-oriented actors) generated extra income through the sale of water to low-income residents (dependent actors).

In-depth interviews revealed that the prices per unit of water were determined by market-oriented actors. The price per 20 liters of water ranged from 100 TZS ($ 0.043) to 500 TZS ($ 0.22). Relatively, water from the utility was the cheapest. A 20-liter bottle of water was sold for 100 TZS ($ 0.043). Residents coped with the high and uneven prices by oscillating between water suppliers. As a resident disclosed, "on average, I pay 25,000 TZS ($10.87) as the monthly water bill to the supplier, and he comes to my house for the money monthly. This amount is expensive because, those connected to the utility in other areas pay an average of 7,500 TZS ($3.26) as monthly bills, but we do not have any choice as the utility service has not reached us (Kibululu, September 27, 2020). Not only were prices higher, but they also varied per liter of water based on the source, the perceived quality of the water (Smiley, 2020), the season, and the distance at which water was sourced for both sale and household usage. Tankers registered with the utility had the lowest costs. The 20 liters of groundwater (with salty content) from tankers were sold at 100 TZS ($ 0.043), while water sourced from the utility by tankers was sold at 130 TZS ($ 0.056). Water kiosk actors sold 20 liters of groundwater (with salt content) at 200 TZS ($ 0.086), water harvested from the rain at 300 TZS ($0.13), and water sourced from the utility network at 400 TZS ($0.17). Water collection was mediated by the cost of the water and the financial ability of residents to purchase water for domestic use.

Besides, interactional relations and operational mechanisms produced and differentiated water supply and access, which favoured residents with purchasing powers. Especially tanker trucks registered with the utility were more willing to supply water to residents who could afford to pay for at least half or full trucks of water (Dakyaga et al., 2018). This differential treatment in terms of water supply favoured the high-income residents who could afford it. In view of socioeconomic inequality, self-governance of water supply may deepen water access woes, perpetuate further inequalities in water service access, or produce social stratification (Truelove, 2020). Interviews also revealed that seasonality shifts heighten the scarcity of water and hamper access, particularly by increasing the bargaining power for water access. The water expenditure of households without water systems or technologies varied by the season: the dry and rainy seasons. Most households spent 7000 TZS, or $3.01 per week, in the rainy season and 8000 TZS, or $3.45 per week, in the dry season due to high demand and scarcity of water. Households harvest rainwater in the rainy season and store it in tanks to reduce the cost of purchasing water and for water security. Considering the affordability index of 5% vis-à-vis spending, the findings revealed that 66% (192) of the households in the peripheral communities spent more than 5% of their monthly household disposal income on water. Comparatively, only 11% of households in the relatively high-income category spent more than 5% of their disposable income on water. About 44% of middle-income households spent 16%–19% of their disposable income on water. while all the low-income residents spent almost all their disposable income on purchasing water (Rusca and Cleaver, 2022). Few households, 29.1% (85), disclosed that the cost of accessing improved water affected monetary commitments on clothes and

transport. Although most of the interviewees preferred the self-drilled and mechanized water network in the absence of the utility service, not all could afford this.

6.5.7 The quality of water of the non-utility-networked water infrastructure

Although improved water remains the normative indicator of water access and domestic water use globally, the quality of self-supplied groundwater was problematic (Wutich et al., 2020). Key water quality issues revealed were the taste of the water (high salinity content) and turbidity (particles), especially in self-drilled and mechanized boreholes, and standpipes. As a 56-year-old owner of water infrastructure disclosed; "… this is my water system, I drilled it 15 years ago, but the problem is the taste of the water, the salt…" The interview with the MWE revealed that while market-oriented actors ordinarily financed the production of water, they were often less capable of regulating and sustaining drinking water quality within the recommended standards, e.g., the conductivity level of the water within 0.5 to 3 µS/cm, and sodium of 30 mg/L for drinking water. The MWE disclosed that the prime motive of market-oriented water actors was to obtain income through the sale of water, which sometimes leads to lax quality assurance. This suggests that drinking water, for the reason of quality requirements, is distinctive and more complex to govern as compared to other resources, such as energy, where great successes of self-governance have been observed (e.g., Mattijssen et al., 2018a).

The interviews revealed that residents (providers and consumers) undertook diverse practices to tentatively attain acceptable water quality for household use. Such practices included on-site chlorination of water after drilling in the case of groundwater (water kiosks, mechanized boreholes, protected wells) and washing of storage containers in the case of water resellers (carts, tankers, kiosks, private taps). For most dependent actors (residents without self-owned water systems), the complementary process of boiling and filtering water bought from market-oriented actors (almost 88% of households disclosed this practice) enabled the attainment of acceptable water quality and served as the routine for quality water assurance (Rusca and Cleaver, 2022). However, these practices did not always produce satisfactory quality water and required further alternatives (Allen et al., 2016). Although bottled water served as an alternative for drinking purposes, the low financial power of low-income residents preserved their reliance on groundwater and resellers. Occasionally, dependent actors purchased a smaller quantity of water from tankers registered with the utility, mainly for drinking.

For most independent self-help actors (residents who owned water infrastructure), water quality was enabled through the purchase of bottled water and water from tankers for drinking, while utilizing water from mechanized water systems for household sanitary needs. The limitations of self-supplied water compelled residents to oscillate between tankers that distributed the utility's water, independent self-help provision, and market-oriented actors for water. However, oscillations across multiple water suppliers symbolized socio-economic power that produced and sustained access advantages for financially powerful residents, but disadvantaged dependent actors (Ekers and Loftus, 2008). This is because oscillation requires negotiations for water collection, the financial power to purchase containers and technologies to sustain water collection and storage of different

waters (Sultana, 2013). As Sakijege (2019) reported earlier, in these study communities, self-supply of groundwater represented a risk. About 48.7% (142) of the surveyed households had suffered from typhoid and 21.3% (62) from diarrhea. Following the health records of the ward clinic, the Ward Health Officer disclosed that children were the most affected by cholera, typhoid, and diarrhea. In this context, citizen self-initiative and practices in relation to water supply are complex systems that hold both potential and weaknesses (McGranahan et al., 2016). Although interviews with municipal officials disclosed that self-supply of water required certification from the Municipality and the utility, the study found that the establishment of off-grid water infrastructure for water supply was based on households' financial capacity. As a resident revealed, "…. even I can buy my water and start selling….". While state actors were aware of these ordinary but informal practices, their failure to regulate their operations demonstrates their silence. Water quality surveillance in the municipality was conducted upon suspicion of an outbreak of waterborne diseases in the neighbourhood and not on a regular basis.

6.6 Conclusions and planning policy implications

The study explored the potential and limits of everyday practices and self-governance of water infrastructures that supply water beyond the utility and how they shape water access in peripheral communities. This study contributes to the theoretical debate on everyday practices and self-governance by providing a very nuanced picture of what such arrangements achieve and where their limits are in terms of providing access to a vital resource, water. Generally, the findings indicated that off the utility grid water infrastructures were ordinarily governed by market-oriented actors, independent self-actors and dependent actors in the absence of the utility network. The ordinary practice of providing and operating water systems such as mechanized boreholes, standpipes, protected wells and water kiosks represented a reactive measure that enabled residents to secure water. Self-supply and collection of water evolved both as "desire" and "need" of the residents to simplify the water access situation, earn extra income and fulfil the basic water demands in the absence of state utility.

Indeed, everyday practices also reflected more or less survival and tactical urbanism (Webb, 2017; Rusca and Cleaver, 2022). Moreover, without state regulation, these practices and governance arrangements may produce situations that favour actors who have the means to generate a surplus by investing in technologies and infrastructures that enable them to exploit water resources and determine the norms and rules of local water access. The practices were embodied by informal relations, the silence of state actors, and financial powers to provide and regulate access by the non-state governing actors (independent self-help and market-oriented actors). This (re)produced geographies of access advantage in their favour and access disadvantage to the actors being governed in the absence of state utility. The sovereignty to self-finance the provision and operation of water systems fostered propertization of water systems via absolute control and regulations to upright exclusion of others from water collection.

One could argue that in light of the failure of the state utility, these arrangements may provide an entry point for collaborative extension of water networks (Orum & Lukas, 2019). Our study has

shown that self-governing actors have some technical know-how and deep knowledge of local water situations. Perhaps, this expertise can be built upon through formal co-production arrangements with formal water institutions to improve water quality, regulate costs, and avoid service segregation and social stratification in peripheral communities. While we agree with other studies about the potential of ordinary practices and self-governance arrangements (see Meehan et al., 2020), we are mindful that these arrangements may widen social stratification due to the profit-seeking motives of market-oriented actors (high and middle-income residents) at the expense of poorer residents. This is due to the uneven power relations, the propertisation and commodification of water systems and the silence of the state to regulate water provision and supply. Overall, this study contributes to evolving debates on urban water infrastructure in the sphere of self-governance and everyday practices, by revealing that ordinary practices are often shaped by the desires and needs of the governing actors in a location specific context usually to simplify a given situation, and as well as enables the involved actors to earn extra income and to fulfil the basic water needs. However, ordinary practices are often characterised by informal relations, and financial powers to supply water and to restrict use. These (re)produced geographies of access advantage in favour of the suppliers and access disadvantages to residents who depended on off the utility grid water infrastructures in the absence of state utility. We conclude that although ordinary ways of supplying and regulating water systems hold some potential for fulfilling the water access gaps, the uneven power relations, propertisation and commodification of water infrastructures limit their usefulness. Our study recommends future studies pay attention to the mechanisms that determine and govern water prices in decentralized water systems.

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CHAPTER SEVEN

CONCLUSION AND DISCUSSION

7.0 Introduction

In line with recent scholarly provocations on thinking beyond the utility network (Domènech, 2011; Furlong & Kooy, 2017), heterogeneous non-utility-networked water infrastructures such as boreholes, shallow wells, tanker trucks carrying water for distribution, pushcarts, and protected deep and shallow aquifers (tubes), amongst others are believed to be the future of urban water supply in the global South (Dakyaga et al., 2018; Lawhon et al., 2018; Truelove, 2019; Adéníran, 2022; Smiley, 2020). Although these water infrastructures do not reflect the universal and modernist infrastructure ideal of water supply, their flexibility, socio-cultural and ecological adaptability, to changing water supply conditions provide optimisms, for limiting the complexities of water access heightened by rapid urbanization and climate change (Sapkota et al., 2015; Leigh & Lee, 2019; Keough & Saidou, 2021; Ramakrishnan et al., 2021; Dakyaga, 2022). However, urban scholars have highlighted the utility of governance in urban water supply for fostering water supply and access via the institutions of rules and regulations, their enforcement, coordination, and monitoring (Reymond et al., 2020; Hegga et al., 2020; Millington & Scheba, 2021). For some scholars, governance is central to promoting equitable water supply, justice, and human welfare in terms of water access (Perreault, 2014; Millington & Scheba, 2021). But while debate on thinking beyond the utility network is evolving steadily, especially concerning non-utility-networked water infrastructure (Furlong & Kooy, 2017; Lawhon et al., 2018), the governance of this water infrastructure remains understudied and less understood in urban studies. In light of this, this dissertation contributes to the aforementioned debate by examining the extent to which heterogeneous non-utility-networked water supply is governed, the practices mediating such water infrastructure provision, and how governance can improve water access beyond the utility network. Evolving debates on thinking beyond the utility network provide a pivotal scholarly foundation for further reflections on the character of non-utility-networked water infrastructures (Furlong & Kooy, 2017; Grönwall & Oduro-Kwarteng, 2018). Invariably, it offers impetus to unearth in depth the ways in which these water infrastructures are configured or developed and work to service (un)served residents in cities in the global South. It argues that a nuance understanding of the practices embedded in non-utility-networked water supply arrangements, the modalities, the spatialities, and the mechanisms that mediate water collection is crucial in efforts towards improving water supply beyond the utility network.

In the context of Dar es Salaam, I build on the works of Kjellen (2007) and Bourque (2010), who both highlight the actors' constellations, as well as the public-private arrangements, individual-collective, and local-global circuits that shape water flow in Dar es Salaam. In building upon the aforementioned studies, I distinctly provide an explicit understanding of the governance of non-utility-networked water infrastructures, first by proposing a comprehensive framework for analyzing the governance arrangements of heterogeneous, non-utility-networked water infrastructures (see Chapter 3). This framework provides an entry point for the examination of

heterogeneous water infrastructures beyond the utility network. The framework encapsulates the infrastructure categorizations of non-utility-networked water infrastructures outside the utility, the modes of governance, actors and modes of interactions, and the powers and regulatory mechanisms. Additionally, the dissertation highlights the ways in which non-utility-networked water infrastructures are developed and sustained (*see Chapter 4*), the pricing practices and governance (*see Chapter* 5), and the potentials and limits of self-governance and everyday practices in shaping water access beyond the utility network (*Chapter 6*). Through the case of Dar es Salaam, a rapidly urbanizing city in Tanzania, I offer clarity in terms of the ways in which the production and distribution of water infrastructures are governed beyond the utility network to supply water. In so doing, I scrutinize the practices embodied in the varied non-utility-networked water infrastructure, the governance modalities, the mechanisms through which prices are determined to mediate water collection. The overarching goal and objectives of the dissertation have been addressed through the following questions:

1. What framework can foster a comprehensive understanding and analysis of the governance arrangements of heterogeneous water infrastructures that produce and supply water beyond the utility network?

2. How do everyday practices of non-state actors mediate the development water infrastructures beyond the utility network? What mechanisms determine the sustainability of such infrastructures for water supply beyond the utility network?

3. Who are the actors? And what mechanisms determine pricing of water of the heterogeneous infrastructures beyond the utility network? And how are such prices regulated?

4. What are the potentials and limits of the ordinary practice of self-governing water infrastructures beyond the utility network in terms of improving access to water?

In order to realize these, the study draws on an inductive approach alongside a case study research strategy. These enabled the collection of field data from multiple participants and with multiple methods. I situated governance as a "practice of governing" grounded on practice theory (see Rouse, 2006). Additionally, the chapters situate the major findings of dissertation in theory, making reflections on the theoretical debates presented in *Chapter 1,* such as "thinking beyond the network." The next section presents a synthesis of the major findings of the study.

7.1 Synthesis of findings

This section presents a brief summary of the key findings that emerged from each of the research questions addressed in the dissertation. Specifically, the findings are drawn from *Chapters 3–6* of the dissertation as follows:

RQ 1. *What framework can foster a comprehensive understanding and analysis of the governance arrangements of heterogeneous non-utility-networked water infrastructures that produce and supply water beyond the utility network?*

Owing to the varied nature of non-utility-networked water infrastructures in Dar es Salaam, the proposed framework of; "Governance Modalities, Actors, and Interactions Within Heterogenous Infrastructure" was instrumental for analysing the governance of water infrastructures that produce and distribute water beyond the utility network. The framework offered categorization of infrastructures, actors and modes of interactions, power and regulatory mechanisms, and modes of governance.

By situating the framework in an empirical case (*see Chapter 3*), the findings revealed four broad and interconnected sets of non-utility-networked water supply infrastructure in Dar es Salaam. These comprised Community-Owned Water infrastructures (CWI), hydro-mobile infrastructures, independent household self-supply, and privately networked water infrastructure. These infrastructures differ in terms of ownership, sources of water, and distribution methods. The development of Community-Owned Water infrastructure was financed by religious bodies, development agencies, and NGOs. These consisted of boreholes with hand pumps or mechanized boreholes. Independent household self-supply includes rainwater harvesting facilities and mechanized boreholes, primarily used by individual households. Privately networked water infrastructures provided running water via pipe networks connectivity to residents who could afford the estimated cost of connection. These varied water supply infrastructures evolved to serve the diverse water needs of residents in Dar es Salaam, by supplying water to residents beyond the utility network.

The varied categorizes of non-utility-networked water infrastructures (for example, community-owned/shared infrastructure, hydro-mobile infrastructures, private-networked infrastructures, and self-supply water infrastructures) were governed by diverse modalities. Specifically, water production and distribution of Community-owned or shared infrastructure, such as mosque water, community-based water, and shared water networks, were co-produced and self-governed, with limited market-orientations, co-governance, co-management, and networked governance. With the exception of some unregistered tanker truck drivers with self-extracted groundwater sources, other hydro-mobile infrastructures, such as utility-registered tanker trucks, pushcarts, and utility kiosks, played the sole role as water distributors. The tanker trucks water distribution was facilitated through formal co-production, market-oriented governance and co-governance arrangements. Co-governance arrangements existed between registered tanker drivers and the utility. While informal co-production and market-oriented governance arrangements facilitated water distributed by hydro-mobile water infrastructures such as pushcarts and unregistered tanker trucks. These actors acted as private investors who exerted a high level of influence on the water distribution in the city. Also, private networked water infrastructures such as private taps and bore-wells with connectivity to residents and neighborhoods produced and distributed water beyond the utility network. Water production and distribution of these infrastructures were driven by market-oriented governance, self-governance as well as formal and informal co-production. Although the operators engaged in

the sale of water, some private networked water providers regarded their acts as not for profit, but as a kind gesture to their neighbourhoods in response to utility absence and failure. This was also the case of self-supply water infrastructures providers such as households that mechanized bore-wells for self-use.

Moreover, water was produced and distributed beyond the utility network. Rather than by varied actors and interactions. These range from co-producers-distributors, for example, the practices of mosque water vendors, self-supply households, community-based water vendors, private taps, and private kiosks' water operators. These actors interacted among themselves and with the utility to produce and distribute water beyond the utility network. In so doing, they acted as civic cooperators, voluntary participants, partners, collaborators and interdepending actors in the water supply chain. Co-distributors of water, such as resellers of the utility's water, pushcart operators, utility kiosk operators, and tanker truck drivers registered with the utility, interacted and distributed water by acting as civic cooperators, voluntary participants in the water supply chain, partners, and collaborators. Water production and distribution beyond the utility network were facilitated by co-financers and technicians, such as NGOs, development agencies, Faith-Based Organizations (FBOs), plumbers, hydrologists, and water pump technicians. The interactions and the (in)direct regulatory roles of utilities, the Basin Water board (BWB), the Ministry of Water (MoW), Municipal water engineers, and ward leaders *(Mtaa*) shaped non-utility-networked water production and distribution beyond the utility network. Consumers, such as residents, served as clients to the co-producers and distributors of water.

Comparatively, EWURA, DAWASA (Utility), the Ministry of Water, *Mtaa* leaders, the Ministry of Health, and the Ministry of Water were the major state actors with regulatory power in the provision of non-utility-networked water infrastructures. Above all, the EWURA exercised its legal mandate as the regulator of utilities, acting as a mediator between utilities such as DAWASA, Tanzania Electricity Supply Company (TANESCO) and their consumers. In the context of water supply, DAWASA exercised regulatory power over non-utility-networked water providers in its service areas. However, historical records of uneven network water distribution place the utility in a vulnerable position to uprightly exclude non-utility-networked water providers in its service area. Water supply via the non-utility-networked water infrastructures is not criminalized but is nevertheless regarded as temporal infrastructure solutions by the utility. Although formal regulatory mechanisms existed, including formal registration and obtaining licenses, water providers such as pushcarts, tricycle operators, private taps, utility kiosk water resellers, and private tanker trucks lack formal registration and licenses.

In conclusion, varied forms of governance modalities, including co-production, self-governance, market-oriented governance, co-governance, and networked governance, shaped the ways in which water is produced and distributed beyond the utility network in Dar es Salaam. In addition, informal co-production, market-oriented governance and self-governance arrangements were the predominant modalities that facilitated the production and distribution of water via non-utility-networked water infrastructure. These modalities embody a range of actors, powers, conflicting

responsibilities, and both formal and informal regulatory mechanisms. The diversity of governance modalities shaped the interactions and powers of the different actors. These led to the creation of diverse arrangements for water distribution across different non-utility-networked water infrastructure categories (see *Chapter 3*).

RQ 2: *How do everyday practices of non-state actors mediate the development of water infrastructures beyond the utility? What mechanisms determine the sustainability of such infrastructures for water supply beyond the utility network?*

Chapter 4: Highlights the specificity of practices engaged by the varied actors towards the development and sustainability of non-utility-networked water infrastructure beyond the utility network. The chapter highlights the kind of resources, the discourses, and the rules and mechanisms devised by the actors to sustain water infrastructure beyond the utility network. Non-utility-networked water service providers encompass various groups (mechanized boreholes, water kiosks, protected wells, standpipes, pushcart water service providers) and individuals (tanker truck operators). Two main purposes drive the engagement of these actors. Firstly, to reduce the burden of searching for water for domestic use, especially in the dry season, and secondly to earn income through the sales of water within the neighborhoods. These practices evolved due to water scarcity and the location of residents beyond the utility network. In this context, the actors viewed water situation in their neighbourhood as problem and an economic activity. In so doing, the actors devised entrepreneurial tactics to partially alleviate the problem, by financing the construction of water supply infrastructure and managing its operations to ensure everyday water collection.

The actors developed low-cost water servicing models and infrastructure, such as drilling and mechanizing water systems, to address water scarcity issues. Other activities included installing equipment and storage tanks, extending PVC pipelines to interested neighbours that could afford the cost, and therefore negotiating with plumbers for water network extensions. These activities varied depending on the type of water infrastructure and the water delivery model. These actors mobilized diverse resources, including financial, material, technological, and technical expertise, for water provision. The actors used social networks and human agencies to obtain financial and material resources for the development of non-utility-networked water infrastructure. These include, fund from personal savings, family contributions, or collective groups. For example, mechanized borehole water service providers financed drilling and construction costs while securing materials such as cement, iron rocks, sea sand, water storage tanks, and PVC pipelines. In these water systems, standby generators were used as alternative technology for pumping and distributing water. The actors recovered costs through monthly billings based on client consumption measured using meters. Mechanized borehole water systems were managed by hired labour or family members, with operators being paid through service fees obtained from clients.

The operation and sustainability of mechanized borehole water systems depended on the availability and stability of groundwater and water storage capacities. Actors formed partnerships and networks to redistribute water. In this arrangement, pushcarts and tankers truck drivers acted

as hydro-mobile water infrastructures. Negotiation, cooperation, and partnership among actors were valuable in sustaining the water infrastructure and maximizing the value of their activities. For example, kiosk water operators accessed water from tanker truck operators registered with the state water utility and served as water redistributors. Water kiosk service providers utilized resources such as cement, sea sand, and money for the construction and purchase of storage tanks. These water infrastructures were commonly managed by family members or owners, with the majority of operators being women. Water kiosk operators relying on other water service providers required fewer resources and spent less on infrastructure, purchasing water from tanker truck drivers. Poly-tanks were used for water storage and distribution, with residents fetching water through gravity.

Internal rules regulated the relationships and operations among the actors involved in water supply, including trustworthiness, proper maintenance of water infrastructure, responsiveness, and regular payment for water supply. The rule of "cash and carry" characterized the transactions between water producers and resellers. This was commonly found among all water redistributors and their partners. These rules and mechanisms governing water actors and their clients were undocumented but shaped the daily interactions of the actors. They were flexible and subject to transformation based on circumstance. The actors consciously and unconsciously adhered to these rules and mechanisms in their everyday practices of providing and collecting water.

In conclusion, the findings highlight the importance of diverse resources, actors in water governance, the influence of financial capabilities, and the role of citizen self-governance on non-utility-networked water infrastructure provision. It also demonstrates the entrepreneurial strategies employed by residents to address water access challenges in the studied settlements. Overall, it highlights the importance of informal rules and negotiations in governing water supply, where formal regulations in urban spaces where water is supplied beyond the utility network.

RQ 3: *How is the pricing of water provided beyond the utility network governed?*

Chapter 5: highlights the varied actors involved and the infrastructures in which water is supplied to residents beyond the utility network, and the ways in which payments were made. Residents organized water from various water systems through diverse piecemeal arrangements and practices. These practices involved self-searching for water providers, contacting neighbors, and receiving referrals from relatives. Payment modalities varied among different water intermediaries. "Pay as you collect" was common for standalone kiosks and standpipes, while hydro-mobile infrastructures and privately mechanized in-house networks used "pay as was delivered" or weekly/monthly payment systems. The price per cubic meter of water varied among resellers and intermediaries, such as pushcarts, tankers, water kiosks, and distributors, and also across neighborhoods. Prices were influenced by factors such as location and water sources. Water from utility water resellers was priced higher and much desired for by residents compared with groundwater sources. Varied prices were found within neighborhoods due to non-collective ways

of determining prices. The motives and perceptions of water providers, especially as a service to community or a business influenced pricing practice.

Also, prices were shaped by factors specific to different water infrastructures and driven by state and non-state actors. State actors included regulatory authorities such as EWURA, DAWASA, and TANESCO, while non-state actors comprised consumers, caretakers, owners of water systems, distributors and religious organizations. The utility, DAWASA, collaborated with private tanker truck drivers to establish price ranges per cubic meter of water based on factors such as distance traveled and operational costs. The prices ranged from 10,000 TZS/$4.33 to 15,000 TZS/$6.49 per cubic meter, depending on the mentioned factors. The utility introduced hydro-mobile water infrastructures (tanker trucks) that collected water from the utility for onward distribution to areas beyond the utility network. This served as a benchmark for negotiating prices between consumers and tanker water distributors. For example, the price of tanker water was influenced by distance, fuel costs, and vehicle maintenance, while the price of water from pushcarts was influenced by the distance of water sourced and profit margins. Ownership of the means of water distribution (trucks or carts) affected pricing, with caretakers being obliged to meet daily monetary targets set by tanker truck owners. Prices for privately mechanized in-house water networks and communal shared water systems were determined based on recurring costs like electricity, material technologies, repairs, maintenance, and paying employees. Utility actions, such as changes in electricity tariffs, influenced the price per cubic meter of non-utility-networked water infrastructures.

Prices of water supplied beyond the utility network were less regulated. Providers had the power to influence prices to meet their targets and maximize profits. Competition among water providers played a role in determining prices, particularly for pushcarts and tanker truck water delivery. New operators lowered prices to attract customers and establish their business. Prices per cubic meter of water were determined through negotiation and bargaining, guided by factors such as the source of water (utility or groundwater), mode of delivery (direct or indirect), social relations between providers and consumers, purchasing power of consumers, and the principle of demand and supply. Common social knowledge especially of the price of the utility water guided the bargaining processes for water supply. However, prices were relatively stable over the years but varied among providers.

In conclusion, the findings highlight the complex and diverse factors influencing the pricing of water in different contexts, including the source of water, mode of delivery, social relationships, competition, ownership, and operational costs. It also highlights the diverse sources of water and the varied pricing and payment systems associated with different water intermediaries. It also emphasizes the need for addressing equity in water supply and the role of social knowledge in negotiating water prices. In addition, it demonstrates the importance of trust, rapport, and personal relationships in ensuring access to clean water beyond the utility network. Residents relied on referrals and recommendations from trusted sources to find reliable water providers. These practices were more prevalent for tanker water and pushcart operators, while standalone kiosks operated differently due to their neighborhood-based operations.

RQ 4: *What are the potentials and limits of the ordinary practice of self-governing water infrastructures beyond the utility network in terms of improving access to water?*

On the continuum of provider-consumer, the actors engaged in water supply beyond the utility network can be categorized into independent self-help, market-oriented actors, and dependent actors. The roles of market-oriented actors (residents who owned water supply systems for both sale and consumption) and independent self-help actors (residents who owned water supply systems mainly for domestic use) influenced the production and distribution of water beyond the utility network. The practice of these actors in aspects of producing and distributing water beyond the utility, enabled dependent actors—residents without utility network connections and owned-water sources—to collect water for domestic use. A significant majority of households had access to water within the 400-meter threshold, indicating relatively good spatial accessibility to water in the absence of the utility. The majority of households (79%, or 231 households) had access to water within a distance of 200 meters. Only a small portion (21%, or 61 households) collected water from sources located more than 200 meters away. When considering the 400-meter distance indicator set by the United Republic of Tanzania for accessible water, about 91% (266) of households in the study had access to water. The prevalence of water systems provided by market-oriented actors influenced their accessibility, driven by the actors' desire to provide water and earn income.

In the absence of a state utility, independent self-help water infrastructure tends to provide a consistent water supply. It also suggests that for dependents of non-utility-networked water infrastructure, significant time was devoted to activities such as commuting to the water source, waiting in queues, filling containers, and returning to dwellings. The majority of residents (80%) relied on "footing and cash and carry" methods to collect water. The dynamics of water collection varied between rainy and dry seasons. In the rainy season, residents could negotiate and obtain water immediately, while in the dry season, the process became more complex, often requiring advance notice. These dynamics were influenced by factors such as seasons, water scarcity, and the actors involved. Everyday politics such as power relations, rule setting, and procedural arrangements emerge from the complex daily dynamics through which water was collected. Social ties such as belongingness, neighborliness, and family relations played an important role in mediating water collection by residents beyond the utility network, especially residents without self-supply water infrastructure. These relationships provided opportunities for support and cooperation among community members. Social relations and power dynamics played a significant role in shaping water flow, quality, and quantity, affecting governance and equity.

Chapter 6 shows that distance is not only a physical measure but also influenced by the prevalence of water infrastructure, and the dynamics of water provision. The study highlights the importance of considering the role of distance and its redefinition in understanding water access in communities where ordinary practices shape the water supply. Distance to water varied significantly among different socio-economic groups, including high-income, middle-income, and low-income residents. In areas of the settlements with relatively high population density, market-oriented actors such as water kiosks and private taps dominated the water supply, leading to an

increased in proximity to water supply systems. In comparison, 46% of low-income residents (dependent actors) collected water from a distance of less than 10 meters due to the proximity of their dwellings to market-oriented water infrastructures. The study revealed spatial segregation in water supply, where a majority of high-income residents (74%) had access to water within a distance of less than 10 meters due to ownership of mechanized boreholes, that provided in-house water supply. Though tanker trucks could serve approximately 48% of households, key barriers such as steeply sloped areas and congestion due to informal development limited the ability of tankers to navigate and supply water effectively. These barriers contributed to uneven distances and access to water among residents and households. The challenge faced by tanker truck drivers in reaching areas unserved by the utility networked leads to the continued (re)production of (un)even water distribution.

While ordinary practices enabled some level of water collection, access to privately networked water was determined by households' ability to negotiate supply, finance the costs, and pay for water supply. Residents without water self-supply water infrastructure relied on market-oriented actors for water services. Financial power indirectly influenced the availability and cost of water supply. For example, it is an advantage for dependent actors to be located closer to self-financed water systems in the absence of a utility water supply system or to be located by persons with the financial capacity to self-finance the production and distribution of water. Consequently, High-income residents tended to have shorter distances to water due to ownership of self-supply water infrastructure, while low-income residents relied on market-oriented water systems in close proximity to their dwellings usually for water. This means that individuals with greater financial resources are more likely to have consistent access to water.

Approximately 87% of households collected water from market-oriented water actors, including tanker owners, kiosk operators, standpipes, and mechanized borehole water systems. A significant proportion of households (66%) in peripheral communities spent more than 5% of their monthly disposable income on water, while only 11% of relatively high-income households exceeded this threshold. Although most interviewees preferred self-drilled and mechanized water networks in the absence of utility services, not all households could afford these options. Residents undertook various practices to attain acceptable water quality, such as on-site chlorination of groundwater and washing storage containers. Dependent actors boiled and filtered water purchased from market-oriented actors. Independent self-help actors purchased bottled water and utilized water from tankers for drinking. The consumption of water supply beyond the utility network also poses health risk. A number of households reported to have been affected by waterborne diseases such as typhoid and diarrhea.

In conclusion, ordinary practices and governance arrangement of residents towards water supply had both potential and weaknesses. Social ties and community support can be significant mediator in facilitating water collection for unserved residents beyond the utility network. Seasonality shifts does not influence the price of water, but often shaped the bargaining power of residents for the collection of water supply beyond the utility network. Self-supplied groundwater, was found to have

been characterized by salinity content and turbidity, especially in self-drilled and mechanized boreholes and standpipes.

7.2 Theoretical reflections

7.2.1 Thinking beyond the utility network infrastructure for urban water supply

The practices that characterized non-utility-networked water infrastructures beyond the utility offer dual windows for reflection towards improving water supply. The dissertation contributes to debates on thinking beyond the network, by highlighting the need to "(Re)think governance of non-utility-networked water infrastructures that supply water beyond the utility network". While I acknowledge that "there is more to gain than lose from the already existing multiple" non-utility-networked water infrastructures (Wamuchiru, 2017a), I also acknowledge the limits of the varied non-utility-networked water infrastructure. Harnessing the potentials of the historical roles of non-utility-networked water infrastructures requires "thinking" as well as "re-thinking" about the practices that mediate the production and distribution of water beyond the utility network. Our motivation to "think beyond the utility network" can be deduced from the varied roles and potentials of the non-utility-networked water infrastructures, especially in the context of the global South, where the networked infrastructure has historically been uneven (Furlong & Bakker, 2011; Smiley, 2013). In the absence and failure of the networked, varied non-utility-networked water infrastructure serve as alternative sources in which households with and without the utility connection gain access, often by oscillating between multiple water suppliers for water. It provides a fine-grain remedy, as it enabled different socio-economic groups to adapt to the utility's absence and failures (Dakyaga et al., 2018a; Alba & Bruns, 2021). The oscillation symbolized resilience and the possibility of avoiding the risk of failure (Björkman, 2014; Lawhon et al., 2018).

But in another context, oscillation across the diverse infrastructure does not often occur automatically and evenly, but symbolized socio-economic power, influenced by the financial abilities of residents. In the case of this study, financially abled residents had an advantage and oscillation power across the varied water infrastructures. High- and middle-class residents could rather afford to engage in water provision, having drilled groundwater for self-supply or organizing bulk supplies of fresh water from the utility network via tanker truck suppliers (Uitermark & Tieleman, 2021). Therefore, while I acknowledge the already prevailing inequalities in access to water (Hofmann, 2022), "thinking beyond the utility network," may further deepen inequity and inequalities in access to water through the daily practice of pricing water driven by the discretions and motives of water providers. This can be deduced from the ways in which water is produced and distributed. Water production and distribution are more facilitated by informal co-production, self-governance, and market-orientations with limited state intervention. By this arrangement, high and middle-income residents may continue to build resilience by gaining access to multiple resources, while dependent actors remain salvageable within the complex chains of procedural injustices in the daily water collection chain.

Market-oriented water actors, who financed the production of water, were often less capable of regulating and sustaining drinking water quality within the recommended standards. Their prime motives tend to center around generating income through the sale of water, beyond social good. Market-oriented actors determined prices and sold water to low-income residents, creating disparities and exploitation. Additionally, hydro-mobile infrastructure, such as tanker trucks registered with the utility, were more likely to supply water to residents who could afford to pay for at least half or full trucks of water. This arrangement obviously works to the advantage of high-income residents. Although most interviewees preferred self-drilled and mechanized water networks in the absence of utility services, not all households could afford these options. Residents coped with high and uneven prices by switching between water suppliers, such prices remained higher for low-income residents compared to those connected to the utility, due to the daily practice of paying as they collected water from non-utility-networked water infrastructures. Self-supplied groundwater represented a risk, with a significant number of households suffering from waterborne diseases such as typhoid and diarrhea (Sakijege, 2019; Sultana, 2013).

Water supply via non-utility-networked infrastructures fostered the development of hydro-social relationships (Keough & Saidou, 2021), where neighbourhoods in the fringes shared and gifted water to others beyond the utility networked, but without self-supply water infrastructure for household use (Wutich et al., 2018). Although it constitutes an important element for lessening water access problems among unserved households, gifting and sharing of private mechanized boreholes networked to neighbours is rather exceptional, and not often the character of the several independent self-supply households that drilled groundwater for self-use. While some self-supply households may drill and collect groundwater as a common pool resource (e.g., Grönwall, 2016), the water is usually restricted to a few owners and does not necessarily foster or warrant universal distribution (Truelove, 2019). In rare cases, where affluent households gifted or shared water networked with their neighbourhoods, such arrangements often arise as an opportunity for low-income households with proximity to affluent households willing to share the network. Therefore, gifting and sharing of water maybe suitable for urban spaces denominated by community-owned or shared water infrastructure, such as mosque water, community-based water vending systems, and areas where the culture of neighbour-shared mechanized borehole connectivity prevails. This aligns with the findings of the present study but is not necessarily the case elsewhere, such as in India, where access to water from tube wells remains contested and embodied in power relations and commercialization (Truelove, 2019). In the context of this study, gifting and sharing of water was less common among hydro-mobile infrastructures (unregistered tanker truck water supply, pushcarts or tricycles), private networked infrastructure (mechanized boreholes for commercial motive, private taps), and self-supply water infrastructure (households with bore-wells mainly for self-use). Therefore, thinking beyond the utility, especially towards non-utility-network infrastructure, requires context and geographically specific knowledge of the socio-cultural environment that facilitate or mediate the provision of the different categories of non-utility-networked water infrastructure.

I agree with previous studies (Wamuchiru, 2017) about the multiple hurdles of governing multiple non-utility-networked water infrastructures on a daily basis, as I consider governance as central to

coordinating and fostering collaboration and partnerships of the varied actors that supply water beyond the utility network. It is through governance efforts that the battle for improved water access beyond the utility may be won. However, much is yet required of state actors in bridging the gap between water produced and distributed beyond the utility network towards improving water access. As indicated earlier, the dominant governance models such as informal co-production, market-oriented governance, and self-governance provide opportunities for further reflections of the ways in which water is produced and distributed beyond the utility network. Because while co-governance, network governance, co-management, and formal co-production arrangements are useful for fostering state and non-state actors' engagements in water supply, these governance modalities play less role in the production and distribution of water beyond the utility network in Dar es Salaam.

In conclusion, I acknowledge the manifold roles and potentials of the varied non-utility-networked water infrastructures in terms of producing and distributing water, the allied vulnerabilities, as well as the complexities inherent in such water supply and access (Furlong, 2017, p. 901). In light of this, I argue in favour of "(Re)thinking beyond the utility network" in the global South in the drive towards improving water access. Non-utility-networked water infrastructure provides temporal and complementary services, lessens domestic water woes in the absence and failure of networked infrastructure but may not necessarily address the long-term water supply needs. They can lessen the burden on water supply in historically uneven networked geographies, where formally considered as complementary infrastructure by the state utility. Thinking beyond the mono-centric networked infrastructure requires "(Re)thinking governance" of the varied non-utility-networked water infrastructure that produces and distributes water outside the formal regulations of the state utility and city authorities. The next section provides a reflection on the practice theory, highlighting its utility to the findings of the dissertation and what it implies to efforts towards improving water access beyond the utility network.

7.2.2 Reflection on practice theory – situating governance as a "practice of governing"

The practice theory offers a useful analytical perspective for the practice of governance for improving water access beyond the utility network. Second, it provides useful insight, relevant for urban policy planning in practice. In terms of scholarly relevance, it helps the dissertation to demonstrate the importance of understanding everyday practices, the diversity of actors and institutions involved, and the dynamic interactions shaping water supply in urban areas of Dar es Salaam. This is especially important to the question of governance and how governance can improve water access beyond the utility network, especially via the non-utility-networked water infrastructure in the global South. A reflection on the key premises of the practice theory, such as actors, transmissibility of practices, the transformability of the practices and the creativities enhanced understanding of the everyday acts of residents beyond the utility.

The element of transmissibility of practices postulated in the practice theory, offers a useful insight for theory and urban policy planning practice. It highlights how ordinary practices can, and are transmitted across actors in a given space (Rouse, 2006). These were apparent through the

empirical findings gathered from the acts of non-utility-networked water providers. For example, the practice of determining price, negotiating, distributing water beyond the utility network were found as conventional acts transmitted from generation and from experienced actors such as tanker drivers, pushcarts kiosks operators. Although these have existed for over decades, they remain powerful in determining the production and distribution of water beyond the utility. In urban planning practice, it suggests that formal water governance modalities, practices where instituted and enforced can exist and gain transmission over time. Formally defined tariffs, modes of infrastructures and arrangements guiding tariffs may exist and gain transmission. In terms of planning policy and practice, it suggests that governance is not just a static structure but an active process characterized by formally and informally defined procedures, actors, and modes of interaction. While rules and regulations can be formally defined, they can be transmitted informally (actor-actor learning) to contribute towards the realization of the overall goal.

Practice theory also highlights the need to consider the diversity of actors and institutions involved in water supply beyond the utility network and how they interact to shape policy and decision-making processes and to mediate the flow of water (Rouse 2006). In terms of policy, the diversity of actors, such as how varied individuals and communities engage with, produce, and distribute water on a daily basis, symbolized the diverse potentials, that could be useful for engendering planning policy actions in aspect of water supply. In this context, it denounces generic regard of non-utility-networked water infrastructure as either "useful or not," but rather suggest further understanding of actor-specific practices and nature in relation to water supply. Adequate differentiation between of the practices, actors, and their potentials may provide the possibility of identifying potential actors and practices useful for formal policy planning engagement. For example, empirical observation justified the distinct capacities and potentials of the non-state actors involved in water production and distribution. While community-owned/shared water infrastructure driven by mosque water vendors, community-based water vendors, protected wells, and shared water networked actors could work to compensate utility absence and failure through the prevailing act of sharing and gifting water. The acts of hydro-mobile infrastructure, private networked infrastructure, and self-supply water infrastructure varied in terms of arrangements.

Practice theorists also demonstrate the agency of rules in governance. It emphasizes the specificity of practices and their connection to the material and social aspects of everyday life (Eledi et al., 2023). Practices are invariably guided by rules, norms, conventions, and social meanings somehow understood by the actors. They extend beyond mundane aspects to include highly structured activities across urban spaces (Reckwitz, 2004). The spatialities of practices have been emphasized, such as being either localized, geographically specific, historically rooted, or generic across society (Rouse 2006). Water supply rules play a significant role in governing practices related to water supply beyond the utility network. While adhering to regulations can contribute to improving water access, a lack of regulation and enforcement can also deepen inequality in water access. From the empirical findings, rules and norms concerning water provision and distribution were found to have evolved and remained rooted historically, varied across geographies of the city, and involved actors and infrastructures. Prices of water remain varied across the city and among similar water

providers, such as private networked and hydro-mobile infrastructures. These diversities were shaped by their different localities (Kivule, Magogoni and Goba) and the varied conditions involved in producing and distributing.

In conclusion, practice theory provides a framework for understanding water infrastructure governance as an act of doing. It helps highlights multiples dimensions and nature of practices, the actors, and how transmissibility, transformation of acts as well as the creativities of the actors represent potentials for forging state and non-actors' collaborations towards improving water access. It helps to uncover the procedural arrangements, modalities, and actors involved in the practices of producing and distributing water beyond the utility network. Practice-related studies within this framework highlight the importance of understanding end-user practices and adaptability, especially during periods of disruption. In the context of production and distribution beyond the utility network, practices manifest in multiple and repetitive actions such as producing, fetching, distributing, storing, and saving water for domestic use.

7.3 Recommendations

7.3.1 Policy planning recommendations

Following theoretical reflections and empirical findings, the dissertation recommends the use of a mixed governance model to facilitate the production and distribution of water beyond the utility network. These modalities comprise co-governance, co-management, and co-production (formal). These governance modalities, where employed may contribute towards improving water access beyond the utility. They hold possibility for building formal collaboration between non-state actors and state utility towards improving water supply in geographically varied context. These are relevant as the findings revealed persisting interdependency between the utility and the non-utility-networked water providers. In this context, the utility requires the capacities, experiences of the non-state actors as much as the non-state actors require the support of the state utility and actors.

For example, the adoption of co-governance arrangements such as formal collaboration between tanker truck drivers and the utility towards water distribution may work to increase access to water especially of the utility tanker water distribution in the city. This may not require private tanker truck drivers to be separate entities of the utility but rather recognized as part of the utility workers in co-distributing water to areas extremely beyond the reach of the utility pipe network. Co-management arrangements involving the state utility and the water kiosk actors can enable the provision of standalone water infrastructure at neighbourhood levels. Given that the utility has long engaged in groundwater extraction as a complement to the surface water, the provision of utility-owned standalone kiosks in areas with low or high salinity of water could further increase access to water. These could work via the broader arrangement of formal co-production. These governance modalities are imperative for improving urban water supply especially in the drive towards SGD 6. Chapters 3, 4, 5, and 6 present further explanations of the following arrangements.

7.3.2 Limitations and recommendation for future research

I acknowledge that the findings of the study are limited in terms of understanding causal relationships as well as the impacts of the varied governance modalities in terms of influencing the production and distribution of water beyond the utility network. However, this is expected as the focus was to unravel the hidden practices mediating the production and distribution of water beyond the utility network. For example, while the findings of the dissertation revealed informal co-production, market-oriented governance, and self-governance as the dominant governance modalities facilitating the production and distribution of water beyond the utility network in Dar es Salaam, the level of influence of each of these modalities in the production and distribution is still unknown. This is influenced by the methodological limitations. Therefore, further studies on non-utility-networked water infrastructure governance could focus on a statistical analysis of the roles and impacts of the various governance modalities on non-utility-network water infrastructure production and distribution.

Again, while the study further demonstrates the roles of the varied non-utility-network water producers and distributors towards improving water access, the account or the level of contribution each of the infrastructure categories makes, for example, hydro-mobile infrastructure, community-owned or shared water infrastructure, private networked water infrastructure, and self-supply water infrastructure, is yet less understood. Knowledge about the level of influence of these infrastructure categories could depend on understanding about their likely role in urban water policy, such as which infrastructure category can be promoted as a better complement to the utility.

Lastly, the dissertation focused more on the producers or distributors of water than the consumers. While it offers a vivid understanding of the varied non-utility-networked water infrastructure categories and the specific players, the roles or practices of the consumers in gaining access to water from the varied infrastructure are yet less understood. For example, how do households navigate the varied non-utility-networked infrastructure to secure water? An understanding of the navigation, processes, and practices of varied households could further our understanding of the state of inequality and inequities in the heterogeneous non-utility-networked water infrastructure settings.

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Appendix A

Interview Guide Target respondents:

(A) Questions as entry point

NB: *Self-introduction and the essence of the data collection*

1. What is the various source from which people collect/get water for domestic usage in Dar es Salaam?
   - *Probe for the following; Water kiosks, Tankers/carts, Rainwater harvesting, Wells, boreholes, private taps, private HH connections, utility kiosks amongst others.*
   - *Probe water whether are alternatives such as wastewater recycling, stormwater*

2. Can you please describe how water is supplied through the above-mentioned water systems in Dar es Salaam?
   - *Probe for how water for domestic use is supplied through the Water kiosks, Tankers/carts, Rainwater harvesting, Wells, boreholes, private taps, private HH connections, utility kiosks amongst others in Dar es Salaam.*
   - *Probe for how water is produced/sourced by the various operators (technologies use by the various operators)*
   - *Probe for how water is stored and treated for domestic use (technologies use by various operators)*
   - *Probe for how water is distributed/delivery to residents for domestic use (the technologies use).*
3. Who is eligible to engage in the provision and operations of decentralized water technologies for domestic water supply in Dar es Salaam?
   - *Probe for whether there are existing processes/procedures that needs to be followed by alternative/different water providers e.g., commercial operators, and self-help actors etc.*
   - *Probe for implications in where everyone is allowed*

4. Are there laws/rules/regulations guiding the provision of water of these alternatives for domestic use in Dar es Salaam?

   - *Probe for the general rules/regulations governing domestic water supply of the alternative technologies?*
   - *Probe for whether there are specifics regulations/laws/rules governing water provisions of specific decentralized water technologies?*
   - *Who is mandated to enforce these rules/regulations/laws governing decentralized technologies for domestic water supply?*
   - *Are (non)compliance/adherence and which actors/water operators?*

5. How are the interactions and power relations between state and non-state actors and among the non-state actors' alternative systems for water supply?
   - *Probe for who has the power and mandate to control alternative water providers e.g., tankers, water kiosks, private HH connections etc.*
   - *How and What is the role/feelings of DAWASA/state about the proliferation of these alternatives water technologies?*
   - *How are the power relations [(a)symmetry, complementary] and mode of interactions among the actors/involved in water supply?*
   - *Are there conflicting interactions, partnerships, and interdependence?*
   - *What is/are the common interest(s) of the various parties involved in the provision and operations of these ordinary technologies for water supply?*
   - *Who has the greatest power in terms of ability to provide water among the actors?*

6. How is the mode(s) of governance of the alternative technologies that supply water domestic use?
   - Probe for the governance modes of Water kiosks, Tankers/carts, Rainwater harvesting, Wells, boreholes, private taps, private HH connections, utility kiosks, wastewater recycling, stormwater etc.
   - Probe for co-production arrangements
   - Probe for self-governance arrangements
   - Probe for decentralized governance arrangements
   - Probe for co-governance/management arrangements

7. How are prices of the water governed/regulated?

   - Probe for the cost of/per litre of water each providers/distributor
   - Probe for payment modalities for supply
   - Probe for how prices are set by providers and distributors (each), *collective/unions, discursive, leadership decision or individual discretion*
   - Probe for key factors that influence/drivers of pricing decisions of water providers and distributors
   - Probe for who has the power to determine and regulate prices
   - Probe for utility roles/interactions of state actors and these alternative providers in the price's determinations
   - Probe for whether conflicting discourses arises among actors, or between actors and the utility and how such are settled
   - Probe for the mode of prices governance – collaborative, etc.
   - Probe for the city-scale (Dar es Salaam) institutions mandated to regulate water prices

Appendix B

Interview Guide Target respondents:
Water providers and Distributors; *Water kiosks, Tankers/carts, Rainwater harvesting, Wells, boreholes, private taps, private HH connections, utility kiosks amongst others.*

1. Location operations, sex, age, duration of existence, customer base daily

2. What is the various source from which people collect/get water for domestic usage in Dar es Salaam?
   - *Probe for the following; Water kiosks, Tankers/carts, Rainwater harvesting, Wells, boreholes, private taps, private HH connections, utility kiosks amongst others.*
   - *Probe water whether are alternatives such as wastewater recycling, stormwater*

3. Can you please describe how water is supplied through the above-mentioned water systems in Dar es Salaam?
   - *Probe for how water for domestic use is supplied through the Water kiosks, Tankers/carts, Rainwater harvesting, Wells, boreholes, private taps, private HH connections, utility kiosks amongst others in Dar es Salaam.*
   - *Probe for how water is produced/sourced by the various operators (technologies use by the various operators)*
   - *Probe for how water is stored and treated for domestic use (technologies use by various operators)*
   - *Probe for how water is distributed/delivery to residents for domestic use (the technologies use).*
4. Who is eligible to engage in the provision and operations of decentralized water technologies for domestic water supply in Dar es Salaam?
   - *Probe for whether there are existing processes/procedures that needs to be followed by alternative/different water providers e.g., commercial operators, and self-help actors etc.*
   - *Probe for implications in where everyone is allowed*

5. Are there laws/rules/regulations guiding your operation and the provision of water of in Dar es Salaam?

   - *Probe for the general rules/regulations governing domestic water supply of the alternative technologies?*
   - *Probe for whether there are specifics regulations/laws/rules governing water provisions of specific decentralized water technologies?*
   - *Who is mandated to enforce these rules/regulations/laws governing decentralized technologies for domestic water supply?*
   - *Do all operators comply/adhere to the regulations?*

6. How are the interactions and power relations between state and non-state actors and among the non-state actors' alternative systems for water supply?
   - *Probe for who has the power and mandate to control alternative water providers e.g., tankers, water kiosks, private HH connections etc.*
   - *How and What is the role/feelings of DAWASA/state about your operations?*
   - *How are the power relations [(a)symmetry, complementary] and mode of interactions among you?*
   - *Are there conflicting interactions, partnerships, and interdependence?*
   - *What is/are your common interest(s) as water providers in Dar es Salaam?*
   - *Do you have a union, defined group or leadership?*
   - *Who has the greatest power in terms of ability to provide water among the actors?*

7. How is the mode(s) of governance of your activities in relation to domestic water supply?
   - *Probe for the governance modes of Water kiosks, Tankers/carts, Rainwater harvesting, Wells, boreholes, private taps, private HH connections, utility kiosks, wastewater recycling, stormwater etc.*
   - *Probe for co-production arrangements*
   - *Probe for self-governance arrangements*
   - *Probe for decentralized governance arrangements*
   - *Probe for co-governance/management arrangements*

8. How are prices of the water governed/regulated?
   - How are prices of the water governed/regulated?
   - Probe for the cost of/per litre of water each providers/distributor
   - Probe for payment modalities for supply
   - Probe for how prices are set by providers and distributors (each), *collective/unions, discursive, leadership decision or individual discretion*
   - Probe for key factors that influence/drivers of pricing decisions of water providers and distributors
   - Probe for who has the power to determine and regulate prices
   - Probe for utility roles/interactions of state actors and these alternative providers in the price's determinations
   - Probe for whether conflicting discourses arises among actors, or between actors and the utility and how such are settled
   - Probe for the mode of prices governance – collaborative, etc.
   - Probe for the city-scale (Dar es Salaam) institutions mandated to regulate water prices

Appendix C

Households SURVEY QUESTIONNAIRE

Date..... Name of Interviewer..... Questionnaire No: .....

Street Name..... Name of the Respondent.....

A1	Age of Respondents	.....
A2	Sex	Male..... 1 Female..... 2
A3	Marital Status	Single.....1 Married.....2 Separated.....3 Divorced.....4 Widowed.....5 Others (specify).....6
A4	Highest Level of education	None.....1 Primary.....2 Middle/JSS.....3 Secondary.....,4 Tertiary.....,5
A5	Sources of income of the household head *Please circle all that applies*	Petty trading.....,1 Farming.....,2 Government worker.....,3 Medium/large scale business.....,4 Others.....,6
A6	Estimated household monthly income	TSZ.....
A7	Estimated amount household spend on water a week or per day (Raining Season)	Day (TSZ..... OR Week (TSZ.....
A7a	Estimated amount household spend on water a week or per day (Dry Season)	Day (TSZ..... OR Week (TSZ.....
A8	Estimated amount household spend on food a week or per day	Day (TSZ..... OR Week (TSZ.....
A9	Estimated amount household spend on education a per month	Month (TSZ.....

A10	Estimated amount household spend on healthcare a week or per month	Month (TSZ.....
A11	Estimated amount household spend on electricity per month	Month (TSZ.....
A12	Household Size	No. of people.....
A13	Have you ever accessed water from DAWASA before?	Yes.....1 No.....2
Everyday water supply and access in Dar es Salaam		
B14	Which sources of water supply services do people depend on in Goba? *Please circle all that applies*	Borehole.....1 Tanker trucks.....2 Tap water.....3 Pushcarts water.....4 Well water.....5 Community Based Water.....6 Water kiosks.....,7 Private water connection to households.....,.8 Others (specify).....,9
B15	Which of these is the *main* source of water to your household now?	Borehole.....1 Tanker trucks.....2 Tap water.....,.....3 Pushcarts water..... 4 Well water.....5 Community Based Water.....6 Water kiosks.....7 Private water connection to households.....8 Others (specify).....9
B15a	Do you normally change your main source of water to another in the dry season?	Yes.....1 No.....2
B15b	If yes to B15a, which water source do you normally depend on in the dry season?	Borehole.....1 Tanker trucks.....2 Tap water.....,.....3 Pushcarts water..... 4 Well water.....5 Community Based Water.....6 Water kiosks.....7 Private water connection to households.....8 Others (specify).....9

B16	What factors did you consider before choosing your main water source? *Please circle all that applies*	The quality of the water source.....1 Affordability of the water source.....2 Continuous availability/Reliability.....3 Proximity to the water source.....4 Flexibility of the payment methods.....5 Quantity available.....6 Registered water operator.....7 None.....8 Others.....9
B16	Is your household connected to the private water supply network?	Yes.....,1 No.....2 If Yes skip to Question C26
B16	How far is your *main* source of water from your house?	< 10 meters.....1 < 100 meters.....2 About 100 meters.....3 About 200 meters.....4 About 300 meters.....5 About 500 meters.....6 Others.....7
B17	How frequent do you go to fetch water?	Everyday.....1 Once a week.....2 Twice a week.....3 Once every two weeks.....4 Others specify.....5
B18	By what means of transport do you use to fetch water from your *main* source of water?	By foot.....1 By bicycle.....2 By pushcart truck.....3 By motor.....4 By car.....5 Households water connected.....7 Others specify.....6
B19	How much time do you spend going to your *main* water point?	< 5 minutes.....1 About 10 minutes.....2 About 15 minutes.....3 About 20 minutes.....4 Others.....5
B20	How much time do you spend at your *main* water source fetching the water?	< 5 minutes.....1 About 10 minutes.....2 About 15 minutes.....3 About 20 minutes.....4

		Others.....5
B21	How much time you spend carrying/transporting the water back home?	< 5 minutes.....1 About 10 minutes.....,2 About 15 minutes.....3 About 20 minutes.....4 Others.....5
B22	Does the time you spend in the water accessing chain affect the time of other equally important activities?	Yes.....1 No.....2
B23	If yes to B22, which of your important activities are often affected due to the delay in fetching water?	(a).....1 (b).....2 (c).....3
B24	What do you think influences the locations/operations of these vending water in your Neighbourhood?	.....1 .....2 3
B25	Are you satisfied with the distance of the distributed water supply centers?	Very satisfied.....,1 Satisfied.....2 Less Satisfied.....3 Not at all.....,4
C	Reliability/availability of water supply beyond the utility	
C26	How will you describe the level of availability of your main source of water to your household?	All weather availability/continuous availability.1 Intermittent/reliable.....2 Available in minimum Quantity.....3
C27	Which of the water points within the Neighbourhood do you think usually have water throughout the year? (*Continuous availability*) *Please Circle all that applies*	Borehole.....1 Tanker trucks.....2 Tap water.....3 Pushcarts water.....4 Well water.....5 Community Based Water.....6 Water kiosks.....7 Private water connection to households.....9 Others (specify).....10
C28	Which of the water points within the Neighbourhood are *intermittent/reliable* sources of water throughout the year?	Borehole.....1 Tanker trucks.....2 Tap water.....3 Pushcarts water.....4 Well water.....5 Community Based Water.....6

	Please Circle all that applies	Water kiosks.....7 Private water connection to households....9 Others (specify).....10
C29	Which of the water points do you think usually have *minimum water* throughout the year? *Please Circle all that applies*	Borehole.....1 Tanker trucks.....2 Tap water.....3 Pushcarts water.....4 Well water.....5 Community Based Water.....6 Water kiosks.....7 Private water connection to households...8 Others (specify).....9
C30	Does seasons affect the availability of the water supply services?	Yes.....1 No.....2
C31	From your experience which of the following water sources within the Neighbourhood are mostly not available in good quantity in the dry season? *Please Circle all that applies*	Borehole.....1 Tanker trucks.....2 Tap water.....3 Pushcarts water.....4 Well water.....5 Community Based Water.....6 Water kiosks.....7 Private water connection to households....8 Others (specify).....9
C32	From your experience, how many hours is your *main* water source opened for fetching?	24 hours.....1 10 hours per day.....2 6 hours per day.....3 Others (specify.....4
C33	Can you please give an estimate of the number of water liters your household consumed per day?	50 liters.....1 100 liters.....2 120 liters.....3 140 liters.....4 200 liters.....5 Others (specify.....6
C34	Does the quantity of water you get satisfies the water demand of your household's domestic activities?	Yes.....1 No.....2
C35	Are there rules and regulations guiding the fetching of water in water points?	Yes.....1 No.....2 I don't Know.....3
C36	If yes to C35 name some of the rules and regulations you know?	.....

		.....
C37	Are you satisfied with the water availability situation in your Neighbourhood?	Very satisfied.....1 Satisfied.....2 Less Satisfied.....3 Not at all.....4
C38	What will you recommend for continuous water availability in your Neighbourhood?	....
D	Perceptions about the quality of water supply beyond the utility network	
D39	What do you think about the quality of the water supplied by the water kiosks in your Neighbourhood?	....
D40	Which of the private water sources within your neighbourhood do you think has the best water quality? *Please Circle all that applies*	Borehole.....1 Tanker trucks.....2 Tap water.....3 Pushcarts water.....4 Well water.....5 Community Based Water.....6 Water kiosks.....7 Private water connection to households...8 Others (specify).....9
D41	Do you treat the water you fetch before using it for domestic purposes?	Yes.....1 No.....2
D42	If Yes how do you do it?	Boiled before use.....1 Filtration before use.....2 Alum introduction.....3
D43	From your experiences, by which ways do your think the water you buy gets contaminated? *Please Circle all that applies*	Transportation of the water.....1 Storage in Jerry cans.....2 Storage in over-head polytans.....3 Long-term storage.....4 Fetching of the water.....5 Others (specify.....6

D44	Do you think the transportation of water to source can affect the quality of the water?	Almost certain.....1 Likely.....2 Moderately likely.....3 Unlikely.....4 Rare.....5
D45	How will you describe the services quality of the private water sellers?	Most reliable.....1 More Reliable.....2 More flexible arrangements.....3 Services suitable to our conditions.....4 Others.....5
D46	How do you normally get access to the water?	Purchasing.....1 Home delivery by the provider.....2 Contracting people to fetch.....3 Receive directly from distributions.....4 Tanker supply services.....5
D47	Do you normally receive information about the availability and quality of the water you drink in your Neighbourhood?	Yes.....1 No.....2
D48	If Yes, to D47 how do you normally get such information?	Verbal communication from colleagues.....1 Information from radio announcement.....2 Personal observation.....3 Water services providers.....4 Media.....5
D49	Are you satisfied with the services and quality of the vending water/small-scale private supply in your Neighbourhood?	Very satisfied.....1 Satisfied.....2 Less Satisfied.....3 Not at all.....4
E	Affordability of water supply utility network	
E50	Does the amount your household spend on water affects your access to other basic needs of the household?	Yes.....1 No.....2
E51	If Yes, to E50 which of the basic need is often not met in your household?	Clothes.....1 Adequate food.....2 Fees for basic education.....3 Health needs.....,.....4 Transport needs.....5 Others (specify.....6

E52	How are the modes of payment for fetching water from your *main* source?	Cash and carry system.....1 Monthly payment.....2 Fixed payment system.....3 Others (specify.....4
E53	Is the mode of payment for the water supply suitable for your household?	Yes.....1 No.....2
E54	If No, to E53 which kind of payment would you have preferred?	.....
E55	If Yes, to E53 Which of the water service provider has the most affordable water supply services to your household? *Please Circle all that applies*	Borehole.....1 Tanker trucks.....,.....2 Public Tap water.....3 Private Tap water.....4 Pushcarts water.....5 Well water.....6 Community Based Water.....7 Water kiosks.....8 Private water connection to households.....9 Others (specify).....10 None.....11
E56	Do you think the amount you pay worth the water services you get from your water service provider?	Yes.....1 No.....2
E57	If No, why?	....
E58	Do you think the water providers charge different prices to different individuals and groups within the Neighbourhood?	Yes.....1 No.....2
E59	If Yes to E58, which people are mostly charged higher prices by the private water providers? *Please Circle all that applies*	To different ethnic groups.....1 Different nationalities.....2 To person in high income bracket.....3 When you lack knowledge of the prices....4 Others specify.....5
E60	Are you satisfied with the amount your household spend on water services?	Very satisfied.....1 Satisfied.....2 Less Satisfied.....3

		Not at all.....4
E61	Which group of people are most likely to depend on the following water sources?	Groups and Individuals to access
E62	Tanker trucks water *Please Circle all that applies*	Low-income households.....1 Everyone within the Neighbourhood.....2 High- & Middle-income households.....3 Others.....4
E63	Household private connection *Please Circle all that applies*	Low-income households.....1 Everyone within the Neighbourhood.....2 High- & Middle-income households.....3 Others.....4
E64	Pushcarts water *Please Circle all that applies*	Low-income households.....1 Everyone within the Neighbourhood.....2 High- & Middle-income households.....3 Others.....4
E65	Community Based Water *Please Circle all that applies*	Low-income households.....1 Everyone within the Neighbourhood.....2 High- & Middle-income households.....3 Others.....4
E66	Water kiosks (over-head polytank) *Please Circle all that applies*	Low-income households.....1 Everyone within the Neighbourhood.....2 High & Middle income households.....3 Others.....4
E67	Public taps *Please Circle all that applies*	Low-income households.....1 Everyone within the Neighbourhood.....2 High- & Middle-income households.....3 Others.....,4