Water for the Masses

An Analysis Urban Water Distribution Methods in Sub-Saharan Africa

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Abstract

In Sub-Saharan Africa, only 33% of urban residents received water piped into their homes by their city's central water utility[11]. The remaining 67% of urban residents rely on small-scale or informal water providers to meet their water needs. This study seeks to understand NGOs' perceptions of the relationship between small-scale or informal water providers and their customers as well as the role of regulation in this relationship through a series of surveys. This document evaluates these perceptions based on quantitative and qualitative analysis of the survey results. The findings indicate that NGOs in Sub-Saharan Africa generally hold a negative view of the quality and pricing of water provided by small-scale and informal water providers. However, they understand that these providers are a vital part of their city's water distribution ecosystem. Additionally, although regulation is not universally effective, NGOs generally believe that the government should play a role in regulating the operations of small-scale and informal water providers in their cities.

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1. Introduction

In 2010, the UN General Assembly ratified the idea that access to clean drinking water is a basic human right[27]. Implementing this idea for the Earth's rapidly growing population of 7.6 billion people remains one of the great challenges of our age. Despite huge strides in the past few decades, 2.1 billion people consistently lack access to clean water and intermittent water scarcity continues to impact 40% of all people, disproportionately affecting individuals in developing countries[8]. The World Health Organization (WHO) estimates that access to clean water is so scarce at least 2 billion people regularly resort to drinking water that is contaminated with feces[9]. These statistics on water access directly impact the fact that more than 840 thousand people, including 361 thousand children younger than five, die each year from diarrhea caused by preventable, water-based diseases[8,9]. Notably, these figures don't include others who contract other water borne diseases such as Hepatitis, Polio, and Cholera or the 240,000 people who are living with parasitic worms due to exposure to infested water[9].

Demographic changes, including rapid urbanization and population growth, are only exacerbating these problems. In the face of rapid growth due to both migration from rural areas and high birth rates, many cities in developing countries have struggled to increase the supply of services fast enough[28, 29]. This is particularly true in the fastest growing neighborhoods which are often low-income, informal settlements that may be constructed without building permits or on land for which the residents don't hold property rights[11]. When city officials expand municipal water supplies, these slums are generally neglected because of their lack of political organization and because cities fear providing these services could provide tacit approval to the existence of these neighborhoods[9]. As a result of their lack of access to the formal water network, these

slums' residents generally have to purchase water from alternative sources. These alternative sources tend to provide water that is significantly more expensive than water from the central water network[10, 29]. This poses problems for the residents of informal communities who are generally less able to pay than residents of formal dwellings[29]. Such problems are particularly pronounced in sub-Saharan Africa where 62% of urbanites across the continent live in these slums[10].

A large portion of urban populations around the world purchase water from one of many different types of small-scale or informal water providers. They're forced to purchase from these vendors due to the aforementioned insufficiency of formal water networks. The type of supply used varies widely both between cities and within them. Some common methods of informal urban water collection include purchasing water from tanker trucks, kiosks, private wells, and spaghetti connections or collecting water from ground water sources or public water taps (see appendix for definitions). These different methods of water provision have varying impacts on the quality of the water, convenience of its supply, and cost to their consumers, who have limited ability to pay.

Developing a better understanding of what factors influence the relationships between these different types of small scale and informal water providers and their customers could help us understand how to most effectively increase access to clean water for the urban poor. By leveraging the insights of experts in local urban water distribution, organizations and governments may be able to more effectively steer residents towards improved water sources and away from sources such as ground water and untested water tanker trucks. Furthermore, an

understanding of the role of public policy in this relationship could help governments develop efficient plans for expanding central water services to currently unserved residents so that they can maximize benefits while minimizing costs. This level of understanding is what the rest of this paper intends to develop through in-depth surveys of development and aid workers operating in growing urban centers across Sub-Saharan Africa.

This paper contributes to our shared understanding by reporting data and information collected from development and aid organizations operating in urban centers across Sub-Saharan Africa in which small-scale and informal water providers play a central role in water distribution. To collect this information, in-depth surveys were distributed to representatives from NGOs in four cities: Dar es Salaam, Accra, Monrovia, and Nairobi. Specifically, this paper asks: how do NGOs perceive the relationship between informal water service providers and the customers who rely on them and the role of government in mediating this relationship?

In order to answer this question, this paper will first aim to develop an understanding of what existing academic literature has to say on urban water distribution methods. It will then delve into the research methodology used to study this question. Finally, this paper will dive into an analysis of the research conducted. It will first aim to develop an understanding of the operations of the formal water provider in each of the cities surveyed in order to better understand the market niche that the small-scale and informal providers are filling. Next, we will dive into the views of a variety of NGOs on the relationships between small-scale and informal providers and their customers. We will break this section down further by looking at NGOs' perceptions of the price and quality of the water sold by these providers. Finally, in

order to understand NGOs' view of the role of government this relationship, we will analyze the information collected from NGOs about their views on regulation in this space.

2. Theoretical Framework

2.1. Challenges of Providing Water Infrastructure

The operation of public service providers in cities across the developing world have been plagued by problems. The biggest is that urban population growth in many rapidly expanding cities has outpaced government spending on service provision by significant margins[17]. In many of these cities, significant portions of the population work in informal labor markets[17]. In these cases, individuals often don't account for the revenue they collect which makes it difficult for the government to levy taxes in order to raise funds for infrastructure projects[17]. Compounding this problem is the fact that many new urban residents migrating from rural areas are extremely poor and settle in informal settlements where service provision is difficult[2]. Specifically, rapidly growing peri-urban neighborhoods on the outskirts of many cities pose significant challenges with regards to service provision due to their low population density, distance from existing infrastructure, and lack of formal recognition[11]. These factors mean that the provision of things like waste removal and potable water is 30-50% less expensive in concentrated population centers than in peri-urban neighborhoods[13].

Adding to the logistical issues of providing water to citizens in these cities is the fact that ethnic tension can politicize access to public services and ultimately reduce service levels provided throughout the city[18]. Of the cities included in the scope of this research, this is of

particular concern in Monrovia, which is still struggling to rebuild much of its infrastructure that was destroyed in a series of civil wars that finally ended in 2003[6].

Although almost all major cities in the developing world have a centralized water distribution method, many provide service that is extremely lacking. In 2015, only 33 percent of urban residents of sub-Saharan Africa received water piped into their homes[11]. This number is higher than the rural population, but lags significantly behind every other region on Earth[11]. The percentage of urban dwellers with water piped into their residences is actually going down in many cities as utilities struggle to keep up with rapid growth[28]. Even new formal settlements often lack water in cities such as Maputo, Mozambique as young networks struggle to increase capacity to match astounding population growth[4]. The problem is significantly worse in informal settlements where a lack government recognition creates an additional barrier to coverage[9]. Peri-Urban neighborhoods, where much of the urban growth has occurred in sub-Saharan Africa, also make formal water service provision difficult because their low population density and large distances from the city center make piping water to them extremely expensive[4]. Finally, the quality of the water provided by the formal water providers is not a guarantee. For example, in Jakarta, although the percentage of people covered by the formal water supply network is higher than in most of sub-Saharan Africa, more than 40% of the water supplied in in the piped network is contaminated with E-coli[20].

2.2 Small-Scale and Informal Water Providers: Filling a Need

In response to the inadequacy of public service provision by the government in many rapidly growing cities throughout the developing world, informal markets for these goods have sprung

up to meet demand[19]. These markets are especially pronounced in the areas where government provision is weakest such as informal settlements and peri-urban environments. In these neighborhoods, residents are often forced to pay higher prices to individuals or small groups who operate illegally to dispose of waste or supply water[3]. In some cities, including Dar es Salaam and Port au Prince, some communities underserviced by formal networks have organized community-based solutions to try to lower the cost of obtaining services such as roads, sanitation networks, and drainage channels[12].

The informal markets for public services are perhaps most pronounced and widespread when it comes to the supply of water. Residents not receiving water piped to them from the central network have a wide variety of options ranging from spaghetti connections to standpipes to purchasing water from a modified pickup truck[6]. However, all of these sources provide water at costs well above the cost of water on the formal network, averaging 5-7 times more expensive according to some estimates[10, 29]. This price differential only worsens when cartels of water providers develop in areas reliant on their supplies with the intention of increasing prices to consumers[15]. The premium paid by people who rely on informal service providers for water is particularly troubling because they are generally the poorest in any given city since those who can afford the upfront capital expenditures required to connect a house to the water network tend to be wealthier[6].

Additionally, development researchers found that informal water suppliers are often inconsistent, especially in peri-urban environments, which forces consumers to purchase water in large quantities for storage since it could be more than a week before the vendors return to their

neighborhood[7]. Furthermore, water provided by the informal sector is more likely to contain a variety of contaminants compared to centrally piped water and those purchasing water rarely know where said water originated[3]. In some cases, water vendors have been observed selling water collected from an unprotected source, claiming it was siphoned from the central water supply[3]. However, not all informal water sources are the same as water that is transported in vehicles is particularly prone to being contaminated by bacteria and chemicals[14]. By developing a better understanding of the most important factors influencing this variation, in the future hopefully cities can craft more effective regulatory policy.

Despite the inadequacies of informal service providers, they also fill an important role in making up for a lack of services provided by the government. Without provision by informal service providers, many urbanites throughout the developing world, and in sub-Saharan Africa in particular, would be without access to waste removal, infrastructure repair, and the most important resource of all: water.

3. Methods and Data

3.1. City Selection

Dar es Salaam, Tanzania; Nairobi, Kenya; Accra, Ghana; and Monrovia, Liberia are the primary cities that I identified as subjects for this research[1]. All have unique characteristics regarding the size of their informal water system and the way those networks operate (see Table 1). Each of these cities is struggling to provide basic services for its citizens under the weight of their extremely high growth rates and limited budgets. The percentage of the population covered

[1] Maputo, Mozambique was also identified as a city of interest for this study but was excluded from analysis due to a lack of survey responses.

by the formal water distribution network in these cities varies from 18% to 69%. As a result, they have taken different approaches to providing water services to their urban poor by formalizing, semi-formalizing, or leaving unregulated their thriving small-scale or informal water provision sectors. Specifically, Monrovia has formalized large swaths of informal water providers by distributing licenses and tokens similar to those available to taxi drivers in the New York[6]. Meanwhile, Nairobi has implemented an interesting semi-formalization scheme in which only water providers distributing greater than 25 liters of water per day need to seek licensing and undergo quality testing[14]. Finally, Dar es Salaam and Accra have decided to adopt a policy of non-intervention in the dealings of small-scale or informal water providers which keeps these essential providers in a legal limbo as they illegally provide essential services to the cities' poorest. Each of these policies have their own benefits and drawbacks and run up against the realities of limited budgets and unique governance structures in each of these cities.

Table 1: City Backgrounds

	Dar es Salaam, Tanzania	Accra, Ghana	Monrovia, Liberia	Nairobi, Kenya
NGOs Surveyed	5	3	1	1
Population	4,400,000	1,600,000	1,000,000	3,100,000
Percent with utility connection	20%	69%	18%	44%
Regulation Currently in Place	Dar es Salaam currently has no regulatory framework in place to manage the operations of informal water providers.	Accra currently has no regulatory framework in place to manage the operations of informal water providers.	Monrovia has formalized several small-scale water providers in 2014 by distributing licenses and regulating water price and quality[6].	Nairobi partially formalized their small-scale and informal water network as only larger distributors (>25L/day) are subject to quality and price controls[14].

3.2. NGO Selection and Description

In order to develop a better understanding of the relationship between these essential water providers, the customers who rely on them for water, and the government, ten urban water access focused NGOs were surveyed in those four African cities. These NGOs were identified through several methods including asking reputable contacts about water focused NGOs operating in their cities, looking at water NGO industry groups in the cities, and searching the internet for urban water focused organizations in each of the cities. Each of the NGOs surveyed are experts in the field of water distribution in their respective cities as many have operated in their cities for decades. As a result, this paper treats the responses of NGOs as proxies for expert opinions in its analysis of their survey responses. However, this paper will point out the rare cases when an NGO's response was inconsistent with external evidence.

In order to receive these 10 responses, 20 surveys were sent to NGOs across the four cities which left me with an overall response rate of 50%. However, this response rate varied drastically across the different cities. In Dar es Salaam, five of the six surveys distributed were filled out by the NGOs that received them, representing the highest response rate of 83%. The reason for this is most likely that in this city, contacts introduced me to the NGOs via email and asked them to fill out the survey. In Accra, three out of the five surveys distributed were returned, again thanks to the help of local contacts, representing a 60% response rate. In Monrovia, on the other hand, only one of four surveys distributed were returned representing a 25% response rate. Finally, in Nairobi, only one out of five of the NGOs contacted as part of the research responded to requests for survey responses, representing a 20% response rate. Follow up requests were sent out to each of the NGOs who did not participate, but the response rate for

secondary requests was lower than for primary requests as only three of the 10 responses came after follow-up requests were sent out.

3.3.Survey Design

I selected a pre-formulated survey containing 48 unique questions as my method of data collection because this format allows me to collect a variety of both qualitative and quantitative data in a relatively quick and painless manner. Through these questions, I'm able to deconstruct my central question about how NGOs perceive the relationship between small-scale and informal water providers and the role of government in that relationship and analyze different aspects separately. The categories are broadly broken down as the existing formal network, the existing small-scale and informal network, and the NGOs' views on the regulatory environment. In my questioning I'm able to run quantitative analysis on NGOs' rating of different aspects of their city's formal water network and of the informal networks in order to compare the experts' opinions on the quality of service from the two sources. For more information regarding the specifics of the survey's contents, please see the appendix.

The analysis that I conducted on the survey responses involved a range of quantitative and qualitative questions and responses. With regards to the quantitative research I conducted, the general format was to ask for numeric ratings, generally out of 10, for different aspects of the relationship between small-scale or informal water providers and their clients. Using this information, I was able to more easily and directly compare NGO perceptions of this relationship across the four different cities I received responses from. Additionally, using these numeric

responses, I was able to build graphical representations of the data that I believe do a better job of illustrating the variation, or lack thereof, across NGOs both between and within specific cities.

Looking to the qualitative data I collected, the form that it takes is generally short answer questions explaining the reasoning behind the quantitative questions I posed to the respondents. Using my collections of these answers, I was able to piece together justifications for many of the quantitative numbers that the NGO respondents sent to me and compare their reasoning both within and across cities in order to look for specific trends in wording that further indicates patterns that call for further research.

3.4.Expectations

Before conducting the research for this paper, I developed a set of hypotheses based on the previous academic literature on this subject. These expectations were as follows:

1. NGOs will generally perceive small-scale and informal water providers negatively.
    a. Price will be the primary focus of the NGOs' criticisms of the small-scale and informal water providers.
        i. NGOs will indicate that small-scale and informal water providers work together to fix prices at artificially high levels.
    b. The perceived quality of the water from small-scale and informal water providers will be lower than the perceived quality of the central water authority's water.
2. NGOs will generally be deeply skeptical of the state's ability to supply potable water to all the residents of a given city.

3. NGOs will favor government regulation of small-scale and informal water provision networks to continue supplying the entire city while controlling prices and regulating quality.
4. Perceptions of small-scale and informal water providers will be better in cities with a regulatory framework in place.
5. Some unexpected factors will play an outsize role in NGOs' opinions of small-scale and informal water providers.

4. Empirical Section

This section will analyze the surveys conducted on NGOs in several sub-Saharan African cities in order to better understand the NGOs views of the relationship between water providers and their customers as well as their views on the role of different actors in this relationship. This section will first seek to develop a firm understanding of how NGOs explain the relationship between water providers and their customers in each city respectively. It will then lay out its findings about NGO opinions about the role of government and different agencies in governing this relationship across these different cities. Finally, this paper will compare our findings from across these four sub-Saharan cities to draw more general conclusions about the way NGOs view the relationship between informal water providers and consumers in the region. Specifically, this paper will first provide a high-level outline of each of the four cities surveyed and the NGOs surveyed in each of those cities. It will then develop an understanding of the operations of the formal water supply network in each of these cities so that we can better understand the need that small-scale and informal water providers fill. The empirical section will then dive deeply into the NGO's perceptions of the small-scale and informal water providers, with a particular focus

on their quality and pricing. Finally, this section will seek to develop an understanding of what the NGOs in each city view as the future of small-scale and informal water provision in their city and the role they believe the government should play in regulating this market.

4.1.City and NGO Overviews

4.1.1. Dar es Salaam

Dar es Salaam is the capitol of and largest city in Tanzania. Five of the survey responses from a variety of NGOs and development focused organizations come from Dar es Saaam. The first of the NGOs surveyed in Dar es Salaam was the Tanzania Association of Environmental Engineers (TAEEs) which is a local organization established in 2004 with the aim of building and developing community-based water and sanitation facilities in Dar es Salaam as well as around the country[21]. WEPMO is another Tanzanian NGO that returned their survey request. WEPMO has operated in the city since 1999 with the aim of helping communities in Dar es Salaam and elsewhere in Tanzania maintain and manage their local water and sanitation systems[22]. People's Voice for Development (PEVODE) is another local organization in Dar es Salaam that responded to my survey. PEVODE operates only in the Temeke neighborhoods in Dar es Salaam and focuses on coordinating between the different communities in developing local water supplies[23]. Saifu and Upendo Women Development Organization (SUWODE) is the fourth organization in Dar es Salaam that returned the survey. SUWODE is a local NGO in Dar es Salaam that focuses on empowering women through increased access to water and sanitation facilities in both urban and rural areas in this part of Tanzania[25]. Finally, Sanitation and Water Action Tanzania (SAWA) is a local NGO that aims to provide sustainable water and sanitation

capacity to citizens residing in and around Dar es Salaam by drilling public boreholes among other methods[24].

4.1.2. Accra

In our analysis of informal water providers in Accra, the capitol of Ghana, we distributed surveys to NGOs in a similar fashion and received three responses. The NGOs that we surveyed in Accra are the Professional Network Association, Global Communities, and WaterAid Global Ghana. Professional Network Association (ProNet) is a knowledge management organization and has operated in Accra's water and sanitation sector for the past 24 years as they've built expertise in the realm of urban water infrastructure development[26]. Global Communities, on the other hand, is an aid distribution network that has operated in Accra for the past 10 years as they've aimed to increase access to clean water in Accra's slums, among other admirable goals[30]. Finally, WaterAid Global Ghana is an international water access focused NGO that has operated in Accra for 33 years, over which time they've contributed significantly to the construction of water infrastructure in Accra[31].

4.1.3. Monrovia

Monrovia, the capital of and largest city in the west-African nation of Liberia. In Monrovia, we distributed surveys to four different NGOs and received one back giving the city a 25% response rate. The Monrovian NGO that responded to the survey is the Liberia branch of WaterAid Global. WaterAid Global is an international NGO focused on helping people in cities have easier access to clean water. WaterAid has operated in Monrovia for more than 10 years

and has developed significant expertise in helping provide Monrovians access to safe drinking water[32].

4.1.4. Nairobi

The final city included in the scope of this study is Kenya's capitol: Nairobi. In Nairobi, we distributed surveys to five different NGOs and received one in response. The respondent from Nairobi was Water and Sanitation for the Urban Poor (WSUP), an international NGO that focuses on increasing access to water and sanitation services in cities and has operated in Nairobi for 10 years[33]. Over this time, they've developed significant expertise in the realm of water distribution in the city by aiming to increase access in Nairobi's slums to clean water and adequate sanitation sources.

4.2. Analysis of the Central Water Authorities

4.2.1. Dar es Salaam

With regards to Dar es Salaam's central water authority's (DAWASA) coverage, it is worth noting that, when compared to the UN Habitat's 2015 report on Dar es Salaam's water distribution network, the NGOs overestimated formal coverage by an average of 285%[11]. UN Habitat's report found that a mere 20% of Dar es Salaam's citizens receive water directly from DAWASA's network[11]. This an important factor because it may indicate that, although this analysis presumes expertise, not all NGO opinions may be completely unbiased. This could influence the way they respond to a variety of questions asked in the survey.

Interestingly, however, this trend of overestimating DAWASA's capacity does not seem to apply to the NGOs' views on the quality of water DAWASA produces. Despite consistently meeting WHO standards for water quality, according to several NGOs, the NGOs gave DAWASA's water an average quality rating of 8/10 with a median of 7/10. The reason for the difference between the WHO's and the NGOs' understanding of DAWASA's water quality may be due to the source of analysis as well as the timing of the testing. According to several NGOs, the WHO measures water quality at the treatment plant while the NGOs were generally referring to the water the end users receive. This could vary because there seems to be "leakage" due to "broken water pipes" within the colonial era distribution networks that leads to contamination of some of the water end consumers receive. Furthermore, WEPMO found that chlorination, a process used by DAWASA to kill bacteria in the water before distribution, occurred irregularly at the DAWASA treatment facilities meaning that the quality of the water in the formal network may vary day to day. The imperfect ratings of water quality in Dar es Salaam for the central water authority is an important factor to note because it could be disincentivizing homeowners from investing in connecting their homes to the central network.

Finally, it's important to understand the pricing structure of the central water network in Dar es Salaam. On average, the NGOs estimated that the central water authority charges 1650 Tshs ($0.72) per 1000L of water. However, some noted that there is significant price fluctuation between the rainy and dry seasons. These prices are set by a government regulatory body called EWURA which estimates operating costs and sets prices for DAWASA to charge. One NGO indicated that they expect these costs to go up in the long run as more repairs are required to maintain the aging system. Every NGO in the city expressed concern that investment in the

central water authority was insufficient, however, there's clearly disagreement over both where said funding should come from and what strategy is best for expanding the network. There is consensus that the state should invest more in urban water distribution, but disagreement over what aspects of the infrastructure to focus on and what roles foreign development money and private companies should play in the future of Dar es Salaam's water network. If these disagreements are reflective of the disagreements within the government, residents of Dar es Salaam can expect development not to accelerate in the near future.

4.2.2. Accra

With regards to Accra's formal, centralized water distribution network, the World Bank reported in 2010 that the network covers 69% of the city's residents, which is significantly higher than the sub-Saharan average of 33%[28]. Two of the NGOs surveyed estimated that the network covers 70% of the city's residents, but WaterAid Ghana estimated that a mere 30% of the population has water piped to them from the utility. The accuracy of ProNet and Global Communities' estimates serve as an additional indicator of their expertise in Accra's water distribution. However, WaterAid Ghana's response could be the result of the respondent misreading the question, considering the response was the inverse, or it could be a warning sign that the respondent's answers may not be entirely reliable.

When we take a look at the NGOs' analysis of the quality of the water provided by the central water authority in Accra, we again see the NGOs rating the water at an average of 8 out of 10. This is despite the fact that the NGOs indicated that "production is done following strict hygienic and technical standard[s]" and that water is subject to "random sampling and testing"

by a public utilities regulatory commission. As in Dar es Salaam, all three NGOs indicated that contamination is sometimes introduced to the water by way of the distribution system as the testing primarily takes place at the site of production. In particular, cracks in aging pipes, illegal connections, and mining were named as sources of potential contamination in the water supply.

Furthermore, it's important to understand the pricing model of the formal water supplier in Accra in order to round out our understanding of the primary alternative to informal water suppliers in the city. The NGOs indicated that, on average, the water provided by the central authority in Ghana costs individuals between 2 and 2.5 GHC per cubic meter with the utility's operational costs being by far the largest factor in pricing. This is likely because Accra's central water authority is a non-profit government agency rather than a private company which makes the inclusion of profit margins unnecessary. Within operational costs, the cost of energy and expected repairs are both mentioned by the NGOs as the largest and most volatile variables that can lead to changes in the price of water.

Finally, looking to the future of Accra's central water distribution network, all of those surveyed indicated some level of frustration with the pace of expansion. They specifically cited a lack of long-term strategic planning and funding contributed by government towards building the central water network's capacity with the system's inability to keep up with population growth. This makes sense considering Accra saw a 22.5% decline in access to piped water between 2000 and 2010 due to population growth and insufficient investment[28]. Furthermore, the respondents indicated that in the future they'd like to see less of the financing and expanding of the central

network come from outside sources such as international development programs, NGOs, and IGOs. Instead they favor more of the responsibility being taken on by the governments in Accra.

4.2.3. Monrovia

Looking at Monrovia's formal water distribution network, WaterAid estimated that 18% of the population of the city has regular access to water from the central water utility. This number is low, even by sub-Saharan African standards and demonstrates that years of mismanagement and damage due to conflict have had a lasting impact on the state's ability to provide basic services in a centralized manner.

WaterAid declined to comment on the pricing or the quality of the water distributed by the central network, however, they claimed that based on "ethnographic observation," consumers are generally pleased with the water they receive from the utility. Additionally, WaterAid did share that they believe that current funding for the development of urban water distribution networks in Monrovia is extremely insufficient and that the city should work more closely with foreign aid programs to increase capacity.

4.2.4. Nairobi

According to WSUP estimates, the central water utility in Nairobi provides water directly to roughly 50% of the city's population. This figure is slightly higher than the estimate provided by UN habitat which estimates the network's coverage at roughly 44%[11]. That leaves approximately 1.7 million individuals in Nairobi without access to water from the central water utility.

The quality of the water provided by the formal service is roughly 8/10 according to WSUP's ratings thanks to quarterly monitoring and extensive testing of the facilities. Additionally, according to WSUP, Nairobi has invested heavily in maintaining and replacing aging water distribution infrastructure which has helped the city keep its' central water source relatively clean. WSUP chose not to elaborate on why the water quality is not higher than an 8/10 considering that they are investing at what WSUP deems to be a satisfactory pace.

With regards to pricing, the utility is fairly straight forward in that it charges residents 1 KES per 40-liters consumed and makes no profit other than what is reinvested in the system to maintain and grow it. WSUP declined to comment further on Nairobi's water utility's use or sourcing of funding.

4.2.5. Overall Observations

Across these four cities, NGOs have generally positive views of their cities' central water utilities as they are rated an average of 8/10 on quality and the pricing is nearly unanimously regarded as fair. However, there are a few notable trends. The first and most evident is that NGOs believe that greater levels of investment and more organized network expansion strategies are essential to the growth and maintenance of these water distribution networks. Relatedly, the central water purification plants seem to be doing a good job in the eyes of the NGOs, but failings in the aging pipes in the water distribution systems are a common problem that can lead to water contamination.

4.3.Introductory Analysis of Small-Scale and Informal Water Providers

4.3.1. Dar es Salaam

Although the NGOs in Dar es Salaam generally underestimated the prominence of small-scale or informal water providers compared to the UN, none estimated that they served less than 25% of the population indicating that their prominence in the daily lives of Dar es Salaam's population is well understood. When it comes to informal water providers, residents of Dar es Salaam have a wide array of options (see Table 2). However, despite the perception of options and competition, NGOs in Dar es Salaam tend to view these informal water providers with suspicion. Perceptions of the relationship between these informal water providers and their customers as a whole came in at an average of only 4.5/10 across NGOs surveyed in Dar es Salaam. All of the NGOs surveyed indicated that convenience for the consumer was a primary positive factor in the informal providers' relationship with their clients while two NGOs mentioned flexible payment plans as another positive. On the negative side, three of the NGOs surveyed indicated that water quality is a major problem in this relationship while two pointed to price as the main issue between consumers and informal providers.

4.3.2. Accra

In Accra, the 31% of consumers who rely on informal water also appear to have a large array of options as the NGOs each listed five different informal water supply methods commonly used in the city (see Table 2). Given the wide array of options available to the relatively small group of Accra's residents who rely on informal water networks, one may presume that the informal water market must be competitive. However, Global Communities pointed out that not all of these methods are available everywhere in the city. None the less, the NGOs surveyed

view the relationship between small-scale or informal water providers and their customers as a 7/10. In particular, they noted that reliability, convenience, and their ability to serve hard to reach communities are the primary things that the suppliers do well. However, two of the NGOs indicated that the uncertain quality of the water can be a problem while one mentioned these providers' higher costs cause problems for the relationship with their customers.

4.3.3. Monrovia

Given the fact that a mere 18% of Monrovians have regular access to the water provided by the central utility, the other options available to the city's residents are extremely important. WaterAid, the single survey response from Monrovia in this study, indicated that outside of the central water network, residents have five primary options for collecting water to fill their needs (see Table 2). Of these, all but surface water are managed by small-scale private vendors. Fortunately, WaterAid views the relationship between the small-scale vendors and consumers at a very generous 8/10. In particular, WaterAid noted that the quality, availability, and affordability of the water provided by small-scale and informal water providers is generally quite good. However, it did note that issues with the small-scale providers' water quality sometimes arise.

4.3.4. Nairobi

The 1.7 million Nairobi residents who don't receive water services from the central utility seem to have a variety of options when it comes to small-scale water supply. WSUP indicated that there are five different water collection options commonly used by the city's populace (see Table 2). However, despite this, WSUP rated the relationship between small-scale and informal

water providers in Nairobi notably lower than in other cities. In fact, at a rating of 4/10, the relationship comes in as the lowest of any city included in this study. Specifically, WSUP cited the extremely high cost of water from these small-scale providers coupled with the consumer's relative inability to pay with the low score.

4.3.5. Overall Observations

Across these four cities, there are a variety of notable trends in NGOs' overall perceptions of small-scale and informal water providers. Specifically, convenience and reliability of the water provision services for the consumers are commonly mentioned positives, contradicting some of the existing literature on small-scale and informal water providers referenced earlier in this paper. However, the NGOs generally view these relationships as far from perfect. Pricing and quality were by far the two most commonly mentioned grievances with the small-scale and informal water providers' interactions with their customers. Of these two, quality was sighted as a major issue by the NGOs slightly more often than was pricing.

Table 2: Water Sources Available

Water Sources Available	Dar es Salaam	Accra	Monrovia	Nairobi
Utility				
Public Standpipes				
Push-kart Water Vendors				
Water Kiosks				
Water Delivery Trucks				
Informal or Illegal piped connections				
Private Boreholes or wells				
Surface Water				

Note: The information in the table above comes from the survey data collected for this research.

4.4.Small-Scale and Informal Water Quality Analysis

4.4.1. Dar es Salaam

In Dar es Salaam, the average perceptions of the quality of the water served by informal water providers is 5.25/10 which is 34.38% lower than the NGOs' perceptions of water provided by DAWASA. However, there was wide variation amongst the NGOs with some rating the quality as low as three while others rated it a six or seven. TAEEs, which rated the water quality as a seven, even went so far as to say that "water quality from small and informal water providers is fairly good." Three of the NGOs surveyed, including one which rated the quality as a 6/10, specifically mentioned that it is common for contaminants to be introduced to this water during transportation because the tanks are not regularly cleaned or properly treated. For this reason, SUWODE mentioned that many consumers boil their water before consumption, per recommendations from NGOs as well as the Tanzanian government. However, it is also worth noting that water quality perceptions may be dragged down by water pushcarts and delivery trucks specifically as their transport tanks were singled out as a primary source of contamination.

4.4.2. Accra

In Accra, despite the relatively high marks that the small-scale and informal water providers receive overall (7/10), when we dig deeper into the quality of the water provided, the survey respondents unanimously scored the water quality of informal providers at least 37.5% lower than that of the formal water supply. Their average rating was 4.33/10 which indicates serious concerns about the safety of the water being provided to consumers who rely on these distribution methods. As in Dar es Salaam, the lack of sanitation of the containers that the small-scale and informal water providers use to deliver water to consumers is noted as a primary source

of contamination by every respondent. However, unlike in Dar es Salaam, two of the three respondents also sited that some providers source non-potable water "straight from streams and dams" and market it to consumers as purified water since the source is difficult for consumers to prove.

4.4.3. Monrovia

In Monrovia, where 82% of the population primarily receives their water from small-scale providers, WaterAid rated their quality a 7/10 and noted that the vast majority of the time the water quality is quite high. They attributed this primarily to the government's strict oversite of the quality of the water provided by small-scale water vendors in the city. Additionally, WaterAid itself oversees regular water quality testing at a variety of public standpipes throughout the city. However, WaterAid also indicated that there are rare cases in which contaminated water is unknowingly sold by vendors. Additionally, Monrovians who collect water from groundwater sources are, by nature of the source, collecting non-potable water that must be sterilized to be drinkable and even then, may contain chemical components that are harmful to their health.

4.4.4. Nairobi

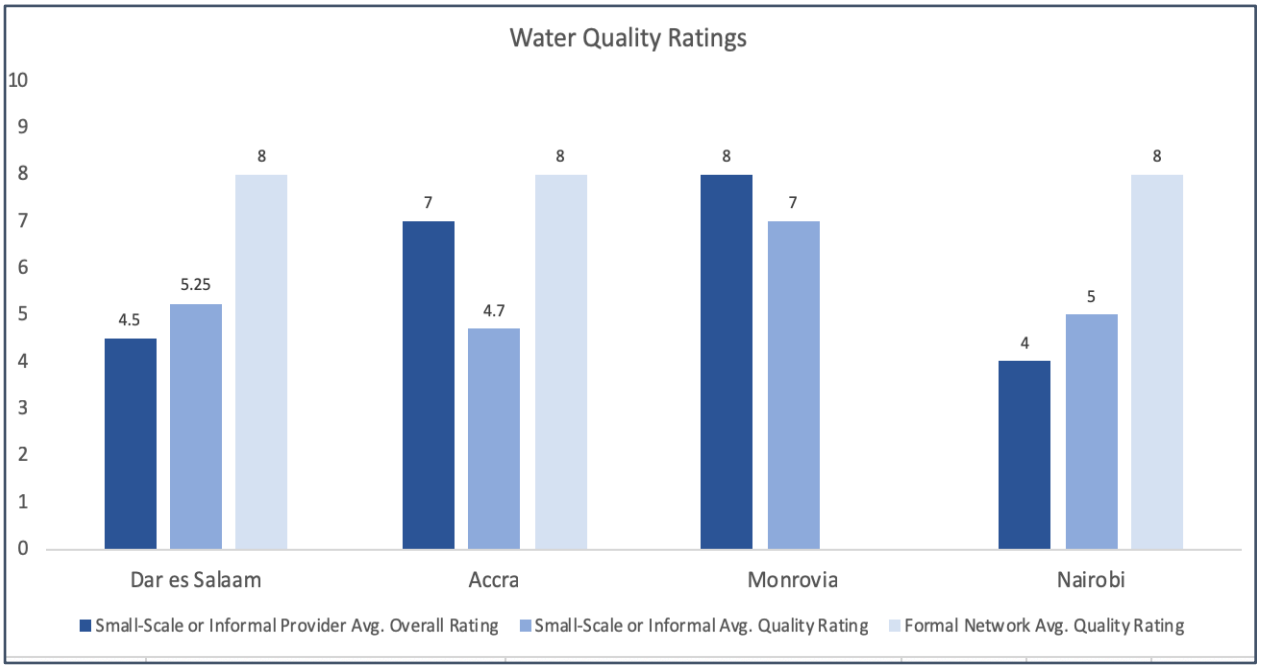
In Nairobi, part of the reason for the NGO's low rating of the relationship between consumers and small scale or informal water providers most certainly comes from concerns about the quality of the water being provided. WSUP rates water quality from these sources 37.5% worse than that of the formal water network despite a significant portion of the water sold by small-scale and informal vendors originating from the formal network. The reason given for

this disparity is that, although the water often starts as clean, storage and transportation may introduce the water to pathogens and chemicals that are harmful to human health.

4.4.5. Overall Observations

Across these four cities, the quality of the water provided by the small-scale and informal water providers is unanimously viewed as worse than the quality of the water provided to residents by the central water distribution networks. The most commonly cited reason for this disparity is that the storage and transportation methods used by these small-scale and informal providers is contamination stemming from providers' failure to store and transport the clean water that they have in sanitary vessels. In particular, the tanks in water trucks and push carts seem to introduce pathogens to the water because they aren't cleaned regularly. On the positive side, however, the false advertising of non-potable water by these providers was only cited as an issue in Accra indicating that the practice may not be as widespread as some prior researches have claimed.

Figure 1: Water Quality Ratings



Notes: The information in this graph above comes from the survey data collected as part of this research.

4.5.Small-Scale and Informal Water Provider Pricing

4.5.1. Dar es Salaam

When looking at the pricing of water by the small-scale and informal water providers in Dar es Salaam, the NGOs are generally more concerned than they are about the water quality. Based on their estimates, consumers pay anywhere between three times and 10 times more for water from informal water sources, with an average estimate of 6.29 times more. These estimates are rough because pricing can vary drastically. According to the NGOs, a variety of factors influence how water is priced by informal suppliers on a given day. One of the most influential factors seems to be the cost of transportation and the distance the consumer is from the water source as three of the NGOs indicated that this was a primary factor. Another

important factor seems to be the demand for water and the competition in the area amongst different providers. Furthermore, two NGOs mentioned that the quality of the water, its salinity in particular plays an important role in determining the price distributors charge. Finally, TAEEs indicated that the season can play a significant role in pricing as water in the dry season can cost as much as five times more than in the rainy season.

This large increase in price in Dar es Salaam is particularly concerning because those using informal water sources, rather than the central water network, also tend to be those least able to pay for water. This unfortunate reality is only compounded by the fact that water prices are generally higher the further one goes from the city center (the clean water source) because those distant and often informally constructed settlements tend to be the poorest. These attributes make the current water pricing situation in Dar es Salaam employed by small-scale and informal water providers extremely regressive. Largely due to this information, three of the water NGOs operating in Dar es Salaam indicated that the pricing of small-scale and informal water providers is exploitative, with one responder abstaining. The reasons they gave for this belief focused on the fact that water prices are largely based off of consumers' demand, thus forcing those in most need of water to pay the most, and the perception that the informal water providers' profit margins are quite high. However, contrary to the findings of researchers elsewhere, none of the NGOs pointed to the formation of water cartels or price fixing as the cause for the price disparity. This indicates that, at least to a degree, water pricing is based off of the costs that the small-scale and informal water providers are facing in Dar es Salaam.

4.5.2. Accra

In Accra, the data collected from the NGO surveys indicates that, like Dar es Salaam, water sold from small-scale and informal water vendors tends to be more expensive that the water sold by the formal network. In Accra, the premium paid for informal water service over the utility reportedly varies between 300% and 2000%, with the former being more common. All three NGOs surveyed indicated that transportation costs, including labor and fuel, were the primary factor driving factors of the increased price. However, clearly the price isn't completely dictated by the costs that these providers are facing as every NGO indicated that the pricing of the informal water providers is "exploitative." Two of these NGOs specifically mentioned that the lack of options for consumers as a driving factor behind their opinion of the pricing model as exploitative. The result of the variation in price is that the 31% of population of Accra without reliable access to the central water network, who are disproportionately poor and new to the city, have to pay significantly more for their water. This effect is compounded for those who live in peri-urban environments further from where the water is brought in from because the cost of transporting the water to them is much higher.

4.5.3. Monrovia

For the Liberian city of Monrovia, unfortunately WaterAid Liberia claimed not to have reliable insights into the exact pricing of small-scale water providers in the city. However, they did indicate that the pricing is tightly controlled by the government to avoid price gouging and that regulatory agencies set prices based on the estimated costs these small-scale suppliers face.

4.5.4. Nairobi

In Nairobi, despite concerns about water quality, the biggest qualm that the experts at WSUP have with the small-scale water market is the pricing. According to WSUP, Nairobi's residents can expect to pay between six and 40 times more for their water if they're not fortunate enough to have water piped into their homes from the central water network. According to our survey respondent, the primary reason for this pricing model is the fact that there are local water cartels operating throughout the city that set the price on a product with extremely inelastic demand (water). Since the consumers have few options, they are forced to pay the prices that WSUP described as "exploitative." This practice creates an enormous burden for many of the urban poor of Nairobi who, as a result, are forced to spend an outsized percentage of their income on water. However, WSUP did note that not every neighborhood who relies on small-scale or informal water providers has their water supply controlled by a cartel and as such water prices can vary greatly in different parts of the city.

4.5.5. Overall Observations

Across these four cities, the pricing of small-scale and informal water providers is a central complaint of the NGOs who generally view the pricing models as "exploitative" and regressive. Across the cities, the pricing of these providers is inherently regressive in nature because those without water connections must pay higher prices to receive their water. These same individuals tend to be somewhat poorer than their neighbors with piped water connections and as a result must spend a larger proportion of their disposable income on water. In three of the cities, competition, or a lack thereof, is also mentioned as a problem because without it the

small-scale and informal water providers have the ability to charge much more as the consumers have few alternatives for obtaining this precious resource.

4.6.The Role of Regulatory Environments

4.6.1. Dar es Salaam

In Dar es Salaam, the government currently doesn't play a significant role in regulating the operations of informal water providers. However, the NGOs surveyed in the city unanimously agree that regulation is necessary. In particular, the NGOs seem to believe that government regulation of the informal water providers' pricing should be a priority with every respondent indicating that managing costs to consumers is extremely important. Two of the respondents also indicated that water quality controls should be an important factor in any future regulation of this sector. Additionally, all of the NGOs who responded indicated that they believe regulation of some sort is likely or possible in the near future.

However, there is widespread disagreement amongst the NGOs over what exactly will or should be enacted in Dar es Salaam. Of those surveyed, two indicated that they believe EWURA, the body that oversees utility operations in Dar es Salaam, should simply expand its mandate to regulate the pricing and quality of small-scale water providers. However, other policies recommended include threshold pricing, the creation of a new government body to regulate this market, or the introduction of a system that increases competition between providers in peri-urban environments. Each of these recommendations have pros and cons, but the disagreement over the best course of action may cause an impasse that will stymie progress going forward. This is in-ideal because every NGO from Dar es Salaam included in this survey

also indicated that they anticipate that informal water providers will continue to play an outsize role in the water distribution systems of Dar es Salaam in the long term.

4.6.2. Accra

Like Dar es Salaam, Accra doesn't have any regulatory framework put in place to oversee the operations of the informal water distributors in their city. However, the NGOs operating in Accra unanimously indicated that they believe that some unspecified regulation around the distribution of water by small-scale and informal water vendors in the city would be beneficial. The NGOs who responded all indicated that it would be beneficial for the city to do something to ensure that consumers are receiving high quality water at a reasonable price. Specifically, the NGOs recommended that a new agency be created to license informal water providers in a scheme that seems fairly similar to the one implemented in Monrovia. However, despite the NGOs agreeing on what should be done, none is optimistic about the odds of Accra implementing any sort of regulation since all respondents gave a tentative "maybe" when asked about whether the government would implement regulation in the future. Perhaps this is because the legislators, like 2/3 of the NGOs surveyed, don't expect informal water providers to continue playing a large role in the city's water distribution system in the long run. However, WaterAid Ghana, which does see a future for these providers in the city, might think this view is overly optimistic considering that the percent of Accra's population serviced directly by the central water network has been in decline since at least 2000[28].

4.6.3. Monrovia

Monrovia is one of the two cities in this study in which the city government has built a regulatory framework for small-scale water vendors to operate within. Specifically, Monrovia employs a licensing scheme in which vendors must pay for a license and receive random water quality checks in order to operate in the city. Additionally, the city mandates that vendors distribute themselves throughout the city to ensure that every population is served and subjects them to some level of price controls to prevent price gouging. In rating the impact of the regulation on the water distribution systems of Monrovia, WaterAid Liberia had nothing but good things to say and rated the impact of the regulation as "extremely positive," the best possible rating. Additionally, they indicated that, at this time, they don't think any changes to the regulatory framework are necessary or forthcoming. For the city of Monrovia, getting this regulatory framework right is particularly important because of how large the percentage of their population relying on these small-scale water providers is and because WaterAid Liberia expects these small-scale providers to continue playing an essential role in the city's water distribution network in the long-term.

4.6.4. Nairobi

Nairobi is the other city that was covered in the scope of this survey that has implemented a regulatory framework. Specifically, the regulation requires licensing for water vendors selling more than 25 liters of water per day[14] . This means that some small-scale water providers may not be required to meet the standards mandated in the law. WSUP declined to comment on the success of the regulatory framework put in place by the city of Nairobi to regulate the informal water market. However, based on their views of other aspects of the operations of informal and

small-scale providers in the city, one could presume that it is not currently having its desired effect of managing the pricing and quality of the small-scale and informal water providers. This poses a problem because WSUP also predicts that informal and small-scale water providers will continue to play an important role in the urban water distribution ecosystem of Nairobi in the long term.

4.6.5. Overall Observations

Across the four cities included in the scope of this research project, the NGOs unanimously indicated that they are in favor of regulating small-scale and informal water providers to ensure that consumers are receiving high quality water at reasonable prices. However, there seems to be a lack of consensus among experts over what shape that regulation should take. The examples of the Monrovia and Nairobi should serve as a case study over why careful implementation of this regulation is important. Based on the responses received as part of this study, Monrovia appears to be a success story for providing high quality and reasonably priced water to citizens without water connections while Nairobi appears to have failed to improve the water quality and pricing structure many residents face through their regulation. Ensuring that the best and most effective policies are identified and implemented is of upmost importance to all of the cities included in this study, and likely for most cities in Sub-Saharan Africa, as NGOs expect small-scale and informal water providers to play an important role in the water distribution ecosystem for years to come.

5. Conclusion

Given all of the above information, how might we conclude do NGOs perceive the relationship between informal water service providers and their customers? What do NGOs view as the role of government in mediating this relationship?

As this research demonstrates, answering this question is not as straight forward as it may seem. However, despite variation in opinions across cities, NGOs generally seem to view the small-scale and informal water providers as imperfect, but necessary. Although they broadly disapprove of the water quality and pricing of these providers, they also recognize that they play a vital role in providing this resource to large populations in cities in Sub-Saharan Africa who might otherwise struggle to collect water. This research also indicates that NGOs in these cities are broadly supportive of significant government regulation of the relationship between these providers and their customers. However, identifying the best form of regulation falls outside the scope of this research.

In further identifying the primary lessons learned in this study, it is important to re-state that this research was not designed to come to firm conclusions that are generalizable to urban water distribution systems in Sub-Saharan Africa. This is largely due to the small sample size and the use of NGOs as proxy experts rather than conducting direct field research. Instead, this paper aimed to test the conclusions of other researchers and identify topics in this field that are worthy of revisiting in greater depth by researchers and policy makers.

The data collected as part of this study confirmed a variety of findings pointed out by previous researchers in single city case studies. This indicates that these trends may be generalizable to the small-scale and informal water distribution networks globally. Specifically, NGOs in all four cities confirmed that the water sold by small-scale and informal water providers is significantly more expensive than water from the central water utility. Confirming this finding is extremely important because it serves as further evidence that investment in expanding central water networks to more people would financially benefit the residents. It would do so because, so long as water prices held constant, the newly connected residents would receive less expensive water. This research also confirmed that, as indicated by other researchers, the quality of water sold by small-scale and informal water providers is generally perceived to be lower than that of the central water utility.

However, this research was also unable to find evidence to support the generalizability of some previous researchers' findings. Specifically, the existence of informal water cartels does not seem to be a widespread occurrence, as WSP Global indicated, since they were only identified by an NGO in one of the four cities in this study[15]. Additionally, small-scale and informal water providers were observed to be falsely marketing non-potable water as potable in Accra, but not in any of the other three cities.

With regards to regulation, this paper found that there seems to be consensus amongst the experts surveyed for this project that regulation of the informal water sector can have positive impacts. Additionally, this study, though limited in its analysis of Monrovia specifically, seemed to confirm Pinera and Reed's findings that the Monrovian regulatory system has been extremely

successful[6]. Monrovia scored better than any of the other cities by a significant margin in every category of perceptions of their small-scale water providers. However, Nairobian providers scored average or below average in most categories indicating that not all forms of regulation are equal.

Finally, this research seems to indicate that there could be high returns to focusing on working to clean the vessels in which water is transported and stored for water-focused NGOs, development groups, and governments. From a cost perspective, this is likely an inexpensive path compared to other water quality improvement initiatives and the survey results indicate that a lack of sanitation in these containers has a significant impact on the quality of water people wind up receiving.

Looking to the future, the results of this survey raise a wide variety of additional questions that would require more in-depth research. Specifically, a more in-depth economic analysis of water supply and demand in these cities that leads to the wade range of water prices could help better understand how to regulate the sector effectively to keep prices down. Additionally, because there was so much variation in both price and quality of the water provided by small-scale and informal water providers, additional research aiming to understand how the different types of small-scale and informal water providers (e.g. water trucks, public standpipes, etc.) impact these two variables could yield important information that could improve water provision in sub-Saharan African cities. Finally, the vast differences between the results of the two cities with regulation that were included in this study begs the question, "What makes a regulatory environment successful?" Why is it that Monrovia's, and not Nairobi's, regulatory

environment succeeded in improving water quality while cutting the costs to consumers? With this information, it would be much easier for aid organizations and governments to improve the quality and reduce the price consumers in Sub-Saharan African cities are paying for water.

6. Appendices

6.1. Survey Questions

1. What city do you work in?
2. What is the name of your organization?
3. How long has your NGO operated in your city?
4. In your opinion, what are the water collection options for consumers in your city? Please check all that apply.
5. If you were to estimate, what percentage of households are getting water from small-scale or informal water providers in your city?
6. In general, do you view the relationship between small-scale water providers and consumers as positive or negative? Please rate the relationship on a scale of 1 (extremely negative) to 10 (extremely positive)
7. What aspects of the relationship between small-scale or informal water providers and consumers do you view as positive?
8. What aspects of the relationship between small-scale or informal water providers and consumers do you view as negative?
9. Please rate the quality of the water provided to residents of your city by small-scale or informal water suppliers on a scale of 1 (extremely bad) to 10 (extremely good).
10. Why do you think that the water quality from the water that small-scale and informal water providers sell is what it is?
11. Please rate the quality of the water provided to residents of your city by the central water authority on a scale of 1 (extremely bad) to 10 (extremely good).
12. Why do you think that the water quality from the central water authority provides is what it is?
13. If you were to estimate, on average how much do the different types of small scale or informal water providers operating in your city charge consumers per unit of water?
14. In your opinion, what factors primarily determine the pricing of the small scale or informal water providers?
15. If you were to estimate, on average how much does the central water authority charge consumers per unit of water?
16. In your opinion, what factors primarily determine the pricing of the central water authority's water?
17. In your opinion, is the pricing model of either of these two groups of water providers exploitative?
18. In question 17, if small-scale and informal water providers is selected: Why do you think the pricing models of small scale or informal water providers is exploitive?
19. In question 17, if the central water authority is selected: Why do you think the pricing model of the central water authority is exploitive?

20. Does the city or state in which you work regulate small or informal water providers to any degree?
21. In question 20, if yes is selected: What regulatory policy has your city enacted towards small or informal water providers?
22. In question 20, if yes is selected: What impact do you think the regulation of small or informal water providers has on urban water distribution in your city?
23. In question 20, if yes is selected: Would you make any changes to the current regulatory framework dealing with small or informal water providers in your city?
24. In question 23, if yes is selected: What changes would you make to the regulatory framework dealing with small or informal water providers in your city?
25. In question 20, if no is selected: Would you like to see regulation on small scale or informal water providers in your city?
26. In question 25, if no is selected: Why do you not want to see regulation of small scale or informal water providers in your city?
27. In question 25, if yes is selected: Why would you like to see regulation of small scale or informal water providers in your city?
28. In question 25, if yes is selected: What regulatory framework would you like to see implemented in your city regarding small scale or informal water providers? Why?
29. In question 20, if no is selected: Do you see the regulation of small scale or informal water providers as a policy that government regulators in your city may implement in the future?
30. In question 29, if yes is selected: If your city were to implement a regulatory framework managing small scale or informal water providers, what do you think they would implement?
31. Do you believe that investment in the centralized water network of your city is sufficient?
32. Who do you think should pay for expansions to your city's centralized water network? Please select all that apply.
33. In question 30, if no is selected: In your opinion, where should additional funding for your city's central water network be directed?
34. Who are the main contributors to funding for urban water distribution in your city? Please select all that apply.
35. Does your city currently have a strategy for expanding the central water network?
36. In question 35, if yes is selected: Do you believe that your government's strategy for expanding the central water network is the right one?
37. In question 35, if yes is selected: What is your city doing right with regards to expanding the central water network?
38. In question 35, if yes is selected: What would you like to see your city do differently with regards to expanding the central water network?
39. In question 35, if no is selected: Do you think your city should implement a strategy to expand the central water network?
40. In question 39, if yes is selected: What strategy do you think your city should implement to expand the central water network?
41. In question 39, if no is selected: Why do you think your city should not implement a strategy to expand the central water network?
42. In the long run, do you believe that there's a role in the water distribution ecosystem in your city for small or informal water providers to continue providing water to residents?

43. Why do or do you not believe there is a role in the urban water distribution ecosystem of your city for small or informal water providers in the long term?
44. Do you have any other comments or pieces of information that may be helpful for me to know during the process of conducting this research on small and informal water providers in your city?

Note: NGOs had the option to abstain from some questions in the survey.

6.2.Definitions

Slum: A slum is a "contiguous settlement that lacks one or more of the following five conditions: access to clean water, access to improved sanitation, sufficient land area that is not overcrowded, durable housing and structure tenure" [11]

Peri-Urban Environment: An area of mixed use residential and agricultural land with population density somewhere between that of urban and rural communities. These areas are generally found on the outskirts of cities.

Formal Supply: Public or Private supplier of a service that is formally recognized by the government and authorized to provide a given service for its citizens. It generally takes the form of the utility.

Informal Supplier: Private supplier of a service that is not formally recognized or authorized by the government. They are considered informal in the sense that they operate informally either in their technical capacity or in their relationship with their consumers[5].

Small-Scale Water Provider: This is a provider that has the capacity to deliver a set amount of water which serves as supplementary to the formal water supply. Small-scale providers can be either informal or formal depending on the regulatory environment.

Improved Water Source: A water source that has either been purified or comes from a place where it is unlikely to have come in contact with contaminants such as unfiltered rain water.

Tanker trucks: Trucks, usually modified pickup trucks, with the capacity to carry large quantities of water from a fill station to paying consumers at the point of delivery.

Kiosks: Water stands manned by an operator where local residents can come and collect water in containers for a per-liter fee.

Private Boreholes/Wells: A pump or well someone has drilled in order to access a groundwater source in order to get clean water.

Spaghetti connections: Small plastic pipes which are illegally connected to the central water grid by residents to pipe water to a home not connected to the formal water supply. These pipes can run for miles and typically have extremely low water pressure.

Formalization: Formalization is a process in which small-scale or informal water providers are recognized in the eyes of the law but must accommodate government regulation of their activities in return.

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