TANKER-SUPPLIED WATER BUSINESS IN JUBA

JABE A. ROMAN

JANUARY 2021

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ii. ACKNOWLEDGEMENT

I would like to express my thanks and appreciation first and foremost to South Sudan Center for Strategic and Policy Studies (CSPS) for commissioning this study. I have received valuable input from Dr. John Gai Yoh, Dr. Melha Biel Rout, Mr. Bul John and the staff of CSPS. I also owe a debt of gratitude to South Sudan Urban Water Corporation and Juba City Council Public Health Department for their insights. Last but not least, I am grateful to all the individuals who found time during these difficult times to respond to the questionnaire whose findings has informed some aspects of this study.

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iv. ABBREVIATIONS

AfDB	African Development Bank
CPA	Comprehensive Peace Agreement
JICA	Japan International Cooperation Agency
JCC	Juba City Council
JMP	Joint Monitoring Programme
MDGs	Millennium Development Goals
MDTF	Multi Donor Trust Funds
MWRI	Ministry of Water Resources and Irrigation
SDGs	Sustainable Development Goals
SSUWC	South Sudan Urban Water Corporation
UNICEF	United Nations Children's Fund
UWSS	Urban Water Supply and Sanitation
WASH	Water and Sanitation Hygiene
WHO	World Health Organization

1. EXECUTIVE SUMMARY

South Sudan's infrastructure, including water infrastructure, was severely underdeveloped due to years of civil war. In Juba, the water treatment facility that was rehabilitated in the 1970s was able to supply most of the old neighborhoods of Juba town. However, after the signing of the comprehensive peace agreement, the population of the city grew immensely and is continuing to grow. Thus, the supply capacity is severely strained. Exacerbating the situation further is the fact that transmission lines that were rehabilitated as recently as 2009 have been destroyed, cutting off supplies to even areas of the town that previously had a water supply. Little has been done since then to rectify the situation. Thus, the piped water system is very limited. It supplies only a few parts of the town.

The limited piped water network in Juba means that water vendors, especially water tankers, have stepped in to fill this supply gap. Hence, this study investigated water tanker businesses in Juba by looking into their operation, challenges, and existing regulation regime, if any. The study used convenience sampling to obtain data from 269 respondents from the three main town blocks, namely, Juba, Kator, and Munuki in addition to the area of Gudele. Although Gudele is not a town block in Juba, it is served by the same water tankers. Interviews were also conducted with representatives of Juba City Council and South Sudan Urban Water Corporation.

The main findings of the study include the following:

i. Less than 2% of the respondents depend on piped water as their main source of water. However, the unreliability of piped water caused this 2% of the respondents to depend on water tankers as a secondary water source.
ii. Approximately 95% of respondents depend on water tankers as their main source of water. The other roughly 5% depends on piped water and borehole water.
iii. The other available water sources include household resellers, bicycle vendors, boreholes, and public wells. They are used as secondary sources of water by 8%, 4%, 28%, and 1% of the households, respectively. For the remaining 49% of households, there are no other options when tankers are not available.
iv. Water tankers are available daily from 6 am-6 pm. However, they are usually not reliable, due to issues such as breakdowns, lack of fuel, etc. Recently, their unreliability has increased due to contentious pricing issues.
v. The average daily water consumption per person in Juba City is about 31.27 L/day. Juba Payam has the highest daily individual water consumption of 45.85 L/day, while

Kator, Munuki, and Gudele have 27.67 L/day, 27.13 L/day, and 26.69 L/day, respectively.

vi. The price of water during the study period kept increasing due to the prevailing economic situation. In November, the price of tanker-supplied water ranged between 350 and 1000 SSP per 200 L. More than 60% of the respondents did not find the prices affordable.

vii. 28.14% of the respondents coped with the high prices by reducing their consumption, 62.36% by reducing money in other budget areas to maintain their consumption, and 7.60% have opted to use cheaper sources of water.

viii. 79% of the respondents use tanker water for drinking. Nearly 52% of those respondents who use tanker water for drinking do not treat their water before drinking it. Treating water by adding chlorine is more popular among respondents than boiling the water.

ix. Although 65% of the respondents find the water delivered by tankers to be clean, 82% have received dirty water from a tanker within the last 9 months.

From the findings, the main challenges with water tankers are to do with their availability, reliability, affordability, and water quality. Although there are plans to improve the piped water system in Juba, the plans have been stalled several times due to conflict. Even when the plans are implemented, water tankers will continue to play a role in water access. Thus, the following recommendations are made.

i. Create an enabling environment for development in the water sector through peace and stability and a true commitment to development.

ii. Establishment of a regulatory framework through the enactment of the Draft Bill of 2013.

iii. Capacity building of the institutions involved in the water sector.

iv. Master infrastructure plan and coordination of efforts between the relevant actors.

v. Effective water quality assurance system that routinely tests and monitors water quality across all points of the supply chain including point of consumption to ensure safe drinking water to all.

vi. Multidisciplinary research on water access.

2. INTRODUCTION

Access to safe, affordable, and readily available water is a human right and essential to an improved standard of living. Fulfillment of the human right to water creates a healthy and economically productive society. Piped water on the premises is seen as the gold standard to fulfilling this right, especially in urban areas. However, water utilities in urban areas in developing countries haven't been able to ensure universal access to safe, readily available water. Water vendors have stepped in to fill the gap of municipal systems and are now prevalent in major cities in Africa, Asia, and South America. Empirical studies on water vendors in these cities show these unregulated service providers are usually characterized by high prices and sometimes poorer quality water which has led many to question whether they improve or worsen the water access situation (World Bank, 2019) (Raina, Gurung, & Suwal, 2020).

The long years of civil war and underinvestment have left South Sudan's infrastructure, including water infrastructure, severely underdeveloped. In 2011, only 2% of the country's population had access to piped water supply against an average of 33% for Sub-Saharan countries (African Development Bank, 2011). The heavy toll exacted by the lack of safe, readily available water on the health and economic productivity of South Sudan has long been recognized by the government and its international partners. Since the Comprehensive Peace Agreement period, the government developed Water Policy 2007 and plans and strategies such as South Sudan Development Plan 2011-2013, South Sudan Development Initiative (SSDI) 2013-2020, South Sudan National Development Strategy 2018-2021, etc. which all prioritize water access as one of the drivers of economic development. The main water infrastructure rehabilitation and expansion plan are the Juba Urban Water Supply and Capacity Building Plan by the Japan International Cooperation Agency (JICA) which would ensure universal coverage of piped water in Juba by 2025. However, implementation of these plans and strategies has been slow mainly due to conflict, insecurity, and weak institutional capacities. As such, water access remains a challenge, even in the capital city of Juba.

The limitations of the piped water system in Juba mean that most residents are dependent on private water tankers and boreholes for their water supply. However, literature about water access in Juba and water vending is limited. The two major studies are surveys by JICA in 2008 (JICA, 2009) and AECOM in 2013 (AECOM, 2014). The two surveys show that the prevalence of tanker water has been growing over the years and like other cities, pricing and water quality were the main challenges. Water quality was the most concerning of the two as borehole water was of high salinity and tankers drew untreated water from the river. Chlorination of tanker

water before delivery has since been introduced but no study has been conducted to see whether this has addressed the water quality issues. Regulation or lack thereof is an important aspect in water vending literature yet no study covers regulation, if any, of water tankers in Juba or the role/attitude of authorities in tanker water service delivery.

The study aims to bridge these gaps in the body of knowledge by investigating how tankers function in Juba, their challenges, and the role of authorities in the business. Government plans for modern infrastructure, once implemented, affect tanker water operations, therefore, they are also investigated.

2.1. The objectives of the study include:

- Evaluating the challenges associated with the use of water tankers
- Determining the role of Juba City Council and other authorities in regulating the business
- Exploring government plans to put in place a modern water supply system

2.2. The paper is structured as follows:

- **Chapter One** introduces the study, its objectives, and structure
- **Chapter Two** presents the literature review on water access and water vending in developing countries and South Sudan
- **Chapter Three** presents the legal and regulatory framework governing South Sudan's water sector, the national institutions involved in the water sector, and some of the challenges faced by the sector.
- **Chapter Four** presents the methodology used to obtain data for the study
- **Chapter Five** presents the findings of the quantitative portion of the study.
- **Chapter Six** discusses the findings of the study
- **Chapter Seven** articulates the conclusion of the study

3. LITERATURE REVIEW

3.1.Access to clean water

Water is the essence of life. As a basic need, it is used for cooking, drinking, and personal hygiene, activities necessary to maintain good health. It has long been recognized that to meet these basic needs, water needs to be available to individuals at an adequate quantity and acceptable quality. Where the quantity of water is not adequate, individuals and communities are vulnerable to water-related diseases. Substandard quality of drinking water is well known in epidemiology as a significant transmission route of diseases.

The quantity of water used by individuals/households is dependent on physical accessibility, which is determined primarily by distance and time. Water sources located on-premises implies minimal time and effort by household members to collect water. Water consumption of individuals who have water sources on the premises is nearly more than double the consumption of those who have no water sources on the premises (Jeandron, Cumming, Kapepula, & Cousens, 2019). As the distance between the water source and the premise increases and/or the time spent queuing for water increases, the water consumption decreases. Quantity is also dependent on reliability as when water services are unreliable/intermittent, both on or off-premises, households will usually store the water and reduce their consumption (UNICEF & WHO, 2017).

The quality of water deteriorates through contamination by anthropogenic and natural pollution. The most common contaminant is microbial contamination from fecal matter, which is linked to infectious diarrheal diseases. Water quality has been shown to deteriorate between the point of collection and point of use (UNICEF & WHO, 2017), usually due to unsafe water handling and water storage practices e.g. open storage containers which are risk factors for microbial contamination (Jeandron, Cumming, Kapepula, & Cousens, 2019) (Shaheed, Orgill, Montgomery, Jeuland, & Brown, 2014). On-plot piped water is the only water source that does not require water storage. However, when the service is unreliable or intermittent, households resort to water handling and storage. Additionally, intermittent piped water systems are not continually pressurized, which makes them prone to microbial contamination through ingress in the distribution network (UNICEF & WHO, 2017) (Jeandron, Cumming, Kapepula, & Cousens, 2019) (Shaheed, Orgill, Montgomery, Jeuland, & Brown, 2014). Chemical contaminants in water can also pose serious health risks when they exceed certain concentrations/levels.

Globally, three in ten people lack access to safe drinking water (UN, UN World Water Development Report, 2019). As such, they must contend with using contaminated sources of water for cooking and drinking. Diseases especially diarrheal diseases are prevalent in such communities leading to loss of life, workdays, and schooldays. Often, those without access to clean water need to travel long distances to get to a water source, a burden often borne by women and girls. This prevents girls from going to school, while for women, a lot of time that could have been spent on more productive tasks is spent fetching water. Beyond the staggering loss of life, the burden of disease, coupled with time spent collecting water, represents a significant drag on the economies of these countries (USAID, 2017). Providing access to clean, readily available water improves access to education and healthcare; creates economic opportunities, and promotes gender equality, which in turn leads to poverty reduction and economic growth. Global cost-benefit analysis has shown that improved drinking water has a benefit to cost ratio of 2.0 (UN, UN World Water Development Report, 2019).

Since the 1980s, the right to water was being expressed as an implicit component of other fundamental rights or was explicitly declared in non-binding instruments that were designed to meet specific ends. The campaigners for its explicit expression argued that the formal acknowledgment of water as a fundamental right would be a way of encouraging the international community and governments to satisfy basic human needs and meet the Millennium Development Goals (MDGs) (Scanlon, Cassar, & Nemes, 2004). Water was finally explicitly expressed as a human right in 2010 by the UN General assembly under resolution 64/292. In response to the 2010 resolution, the UN human rights Council called upon states to "develop appropriate tools and mechanisms, which may encompass legislation, comprehensive plans, and strategies for the sector, including financial ones, to achieve progressively the full realization of human rights obligations related to access to safe drinking water and sanitation, including in currently unserved and underserved areas." The normative criteria for the human right to water include sufficiency, safety, cultural acceptability, accessibility, and affordability. According to WHO, 50-100 L/person/day is needed to ensure most basic needs are met and few health concerns arise. Physical accessibility means distances that are within 1000m of the home with collection time not exceeding 30 minutes. Meanwhile, affordability is defined as water cost that does not exceed 3 percent of household income.

The UN MDGs of the 2000s aimed to motivate and mobilize global development. The target for the WASH sector was to halve the population of the world without access to clean water and improved sanitation by 2015. Although this target was achieved 3 years early, it was

heavily criticized as its benchmarks were considered arbitrary and its improved vs unimproved monitoring system was deemed not suitable (Herrera, 2019). Improved sources were those which, by the nature of their construction and when properly managed, adequately protect from contamination, especially fecal contamination (UNICEF & WHO, 2017). These include piped water, boreholes, protected dug wells, and rainwater whereas unimproved sources included unprotected dug wells and unprotected spring wells (UNICEF & WHO, 2017). The reliability and the quality of water were not included in the monitoring system yet in developing countries, having piped water is not a guarantee that it will be available 24/7 (Ayalew, et al., 2014). In sum, the MDGs grossly underestimated the extent of the water access problem and lacked a concrete framework to enable the realization of the human right to water (Brown, Nelves-Silva, & Heller, 2016).

Goal 6 of UN's Sustainable Development Goals 2030 is to "ensure access to safe water sources and sanitation for all", meaning no one is to be left behind. Not only is access to clean water its own goal, but the UN also sees it as a key foundation in achieving other sustainable development goals such as good health and gender equality. SDG 6 estimates that the economic impact of not investing in infrastructure is much greater than the cost to invest in infrastructure. As more people continue to die from preventable diseases, it undermines prosperity as well as efforts towards a more sustainable future. More effort is being made to put human rights into the present and future politics (Brown, Nelves-Silva, & Heller, 2016). While in the MDGs, human rights were conspicuously absent, the SDGs endorse the importance of human rights as a sociopolitical framework, making explicit reference to the human right to water and sanitation (Brown, Nelves-Silva, & Heller, 2016).

The Joint Monitoring Programme (JMP) recognized the shortfall in their MDG monitoring system. To monitor the SDG 6 targets, it has built on the established indicators by introducing a differentiation on the service levels based on the normative criteria of the human right to water (UNICEF & WHO, 2017). Thus, improved vs unimproved sources are still used but improved sources are further classified into limited, basic, and safely managed. The three elements of safely managed water services are accessibility, availability, and quality (UNICEF & WHO, 2017). Thus, a safely managed source is defined as (1) water-free from fecal and priority contamination; (2) water that is accessible at the premises and (3) water that is available when needed (Jeandron, Cumming, Kapepula, & Cousens, 2019). One already identified a shortfall of the SDG monitoring system is the emphasis placed on the main sources used by households yet the use of multiple sources of water by households is widespread (UNICEF &

WHO, 2017), (Jeandron, Cumming, Kapepula, & Cousens, 2019). Often, these secondary sources are of lesser quality and hygienic practices are sometimes temporarily abandoned (Jeandron, Cumming, Kapepula, & Cousens, 2019).

Affordability is part of the normative criteria of the human right to water and consequently, an important element in the SDG 6 goal. Affordable water means that payment for water should not prevent individuals from acquiring other services and goods protected by human rights such as food, housing, health, clothing, and education (UNICEF & WHO, 2017). Affordability can also be a barrier to accessing safe, adequate water as when the cost of water is above the household budget, households may resort to using water sources that are far from home and/or water sources that are contaminated. The main practical method of measuring affordability is to compare the expenditure on the water as a proportion of annual income with the affordability threshold. However, there is no international agreement on the appropriate value for the affordability threshold (WHO & UNICEF, 2021). It is recommended that affordability standards should be defined by a participatory process at the national and/or local level, involving poor and marginalized people (Heller, 2015).

3.2.Water vending in developing countries

Developing countries especially Sub-Saharan Countries have huge disparities in piped water access in urban areas versus rural areas. However, even in urban areas, water access leaves a lot to be desired. Utilities not only face challenges in expanding the piped water service, but they also face challenges maintaining and operating the existing piped networks (Kjellen & McGranahan, 2006). The capacities of utilities are particularly challenged by rapid population growth especially in informal settlements. Hence, a significant proportion of the urban population especially those in informal settlements lacks access to piped water and even for those with a supply, the service is poor and unreliable (Raina, Zhao, Wud, & Kunware, 2019) (World Bank, 2019). Some cities have standpipes that supply free water to unconnected households or water kiosks where households pay for water by bucket (Kjellen & McGranahan, 2006). However, such services are insufficient and cover only part of the needs of non-connected households (Kjellen & McGranahan, 2006). The decline in access to piped water is matched by an increase in the prevalence of wells, boreholes, and water vendors in urban areas (Morella, 2011).

Water vendors are broadly classified as (1) Wholesale vendors - obtaining water from a source and selling it to distributing vendors (2) Distributing vendors - obtaining water from a source

or wholesale vendor and selling it door-to-door to consumers, and (3) Direct vendors - selling water to consumers who come to the source to collect water. Distributing vendors include water tankers, pushcarts, bicycle vendors whereas direct vendors include household resellers. Distributing vendors are particularly common in urban areas because most people have some form of employment, so they do not have time to fetch water for themselves (Kjellen & McGranahan, 2006). Water vendors play three basic roles. First, they act as gap fillers, helping to extend the coverage of municipal water systems. Secondly, they are pioneers, as they are willing to serve areas that municipal systems do not serve. Thirdly, in some cities, they are sub-concessionaires who resell water from utilities to areas where the piped network has not yet reached (UNDP, 2011).

The pricing of water vendors is usually 10 times or more than the price of water utilities, sometimes even as high as 100 times (World Bank, 2019). Due to this high disparity in pricing, the earlier school of thought was that water vendors exploit the poor as informal settlements are most dependent on water vendors. However, this view is being challenged as several studies show that the high pricing may reflect the cost of supplying water rather than high profits. For example, a study by Luanda (Cain, 2018) found the price of tanker water to be 40 times the price of the utility. However, the margin of revenue over expenditure is 900 USD per week of which the salary of the operators, fuel, and depreciation of a vehicle is taken from. Hence, the study commented that the high cost of the operators reflected transactional costs rather than net exploitive costs. Water vending has high operational costs, and all these costs are transferred to the consumer whereas utility pricing is usually subsidized by taxpayers (Opryszko, Huang, & Schwab, 2009). Although these shifting views mean that not all water vendors should be generalized as profiteers, the question of whether prices are exploitive remains largely unsettled as the evidence presented is not rigorous enough and further, more detailed research is needed (World Bank, 2019).

The second major issue with water vendors is water quality. Water vendors use various water resources i.e groundwater, untreated surface water, or treated surface water. Often, households relying on water vendors have no way of verifying the quality of the water supplied to them. Where vendors sell supposedly treated water, they can sometimes sell untreated water, yet the customer is forced to pay the price of treated water. Regular washing and cleaning of water tanks are part of maintaining the quality of water, yet routine cleaning is barely done by some vendors (Dakyaga, Kyessi, & Msami, 2018). Where cleaning is done, it may not be done in the right way. Ainuson (2010) highlighted that water tanker operators in Ashalley Botwe, Ghana,

only cleaned their tankers every two to three months. The cleaning method involved a cleaner climbing inside the tank with detergent and bleach. In addition to the poor cleaning techniques of water tanker operators, storage tanks used by household resellers are hardly ever cleaned and the evidence of this is the growth of spirogyra in the inner walls of the tanks. Thus, even when the water source is clean, small-scale providers expose end-users to potential health risks due to poor water handling and storage techniques. Other case studies on small-scale providers in other countries such as in Dar es Salaam, Tanzania have similar findings (Dakyaga, Kyessi, & Msami, 2018).

Water vendors are usually viewed as stopgaps awaiting the municipal water system to catch up with the water supply chain (Ayalew, et al., 2014). Because vendors don't conform to the rules and regulations that guide formal water systems, they are consequently considered illegal. They are, therefore, not entitled to financial assistance from government or donors and are not expected to improve or expand their services, which consequently remain temporary (Ayalew, et al., 2014). International interventions on water access in the 1980s first focused on improving piped water infrastructure. During the neoliberalism era, the water access deficit was viewed as an "institutional" objective, therefore reforms were geared towards privatization and commercialization of the water sector. When privatization and commercialization failed, the formalization of water vendors as a policy objective was introduced by the World Bank (Ahlers, Rusca, Schwartz, & Guida, 2013). It was argued that by bringing them into the formal system, vendors would have access to adequate funds to legally invest in their business, which would lead to improved services and low prices caused by competition (Ahlers, Rusca, Schwartz, & Guida, 2013). However, the approach never really took off because the formal sector viewed vendors as unnecessary competition and regulators deemed it impossible to regulate so many small-scale providers (Ahlers, Rusca, Schwartz, & Guida, 2013).

In recent years there has again been a shift of mindset on the part of water utilities and regulators toward formalization which they now embrace as a partnership with small-scale providers to provide water to neighborhoods that have no piped water network (Boakye-Ansah, Schwartz, & Zwarteveen, 2019). In such a partnership, the utilities sell water in bulk quantities to small-scale providers who then distribute this water to end-users. An example of this kind of formalization is found in Kenya where utilities form partnerships with the previously informal vendors through water kiosks, partnerships with landlords, master meters, etc. Low-income areas are usually undesirable to utilities because of illegal connections, low bill payments, and a high frequency of service connections. Through such partnerships, the utility

delegates these customers to vendors while on its part it is seen as fulfilling the right of every Kenyan citizen to water while maintaining its commercial viability (Boakye-Ansah, Schwartz, & Zwarteveen, 2019). While this partnership has improved certain aspects of water vending e.g. water quality, the users are much worse off as the utility is more concerned with recovering costs from the bulk sales while vendors set the prices much higher than the prices prescribed by the utility to secure earnings even when losses are incurred (Boakye-Ansah, Schwartz, & Zwarteveen, 2019). As the regulatory board has a limited presence in such areas, the users are forced to put up with the high prices. Hence, in such a formalization where not all diverse interests i.e., end-users are considered, inequities in water provision are legitimized (Boakye-Ansah, Schwartz, & Zwarteveen, 2019).

Water vendors provide a critical daily basic service by ensuring access to water. During the MDGs, many water vendors' research viewed vendors as a necessary and acceptable path to achieving MDGs as it was considered better to focus on enhancing existing water sources and methods (Opryszko, Huang, & Schwab, 2009). For informal service providers, the method of enhancement was recognizing them as part of the regulatory framework (Ayalew, et al., 2014). The SDGs have set an ambitious goal and again meeting it will rely on informal vendors working alongside traditional formal suppliers. This is evident as the JMP has changed its stance on water vending, particularly water tankers and bottled water. JMP claims that it previously classified them as unimproved due to a lack of data on accessibility, availability, quality, and affordability. As this data is increasingly available, water tankers and bottled water are now classified as an improved source. Like other improved sources, they are evaluated as limited, basic, and safely managed (UNICEF & WHO, 2017). Therefore, the formalization and regulation of informal water vendors remain a topic of ongoing debate in the water sector.

Those in favor of regulation argue that it will lead to improved service delivery as it will address the challenges of water vending i.e., pricing, water quality, etc. However, an important question to ask is, how in practice can regulation be implemented and enforced. The idea that regulation can address challenges of water quality and pricing assumes that enforcement of the regulation is feasible, and compliance is perfect (World Bank, 2019). In most poor and many developing countries, political instability, weak governance, corruption, limited institutional capacities, etc. are the reasons why informal vendors exist in the first place (World Bank, 2019). These same reasons make effective regulation unlikely. The second consideration in the improvement of vending is much of the literature on water vending are not peer-reviewed and lack the rigor of systematic data gathering (Opryszko, Huang, & Schwab, 2009) (World Bank, 2019) hence

the understanding of the issue is not adequate for optimal solutions and a non-critical acceptance can have negative unintended consequences. Those against argue that regulation will result in a fractured water sector. Instead of considering legislation and regulation of Informal service providers, efforts should be directed towards strengthening the licensed providers as sustainable and affordable access can only be achieved through regulated utilities (Karimi, Seur, & Werchota). True enough, examples of successful utilities in developing countries, albeit few, exist whereas there is yet to be concrete evidence in the literature that formalization and regulation of vendors have adequately addressed the key issues in water vending.

3.3.Water Access in Juba, South Sudan

From 1972-1983, the Regional Government of Southern Sudan, with other international agencies improved the water treatment facility in Juba and increased its capacity to 5200 m3/day. This was enough to supply almost all old neighborhoods of Juba town (Malakia, Atlabara, Nimra Talata, Kosti, Amarat) until the signing of the Comprehensive Peace Agreement (CPA) in 2005 (JICA, 2009). In 2009, the treatment facility was rehabilitated, and its capacity increased to 7200 m3/day through funds from the Multi-Donor Trust Fund (MDTF) (JICA, 2009). After the rehabilitation, the treated water was at drinking water standards whereas before it wasn't safe for consumption (JICA, 2009). The piped water network's coverage was confined to the central areas of Juba City, leaving out the outskirts. Although the old, piped water network was also rehabilitated by the MDTF project, most of the newly restored pipes were destroyed during the subsequent rehabilitation of roads due to a lack of coordination between the Urban Water Corporation and the road companies (Martin & Mosel, 2011).

In 2008, JICA (2009) surveyed 269 households in Juba. It estimated that only about 15% of households had access to piped water while 56% relied on public boreholes and 26% on tanker water. The average per capita consumption was estimated to be about 36 L/day during the dry season and about 30 L/day in the rainy season (33 L/day for tanker water). Boreholes had high salinity whereas tankers drew untreated water directly from the Nile and sold it at about $2-$2.5 per 200 L in central areas and $5 per 200 L in the outskirts. More than 50% of the households treated their water by adding chlorine tablets while 30% of the households left it untreated. The treatment was attributed to the free distribution of chlorine and public awareness activities by NGOs and other donors. Over 90% of households expressed dissatisfaction with

their water supply conditions due to high tanker water costs and poor water quality of both tanker water and boreholes. AECOM 2013-2014 survey found that tankers were relied on by 54.3% of the population, making it the most common water supply. The main concern was water quality as 82% treated their water before drinking it, mainly by adding chlorine (AECOM, 2014). In 2018, a survey found that the water delivered by tankers was still raw water from the River Nile. 57.5% depended on water tankers and 57.5% treated the water using chlorine (Ladu, Athiba, Lako, & Alfred, 2018).

There have been targeted interventions by international actors such as a water treatment plant installed by Medair in the Gabat neighborhood, a borehole dug by Norwegian Church Aid and USAID used to chlorinate the water delivered by tankers. However, USAID chlorination was since stopped due to a lack of funding (Martin & Mosel, 2011). The main project in the water supply sector is the Juba Urban Water Supply Development Plan by the Japan International Cooperation Agency (JICA) which plans to improve access by 100% coverage of municipal water through household connections, public standpipes, and private water vendors by the year 2025 (JICA, 2009). The first phase, which was to be completed in 2015, would have increased the capacity to 77000 m3/day but was stalled in 2013 and again in 2016 due to the conflict. It is now expected to be completed in 2022. In 2019, African Development Bank allocated funds for the Strategic Water Supply and Sanitation Improvement Project intending to improve the quality and delivery of water supply in Juba and the rural areas surrounding Juba. The plan complements JICA's project in Juba by building on distribution. It involves rehabilitating the distribution network and adding 40 km to it as well as increasing tanker filling stations from one to twelve and building 50 public water kiosks to be operated by women and youth from the communities (African Development Bank, 2019).

The literature highlights the global agenda to close the domestic water access deficit gap. Important in this global access deficit debate is the role played by informal water vendors in urban areas. It is unanimously acknowledged that informal water vendors play a critical role in ensuring access to water to all in urban areas with poor piped water supply. However, informal water vendors are a substandard model of service and in their current state cannot meet the human right of water. The contentious debate remains whether informal vendors can in fact and should be improved to enable the realization of the human right to water and SDG 6. The multiple unsettled questions on water vending mean ongoing evidence-based research are important to the understanding of the benefits and risks of water vendors and the way forward for water access. The situations are not necessarily generalizable, and an understanding of each

case is important. The available literature on water access and water vending in Juba is limited. The literature on Juba's situation shows that although there are plans of improving access by the piped water system, tanker water will run parallel to the piped water system, at least in the interim. Ongoing research on water vending in Juba including the current situation is important in gaining meaningful insight on the water access situation and where Juba City stands relative to the global agenda, whether developed plans can adequately address the access challenges, mitigation of issues, etc.

4. POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK OF THE WATER SECTOR

The three documents in the water sector are the Water Policy 2007, the WASH Strategic Framework 2011, and the Draft Bill of 2013.

4.1.Water Policy of 2007

The Water Policy was developed through the Ministry of Water Resources and Irrigation (MWRI) in November 2007. Local, regional, and international best practices as well as important global policy developments such as the MDGs were considered in its formulation. Its overall objective is to support social and economic growth by promoting efficient, equitable, and sustainable development and use of available water resources, and effective delivery of water and sanitation services in Southern Sudan through the establishment of basic principles and objectives to guide development in the sector.

The key objectives of the policy for Urban Water Supply and Sanitation (UWSS) include:

4.1.1 To provide safe, affordable, and reliable UWSS services to the urban population on an equitable basis, including poor and vulnerable groups.

4.1.2 To promote an integrated approach to planning the development of piped water supplies and wastewater disposal infrastructures.

4.1.3 To develop an effective institutional framework in which functions relating to regulation are separated from those relating to the delivery of UWSS services.

4.1.4 To establish effective decentralized structures for managing the delivery of UWSS services to combine efficiency and accountability.

4.1.5 To promote active involvement of the private sector in the development and management of UWSS services where appropriate.

4.1.6 To improve the financial sustainability of UWSS systems through the introduction of efficient management practices and effective revenue generation mechanisms.

4.1.7 To promote the technical and management training of staff working at all levels in UWSS services to improve the overall quality and effectiveness of institutions.

5.1.WASH Strategic Framework 2011

The Water, Sanitation & Hygiene (WASH) Sector Strategic Framework was formulated in August 2011. Its purpose is to operationalize the Water Policy of 2007 and ensure its implementation through effective and technically sound Strategic approaches, improved capacity, and involvement of all stakeholders. The framework identifies priority areas for future intervention which include water resource management, sanitation, and hygiene, rural and urban water supply. The Strategic Framework recommends the formulation of a Water Council to provide advisory services at the highest level as well as a Water Supply and Sanitation Regulatory Board to develop and enforce regulations for the water supply and sanitation services.

5.2.Draft Bill 2013

The Draft Water Bill was formulated in 2013. Its purpose is to provide for the establishment of a regulatory framework through the establishment of a Water Council. The Water Council shall regulate both Water Resource Management and WASH service delivery. WASH service regulation shall be under the Safe Water Supply and Sanitation Services Regulatory Board which shall involve local government authorities and service providers. As of 2018, the Draft Bill was awaiting enactment by legislators.

The national institutions involved in South Sudan's Water Sector are:

5.3.**Ministry of Water Resources and Irrigation (MWRI):** The Ministry of Water Resources and Irrigation is the lead ministry in the Water Sector. Among other things, it is mandated to (i) develop policies, guidelines and master plans (ii) oversee the operation of the South Sudan Urban Water Corporation (iii) set tariffs for the sale of water to be used for various purposes (iv) implement groundwater supplies of drinking water for the rural population until states and local governments assume such responsibilities (v) advise, support and build the capacity of state and local governments in charge of water services.

5.4.**South Sudan Urban Water Corporation (SSUWC):** it is the major entity entrusted with the operation of Urban Water Systems. It was formed by a Provisional Order in 2008.

According to South Sudan Infrastructure Action Plan 2011, the water sector faces chronic and severe capacity challenges in terms of human resources, technical skills, facilities, and services. The Water Policy provides for the establishment of mechanisms for effective coordination and collaboration between the relevant agencies in the water sector. However, this has not been realized as the sector is characterized by gaps, overlaps, and a lack of clarity in the roles and responsibilities. For instance, there is an overlap between SSUWC and local government councils in urban water supply provision. A key challenge for the SSUWC is the lack of financial viability and autonomy. Although it was established as a semiautonomous entity, it functions as a civil service institution with its staff guided by civil servant regulations, monthly billing, and revenue reverted to the central treasury. It is heavily subsidized as it is unable to recover its operational costs. Its non-revenue water ratio is about 60% due to high leakage losses and poor bill collection. The proposed Strategic approach by WASH Strategic Framework 2011 for SSUWC is to increase its autonomy and improve its performance concerning NRW, Bill collection, and customer care.

South Sudan's Water Policy 2007 allows for private sector participation in the water sector where possible. It states that there is a "need to legally recognize the role of the private sector within the institutional framework for UWSS and establish procedures and guidelines for monitoring performance of private sector". It further states the need to promote the local private sector and enhance the capacity of the government to work with the private sector. In the WASH Strategic Framework, the role of private participation is further spelled out as "developing deliberate mechanisms to enable setting up of service providers and operators such as water vendors to supply water. By this, the Strategic approach on the governance and institutional side are to develop a system to implement and regulate small-scale water providers. In sum, the JICA and AfDB projects are in line with the legal framework for the sector, that is, SSUWC needs to be improved and water vendors will complement SSUWC in water provision.

6. METHODOLOGY

6.1. **Research design:** This research has several objectives. These objectives need both insights from the end-users of the water (i.e. Juba residents) and the authorities who are currently involved or who should be involved in Juba's water supply. To gather data from the end-users, a quantitative design was chosen as it involves the quantification of opinions and attitudes, among others, which enables this study to arrive at evidence-based conclusions that are supported by solid data. For the authorities/institutions, a qualitative method is chosen. In sum, the design of the study is mixed methods.

6.2. **Setting and participants**: The city of Juba is the area of the study. From observation, the tankers that collect water at the Juba water point usually service the town blocks of Juba, Kator, Munuki, and the areas of Gudele. Gudele is not a town block but as it is designated as one by tanker service, the study treats it as for Town Block. Thus, the respondents are from areas in Juba, Kator, Munuki, and Gudele. Although water tankers usually serve both households and institutions, the study focused primarily on households. Thus, the respondents are household respondents. The authorities in the study were Juba City Council and South Sudan Urban Water Corporation.

6.3. **Instrumentation:** The study utilized questionnaires to glean data from respondents of diverse social and economic backgrounds. Questionnaires were chosen because they are a reliable and efficient method for the researcher to gather data from respondents within a short time. The questionnaire aimed to determine the market share of water tankers, reasons why people depended on water tankers over other pathways to get water, the availability and reliability of water tankers, the water consumption pattern, established relationships between tanker operators and their customers, the pricing and affordability, the perceptions on water quality and the satisfaction and desired improvement in Juba's water supply.

For the qualitative portion, interviews were conducted with representatives from the Juba City Council, SSUWC, and the Ministry of Health. The interviews consisted of brief, open-ended questions.

6.4. **Procedure:** The study used non-probability sampling methods through convenience sampling. This was because of limitations in available resources and the study is a small-scale pilot project. A total of 300 respondents were deemed a good sample size for such a study. The aim was to have 75 respondents from each of the four town blocks. However, due to time limitations, the number of questionnaires was 269. The researcher went to public areas in the four town blocks and asked willing respondents to participate in the

questionnaire. In areas where the researcher knew people who resided there, the researcher visited them. They then took them around the neighborhood, helping to convince their neighbors to participate in this study.

Data processing and analysis: The quantitative data were analyzed by using Excel Software. The qualitative portion of the data was analyzed manually whereby the researcher identified common opinions and grouped them. Interview results were also analyzed manually.

6.5. **Ethical considerations:** The researcher considered several ethical issues. First was the informed consent of the participants in the study. Before answering the questions in the questionnaire, the respondents were first informed about the purpose of the research and their consent was sought before proceeding with the questionnaire. Secondly, the identity of the respondents for the quantitative portion has been kept confidential.

6.6. Problems and Limitations:

i. Due to the use of nonprobability sampling methods, the findings of the study cannot be used to generalize the water supply situation of all households in Juba.
ii. To overcome language barriers, the researcher had on several occasions to translate the questions in the questionnaire from English into "Juba Arabic."
iii. Lack of understanding of the meaning of research by some people made them hesitant or not want to participate in the study.
iv. There was a degree of bias as the researcher was the one collecting the data.
v. Lack of access to some people, organizations, or documents could have widened the scope of the research and its findings.

7. FINDINGS OF THE OF THE STUDY

7.1.Summary of areas sampled

Table 1: Summary of the four town blocks sampled in the study

Town Block	Areas sampled	Total number of respondents	Average Household size
Kator	Atlabara A, Atlabara B, Atlabara C, Kator, Malakia, Jebel, Nyakuron, Nyakuron West, Rock City.	80	8.58
Juba	Hai Malakal, Hai Cinema, Hai Mayo/Buluk, Hai Sora, Hai Neem, Nimra Talata, Hai Jalaba, Hai Gabat, Hai Amarat, Tong Ping, Juba Town, Hai Commercial	59	7.24
Munuki	Munuki Block A, Munuki Block B, Munuki Block C, 107, Munuki/Hai Kuwait, Hai Mauna	70	7.29
Gudele	Gudele 1, Gudele 2, Gurie	60	8.64
All		269	7.96

7.2.Water Sources

7.2.1. Piped Water

Piped Water: There is no fully functioning piped water system in Juba City. Piped water does come from time to time in certain areas in Juba, including Block B in Munuki, Juba University Campus, Hai Cinema, Hai Gabat, Hai Malakal, and Hai Sora. The period of availability of piped water varies by area and even in these areas, it varies by households. For houses in the last row in Munuki Block B, piped water is available for approximately 2 hours every five (5) to seven (7) days, whereas for households in the other rows, water is available only a few times a year. In Hai Sora, households on the upper side have water while those on the lower side do not. Similarly, some parts of Hai Malakal have water while others do not. For households with

access to piped water in Hai Malakal, water is available every night till morning hours. In Hai Cinema, most households have piped water.

The availability of piped water varies also by households within the same area. In some households, water comes daily, either during the day or the night. But once it stops flowing, it will not be available for two days, a week, or sometimes even a month. For households in Hai Cinema who have the same supply line as Juba Hospital, piped water is available daily. It either comes at night or during the day. Given the varied availability of piped water in areas/households, it is no surprise that among the households with piped water, only 30% depend on it as the main source of water as shown in **Figure 1**.

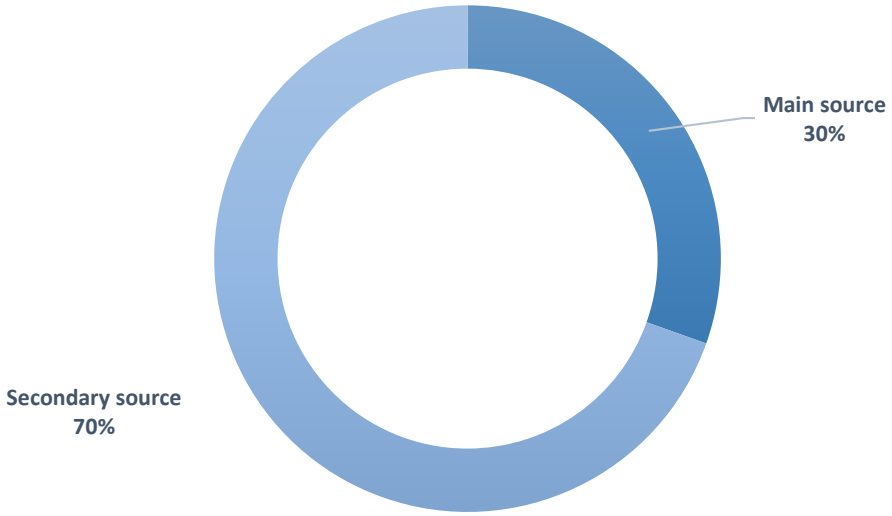

Figure 1: Dependence on piped water among connected households

7.2.2. **Water Tanker**: Water tankers are available in all the areas sampled. They are the main source of water for 95% of the respondents and a secondary source for the remaining respondents.

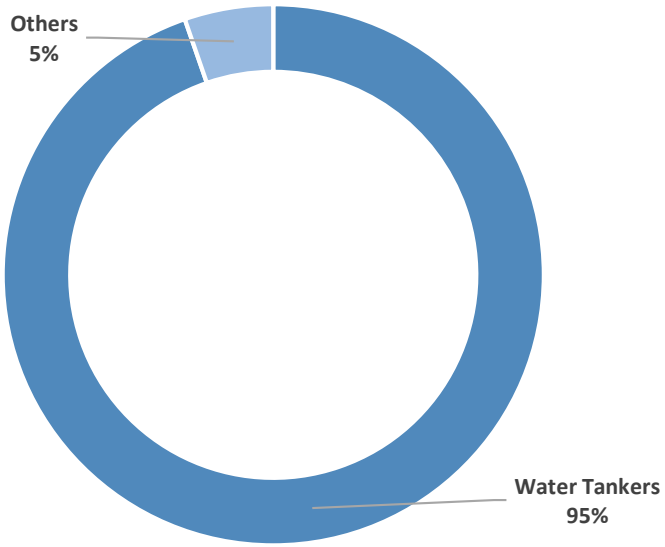

Figure 2: Respondents' Dependence on water tankers

7.2.3. **Rainwater**: 84% of households use rainwater during the rainy period as shown in Figure 3. Many households have storage tanks purposefully reserved for rainwater collection. Two of the households have a large rainwater collection capacity of about 10000 L (2640 gallons). Thus, during the rainy season, they are mainly dependent on rainwater and only buy tanker water during the dry seasons. The perception of most of those who collect rainwater is that it is only suitable for domestic uses such as washing clothes and flushing toilets, not for drinking or cooking. Only a few handfuls of households treat rainwater using chlorine/disinfectant before using it for all household purposes.

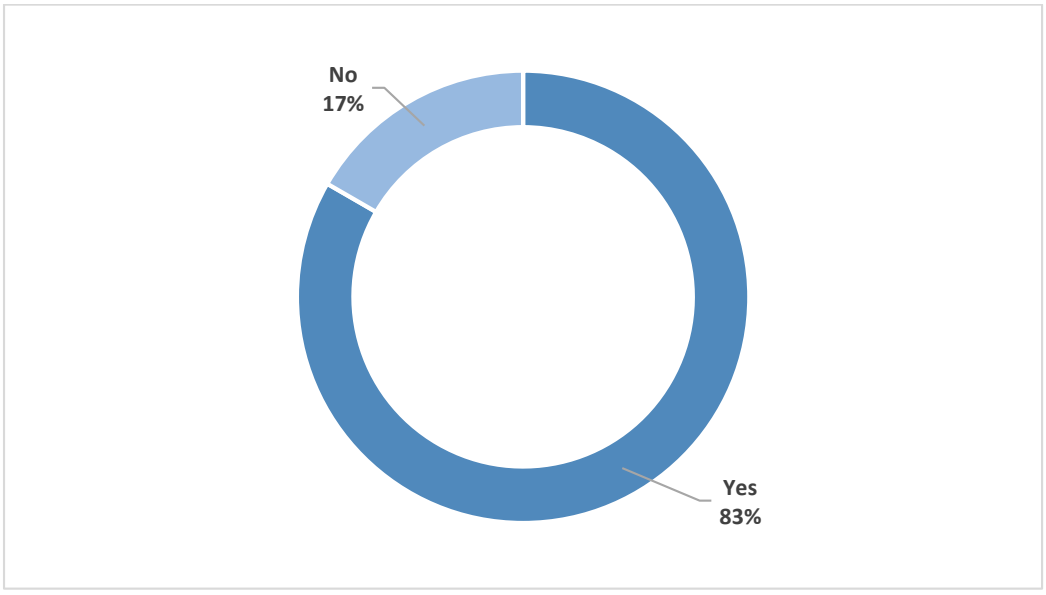

Figure 3: Percentage of respondents who use rainwater

7.2.4. **Public borehole**: Public borehole: Public boreholes are physically available in most areas. However, in most areas, they are no longer working. In the areas of Gudele and Munuki, most of the boreholes are working. For the ones where the borehole is working, users do not use it as the main source of water because the water is of high salinity and/or it's too far from home. Also, they have limited capacity so cannot be depended upon as the main source by most. Thus, the working boreholes are used as a secondary source of water when the main source is not available by 28 % of the households. Only for a few households in some areas in Gudele is it used as the primary source of water. There are two types of boreholes: boreholes that have a custodian and those that do not. Boreholes that do not have a custodian operate for 24 hours so residents are free to collect water at any time. Boreholes that have a custodian operate intermittently. For example, they can operate from 10 am – 2 pm, then again from 4 pm-6 pm. Boreholes with custodians also pay to collect water whereas those without a custodian are free. The money paid is handed to the custodian of which he gets a portion of it as a salary and the rest is for the upkeep of the borehole. When the borehole breaks down, the custodian is charged with contacting the appropriate people to come and fix the borehole. Boreholes that do not have a custodian, once broken down, stay broken down a long time or forever as there is no one responsible for their upkeep.

Bicycle vendors: The bicycle vendors usually cycle through most areas. They mainly deliver water to small businesses and are used as a secondary source by 4% of the households when tanker water is not available. Respondents comment that they do not know the source of the vended water although bicycle vendors usually say their water source is the same as treated tanker water.

Household resellers: Operated by households with huge storage tanks. Usually serves water to boys cleaning cars in neighborhoods. Used as a secondary source by 8% of households when tanker water is not available. The Source of water is tanker water.

Private/public well: Wells are few in this study. They are used as a secondary source by 1% of the households.

Others: Some of the respondents fetch untreated surface water when there are no other options. For those who can afford it, the other option is to buy bottled water jerry cans from the shop. Additionally, in the Gudele 2 area of Joppa, there is a solar water disinfection NGO project.

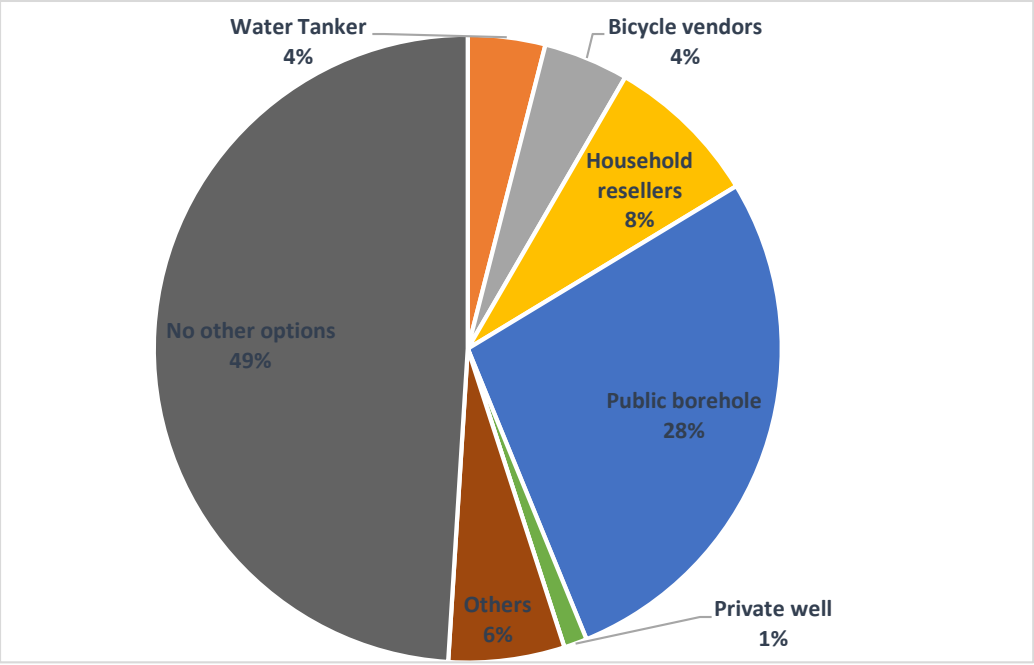

Figure 4: Secondary sources of water used by respondents when other sources are not available

8. Water tankers

95% of household respondents depend on water sold by water tankers as their main source of water and for the remaining 5%, tanker water is their secondary source of water. When asked why tanker water is their main source of water, 5.91% say that because it is cleaner, 12.24% say because takers deliver water at their doorstep, 0.84% say that it is because of lack of storage drums, 3.8% say because of cheaper price whereas 67.25% of respondents say because there are limited options as shown in Figure 5. Others cite other reasons such as the high salinity and limited quantity of borehole water as their reason for preferring tanker water. Thus, the main reason why people use water tankers is that there is no other viable option. From Figure 4, 49% of people have no other viable options for water when tankers do not come. It may be that they choose to not use boreholes despite the lack of other water sources, or it may be because there are no other options. For example, in areas such as Hai Neem and Nyakuron (Hai Jeberona),

there are no boreholes, and the areas are quite far from surface water. Thus, when water tankers are not available, residents in these areas usually have no water for a whole day.

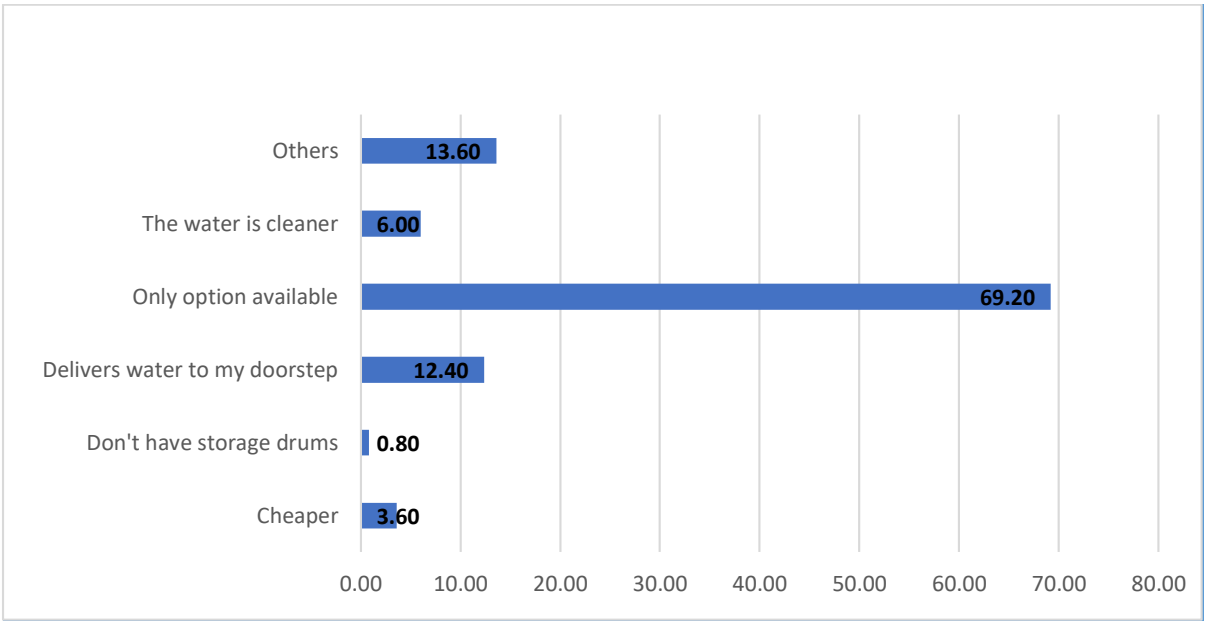

Figure 5: Reasons for choosing tanker water

9. Availability and Reliability of Vended Water

Under normal circumstances, water tankers are usually available daily in most areas except for Sundays. They usually operate from between 6 am – 6 pm. A few water tankers may be available earlier or later. On Sundays, fewer tankers operate, as most of the operators are foreigners and they usually go to church on Sundays. Households either get water from the tankers by calling them through the phone (established relationship) or by calling out to them as they pass through the neighborhood.

Water tankers are not reliable even under normal circumstances. Whether they are called by phone or called from the street, they are usually late, and sometimes they do not come at all because they are busy or lack fuel or the truck has broken down. When it rains, there are some areas in Munuki, Gudele, Nyakuron, etc. where the tankers refuse to serve because the roads (unpaved) are poor, and the trucks may become stuck in the mud. During such times, the residents from these neighborhoods must go to the main streets (paved roads) with their drums

to get water. Once the drums are filled, they need to transfer the water to 20L- jerry cans before carrying them home. It is worth noting that in some areas, the distance between the households and the main roads is at least 30 minutes on foot. The rainy season not only affects areas with poor roads, but it can also sometimes affect the whole city. For instance, during one of the recent rainy days, the river overflowed its banks, making it hard for most tankers to collect water from the river, hence for these two days, only a few tankers operated.

This study was conducted during a period of economic turmoil in South Sudan. Since August 2020, the South Sudanese pound has been weakening against the dollar, which has caused a continuing increase in the price of commodities, including water. Initially, water tanker delivery in Juba City was divided into around three zones, depending on how far from the water source the areas are. Zone 1, which is the nearest area to the water source, paid SSP 250. Zone 2 paid SSP 300 and Zone 3 paid SSP 350. Following the sharp increase in the dollar rate, the price of water increased by 100 SSP for all the zones during the first week of September 2020. Naturally, there was a rejection of this price increase by the citizens, leading to some friction between the operators, authorities, and customers. On 17th September 2020 water tankers were not available in most areas throughout the day and they later came in the evening. Following this incident, most people were forced to contend with the new price of water. The price of water has continued to increase and coincidentally when the price increases, there is usually a "strike" by the operators for a few days. The reasons for the strikes are speculative but people in Juba have come to associate a strike with an increase in prices. Due to the issue with prices, the water tankers that usually roam the neighborhoods have become fewer and some only supply water to their loyal customers (those with whom they have established a relationship). Thus, during this period, the water tankers have become increasingly unreliable due to issues with the pricing of the water.

10. Water consumption

The three storage options commonly used by Juba residents are 20 L jerry cans, 200/250 L storage drums, and storage tanks of varying capacity (usually 1000 L to 3000 L). Jerry cans are used to get water from household resellers, boreholes, or wells. Water tankers usually pour water into the storage drums or the storage tanks. The storage capacity of a household is a key determinant of the relationship between vendors and customers. As mentioned earlier, they are some of the customers who have an established relationship with the vendors (those who call

them by phone). These customers are usually the ones with storage tanks instead of storage drums.

The per capita consumption based on the town blocks is shown in Figure 7. In decreasing order, itis 45.85 L/person/day in Juba, 27.67 L/person/day in Kator, 27.13 L/person/day in Munuki, and 26.69 L/person/day in Gudele. Hence, Juba has the highest consumption while Gudele has the least. The average consumption of Juba City is 31.27 L/person/day.

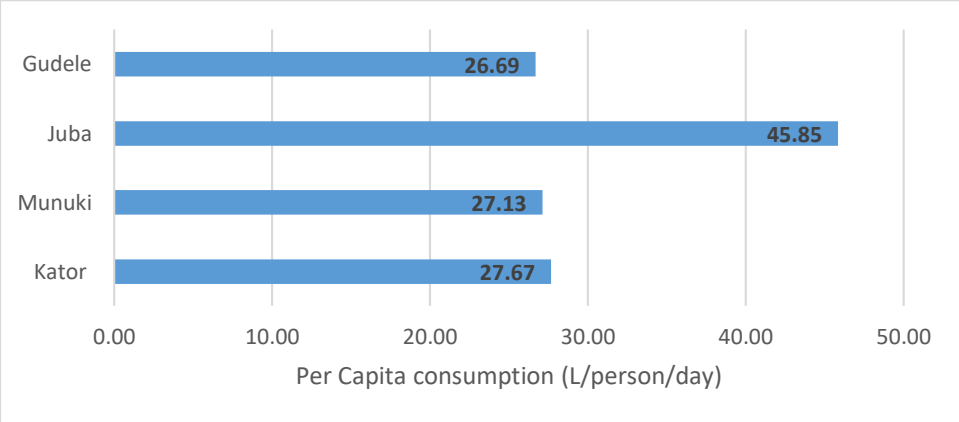

Figure 7: Per Capita Consumption by Town Blocks

Figure 8 shows the consumption of households connected to piped water versus that of households not connected. Piped water consumption is 36.41/person/day, higher than the consumption of non-piped areas which is 30.41 L/person/day.

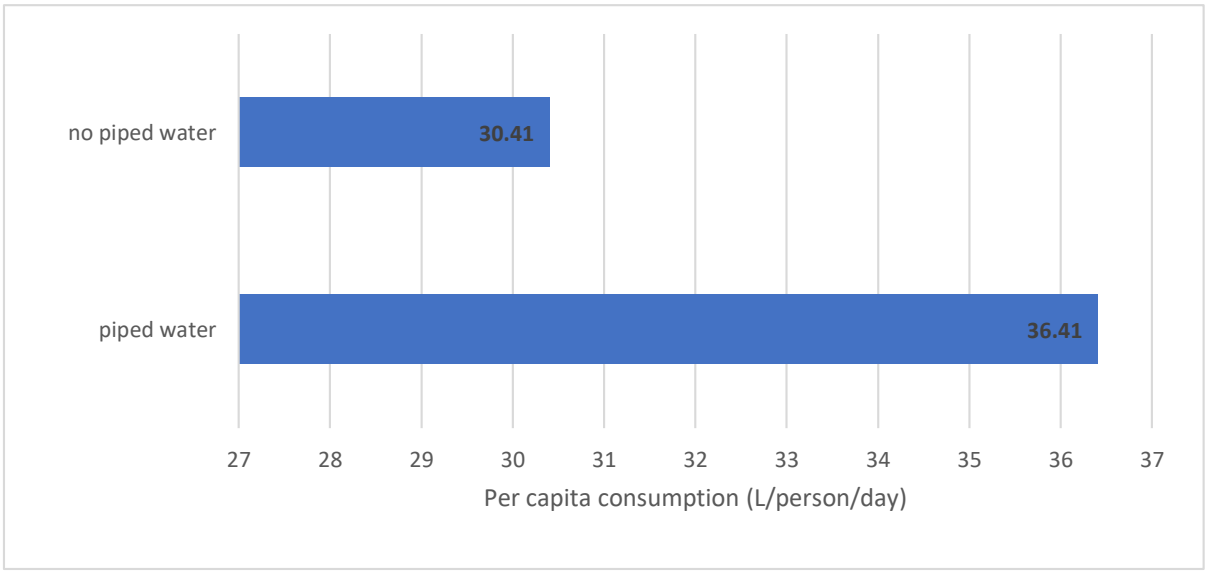

Figure 8: Per Capita Consumption of those with piped water vs those without

As socio-economic data is not available, the presence of storage tanks is used as a distinction of economic status as by observation, concrete and modern houses with flush toilets are the ones most likely to have a storage tank. Figure 9 below shows the per capita consumption of those with storage tanks versus those without storage tanks. The average per capita consumption of those with storage tanks, 38.16 L/day is much higher than those without storage tanks, 26.66 L/day.

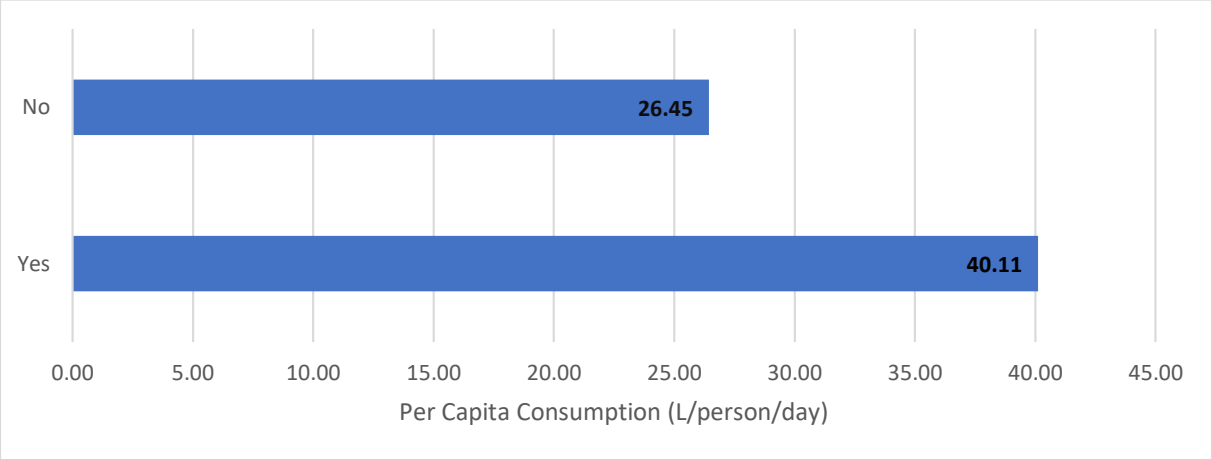

Figure 9: The average consumption of households with storage tanks versus those without

The proportion of households with storage tanks by Town block is shown in Figure 10. 42% of Juba respondents have a storage tank, 35% of Gudele respondents, 32% of Muniki respondents, and 24% of Kator respondents. Hence Juba has the highest proportion of households with storage tanks followed by Gudele while Kator has the least.

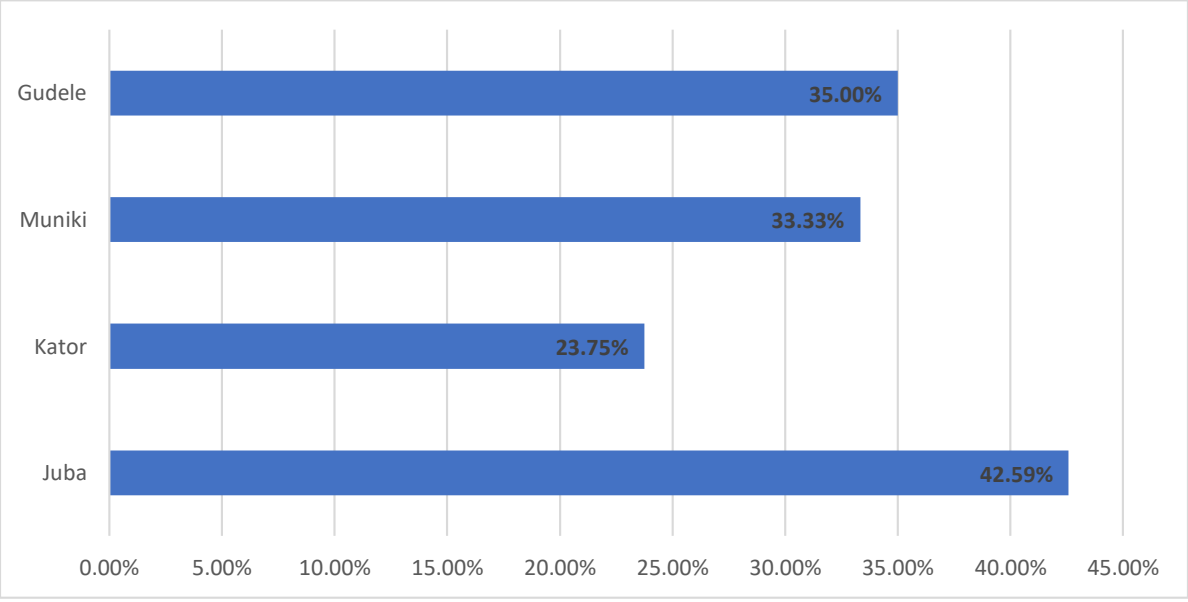

Figure 10: Proportion of storage tanks by Town block

The average per capita consumption calculations were done by calculating the average of the per capita consumption of each respondent household. The per capita consumption of each household was obtained from the total storage capacity and the number of days it takes to refill the storage when full. Firstly, it does not include drinking water consumption as most people have separate storage tanks for drinking water or they drink bottled water. Secondly, the number of days it takes to refill the storage is just an approximate number. Thirdly, the study calculated the storage capacity of storage drums as 200 L. Although most of the drums are indeed 200 L, the newer ones are 250 L.

11. Pricing of Vended Water, Affordability and Coping Mechanism

As mentioned before, the pricing of water before the research period used to be fixed for each zone. However, since the challenging economic situation, the price of water is no longer fixed. The price of water has continued to increase as the research was ongoing hence the cost of earlier respondents is different from those for later respondents. Secondly, even in the same neighborhood during the same period, the price of water varies sometimes because some vendors have taken advantage of the situation to overcharge customers. Thus, the price of vended water is no longer fixed. Based on the prices paid by respondents interviewed in November 2020, the price of water ranged between 350 and 1000 SSP per drum. The areas in Juba with piped water paid the lowest, about 350 SSP per drum while areas in Gudele paid the most, some reaching 1000 SSP. The median price of the water is about 500 SSP per drum. For those with storage tanks, some buy water at a discounted price of about 50-100 SSP less than the normal price.

The respondents were asked whether the current price of water is affordable. 9 % of the respondents strongly agree, 82% disagree, 4% agree and 4% are neutral. Thus, more than 60% of the respondents do not find the water prices affordable.

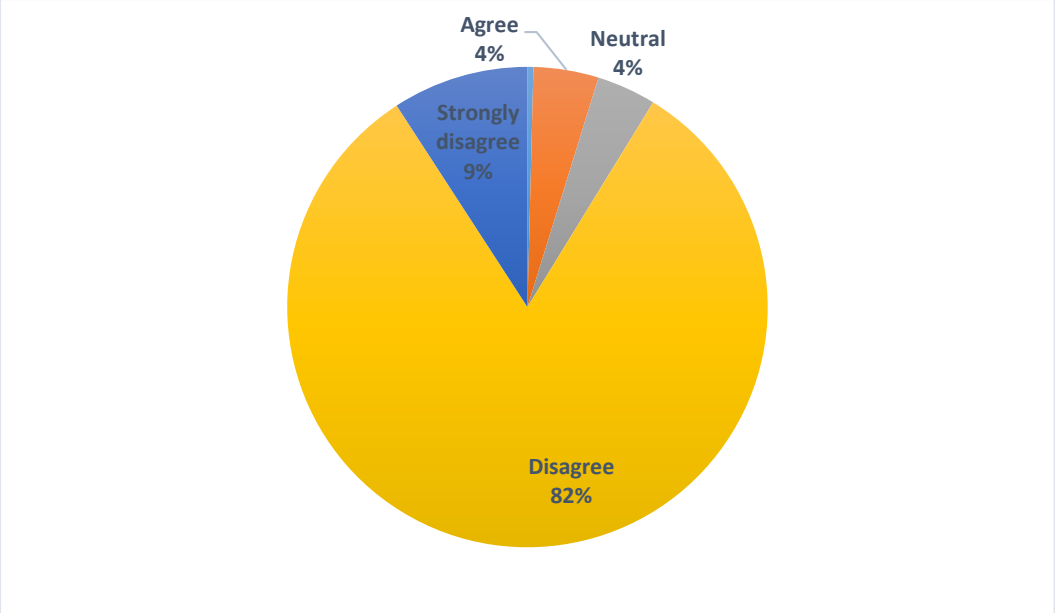

Figure 11 Opinion poll on the affordability of water tankers

Information on the prices of other water sources was also obtained. The table below shows a comparison of the water prices.

Table 2: Prices of different water sources used in Juba

Water sources	Unit sold	Price per unit (SSP)	Price per 200 L (SSP)	Price per 200 L (USD)
1. Tanker water	200 L	500	500	0.83
2. Household resellers	20 L	100	1000	1.66
3. Borehole	20 L	20	200	0.33
4. Bicycle vendors	20 L	200	2000	3.33
5. Bottled Water	20 L	700	7000	11.67

From Table 2, boreholes are the cheapest water sources while bottled water is the most expensive. Household resellers are double the cost of tankers while bicycle vendors are quadruple the price of water tankers.

Given the current situation of increasing water prices, the respondents were asked how they cope with an increase in the price of water. The results of the questions are shown in Figure

12. 62.36 % of people are maintaining the same consumption by reducing money from other budget areas, 28.14 % are reducing their consumption and 7.20 % are opting to use cheaper sources.

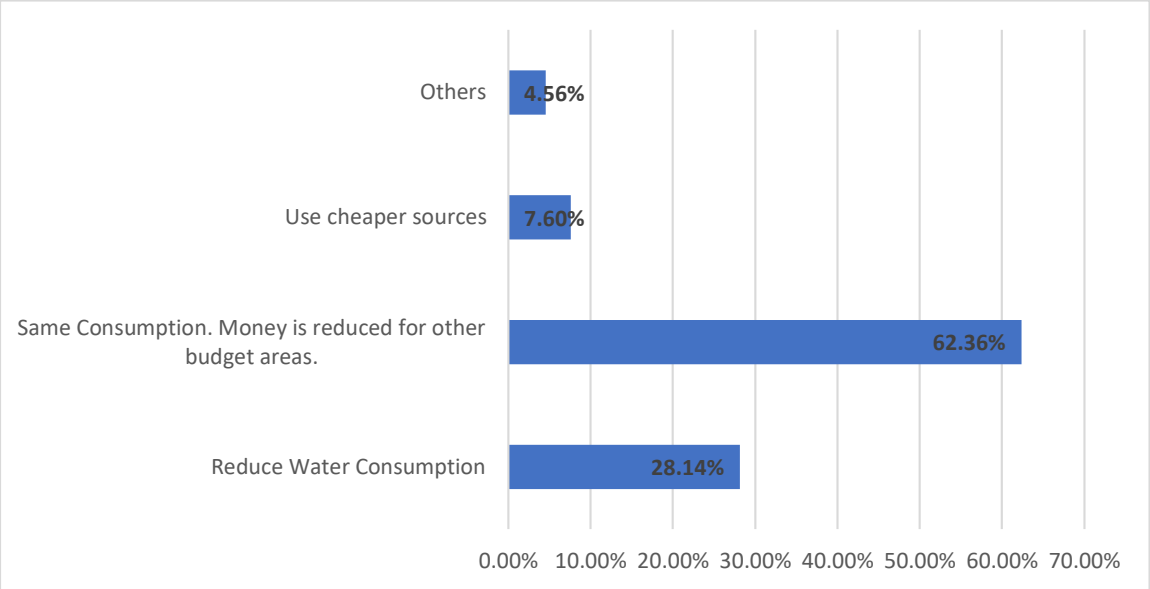

Figure 12: How the respondents cope with increasing water pricing

12. Choice of drinking water, perceptions about water quality

The drinking water sources of the respondents are shown in Figure 9 below. 20.45% of the respondents drink bottled water while 79.17% drank from their main source of water. Since tanker water is the main source of water for 95% of the respondents, the majority of the 79.17% are drinking tanker water. For those who use boreholes as their main source of water, tanker water as their main drinking water source. Thus, in addition to being the main source of water for domestic uses, tanker water is also the main source of drinking water in Juba.

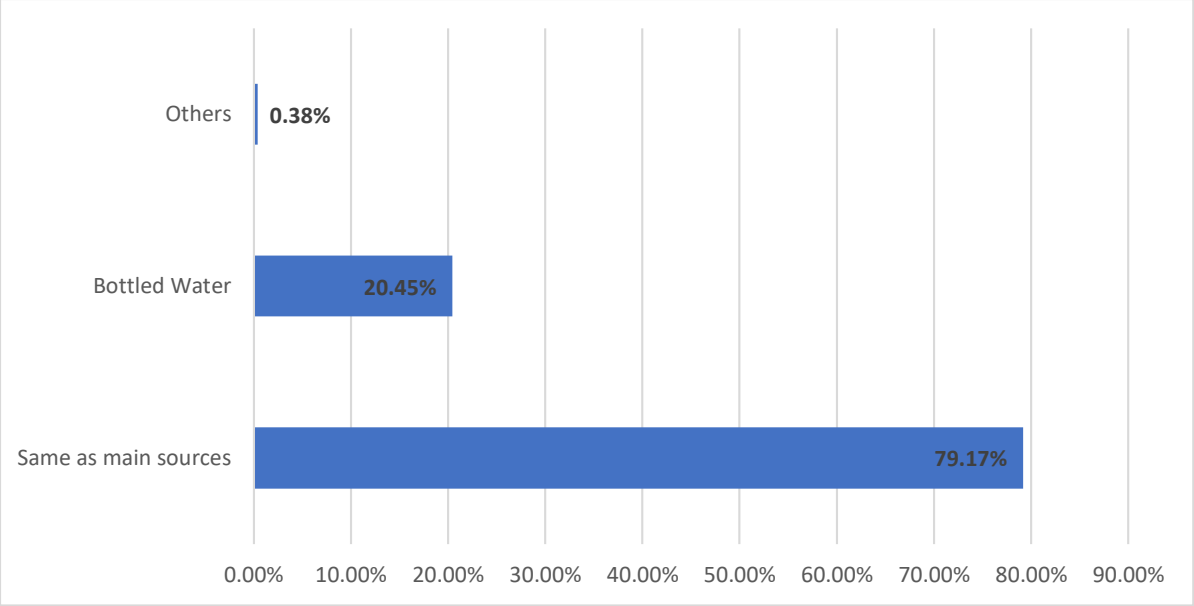

Figure 13: Source of drinking water used by respondents

The respondents who drank tanker water were further asked about how they treated their water before drinking it. The treatment options used are shown in Figure 14 below. 52.63 % of the respondents do not treat their water before drinking it. Most of them remarked that the water is already treated with chlorine before being delivered to them, therefore, it was considered clean enough. 32.54 % of the respondents treat their water using chlorine and coagulant, while 13.88 % preferred to boil their water before drinking it. Thus, more people prefer treating water by adding chlorine than boiling the water. 1.47% of the respondents only filter their water.

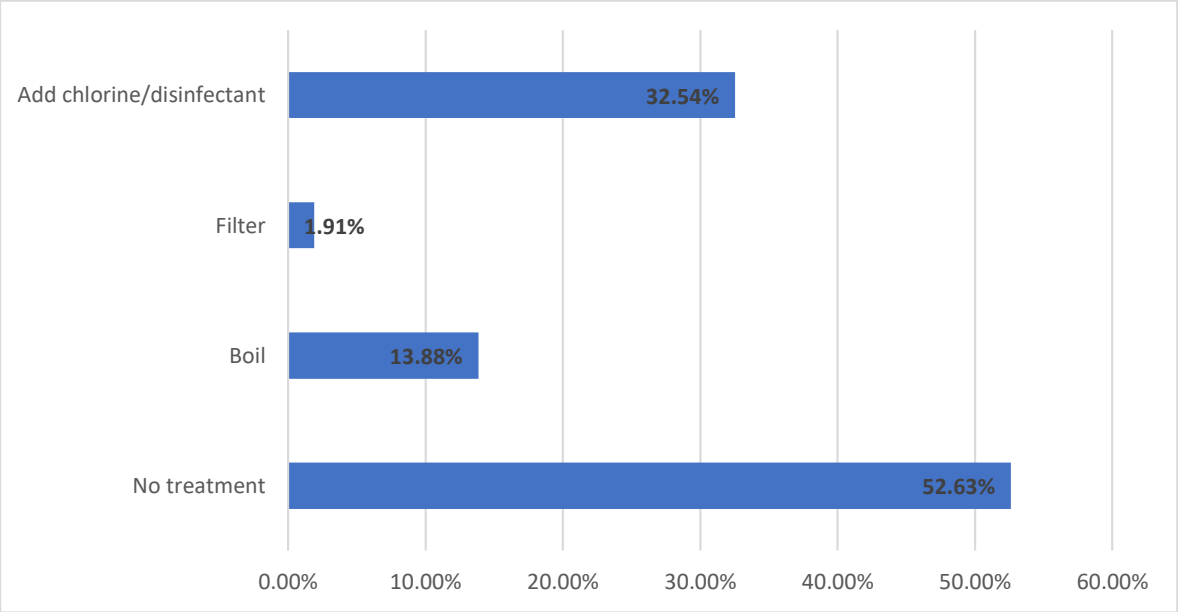

Figure 14: Drinking Water treatment options

The respondents were asked whether they considered the main source to be safe. 65% of the respondents considered the water to be clean. However, it is important to note that the answer given by most of them was actually "sometimes" rather than a definitive yes. Since there were only two options, the researcher chose to select "yes" for those who found it to be clean sometimes and "no" for those who gave a definitive yes. This is further illustrated in the next question where 84% of the respondents have received dirty water from tankers in this year, some even received dirty water a few days before or on the day the data was collected. When dirty water is delivered, residents are most of the time unable to confront the operator immediately for delivering dirty water because the residents only realize that they have been created long after the vender has poured the dirty water into the containers and the water tanker has already left. Of the 35% who considered the water to be dirty, some remarked that the water was clean when it was drawn from the source and that it becomes contaminated as the water tankers are dirty.

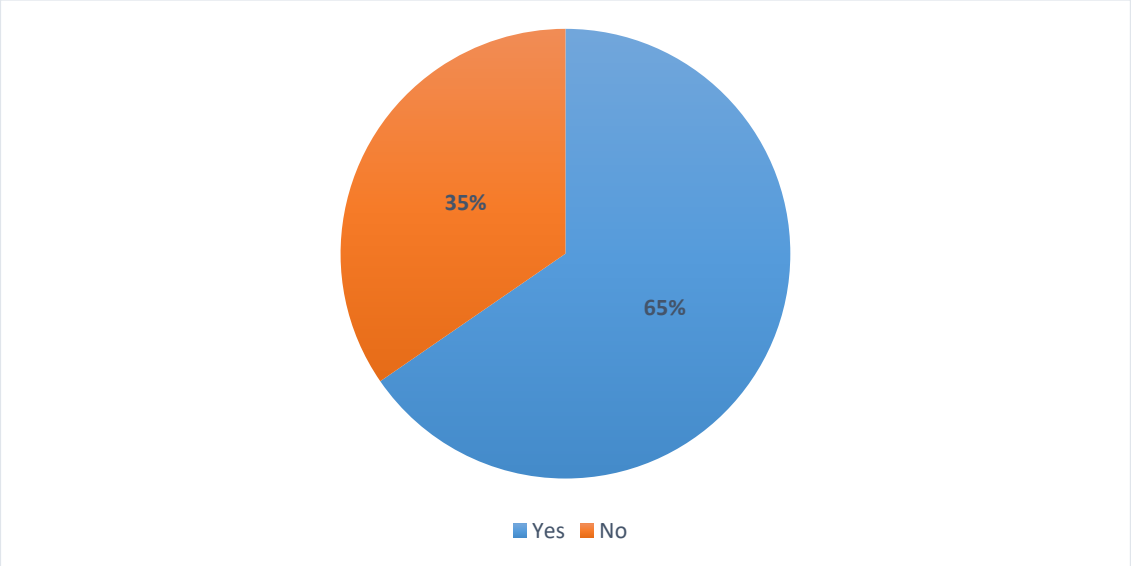

Figure 15: Opinion poll on the cleanliness of main source

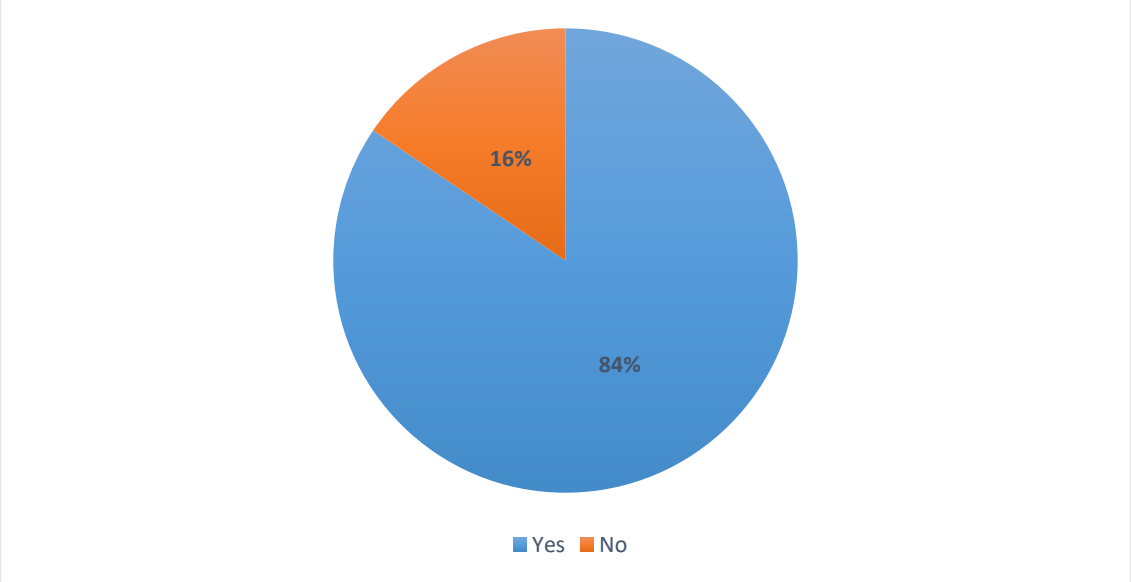

Figure 16: Recently received dirty water

The respondents were asked about the attributes they use to judge the cleanliness of the water. 85.23% use physical attributes such as color, odor, and taste. Those who have an established relationship with their vendors can also trust their vendors to deliver quality water to them.

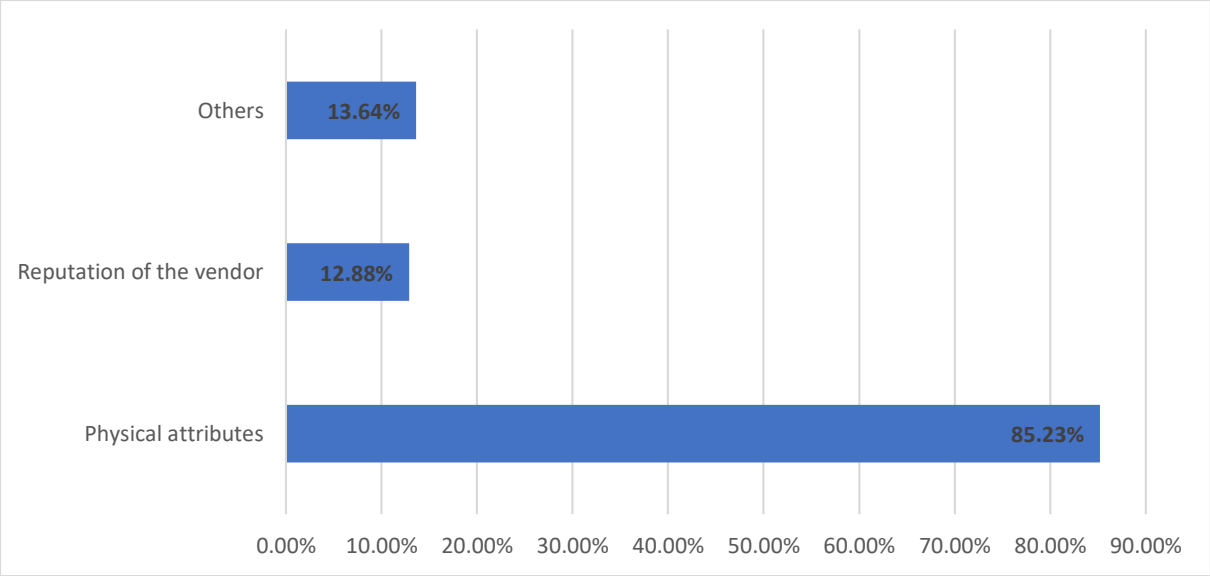

Figure 17: Judging the quality of water

13. Satisfaction, Challenges and Desired Improvement

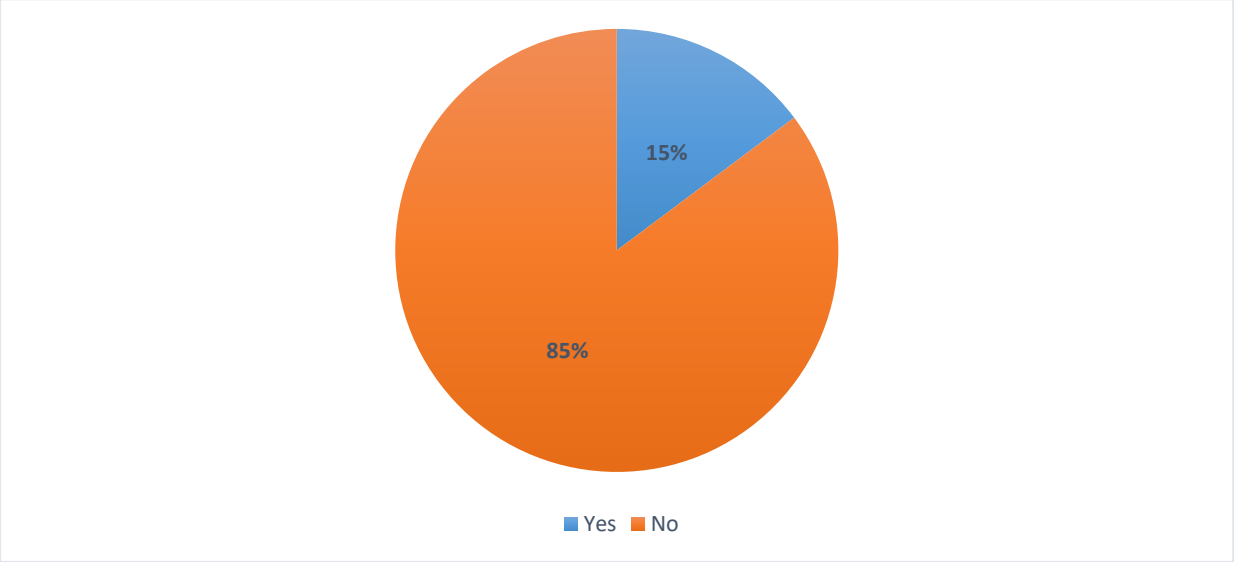

Figure 18: Satisfaction with current water supply situation

The respondents were asked whether they were satisfied with their current water supply situation. 85% are not satisfied with their current water supply situation. The answer to the challenges reflects what was already highlighted in other sections, namely that water is expensive, prices are unstable, the service is unreliable, and the quality of the water is questionable. Additionally, having to pay for water daily is considered more difficult, compared to paying a monthly bill. Most respondents say that having piped water or reliable piped water (those that already have piped water) will improve the water access situation.

14. DISCUSSION OF THE FINDINGS OF THE STUDY

14.1. Evaluating the challenges associated with the use of water tankers

The piped water system in Juba city is extremely limited. Its treatment plant has an insufficient capacity of 7200 m3/day, yet the projected demand for 2020 was about 70839 m3/day (African Development Bank, 2011). Due to the destruction of the newly rehabilitated piping in 2009, the current system only serves about 2290 households (about 2%). These are mainly in the Juba town areas of Juba Payam. The piped water service to the connected households is usually available for only a few hours and is unreliable. This is because of financial constraints faced by SSUWC which led to limited operations. The deficiency in the piped water system has led residents of Juba, including connected households, to seek other means of getting water.

Community boreholes and water tankers are the main alternatives for households' water access. Boreholes are cheaper than tanker water, but households need to fetch the water themselves. This makes it time-consuming which takes time away from productive tasks and it is physically taxing hence water is fetched in small quantities. Additionally, borehole water in Juba has high salinity. By contrast, water tankers deliver water in bulk quantity to the doorsteps of customers, and the water quality is perceived to be better. Hence, water tankers are the main source of water for 95% of respondents while borehole water is a secondary source. The exceptions are in the cases where borehole water is the only option available e.g. areas where tankers don't pass.

Household resellers and bicycle vendors are the other secondary sources of household water in Juba. Household resellers purchase water from water tankers then resell it at double the price and in smaller quantities. Essentially, they are a continuation of the tanker water supply chain. They are preferred to boreholes as a secondary source, but they are not as widespread and are subject to tanker water supply deficiencies. Bicycle vendors obtain water from the same collection points as water tankers. However, their prices are quadruple that of water tankers as it is more physically taxing than water tankers. They are the least preferred secondary option. Instead, they usually serve a niche group of small businesses with limited storage capacity.

The comparison of the different choices shows that where options are available, water tankers are the preferred choice. However, for 49% of the respondents, water tankers are the only option for accessing water. This is either because no other options are available in the area or some options may be available but are not viable for the household. Whether water tankers are

the preferred choice or the only choice, they are critical in having access to water. However, availability, reliability, affordability, and water quality are major constraints to access to safe, reliable, and affordable water.

Water tankers have limited availability. They usually operate for 12 hours daily with fewer trucks operating on Sunday. Every few hours, 1 to 3 tankers usually pass through a neighborhood/area. At capacities of 4000 – 4500 L each, they can't fill up all the households. As such, some households would miss the passing water tanker and would need to wait for the next one. Hence, households must wait from a few minutes to a few hours to get their water storage filled. Households can have a system of ensuring the availability of water at their disposal by keeping one drum full always (i.e., if one has 3 drums, when 2 drums finish the two can be refilled rather than waiting for all three to become empty). However, such a system is not full proof as it is dependent on the reliability of the water tankers, and it is difficult for households that fill their storage daily to maintain such a system.

Generally, water tankers are unreliable as they are susceptible to issues such as delays due to queuing at the collection points, lack of fuel, mechanical problems, the operator being sick, etc. Since the economic crisis, this has been exacerbated by strikes and some tankers choosing to operate in select neighborhoods or having select customers who will pay, leading households to conserve water on such days and some residents having to go without water for a whole day.

Water tanker pricing was previously 250-350 SSP per barrel. Due to economic woes, the pricing increased to about 350-1000 SSP. Water tanker operators attribute the increase in the price of water to a hike in water price enforced by water treatment companies who blame the price hike on the increase in the cost of imported chemicals used to treat water. Additionally, the "tax" paid to the City Council by water tanker operators has increased. More than half of Juba residents find the water prices unaffordable. However, as there is little or no alternative to water tankers, residents are forced to put up with the high prices charged by water tanker operators or go without water.

Some of the respondents are coping with the increase in pricing by reducing their water consumption. The average consumption in Juba is about 31 L /person/day, which is consistent with the study conducted by JICA. This consumption rate is already below the UN human rights threshold of 50-100 L/ person/day. Very few houses have consumption of 50 L/day and above whereas water consumption of more than 30% of the households falls below even 20 L/day, the minimum threshold for survival. With the increasing price of water and decreased

reliability of water tankers occasioned by the current economic situation, the precarious water consumption is exacerbated, making the population more vulnerable to diseases.

The second coping mechanism is to maintain the same consumption rate while simultaneously reducing money usually budgeted for other items. This means that for low-income households, the choice is being made between food, water, and other important basic needs. This is particularly challenging under the current economic situation that impacts all commodities, not just water, at a time when salaries and wages have remained the same. The third option is to use cheaper sources of water. As has been highlighted, borehole water has high salinity levels which makes it unsafe for drinking. Most households use rainwater to supplement their water source. Thus, during the dry season, when households are most dependent on tanker water, the pricing issue will be heightened.

Juba Payam's consumption of 45 L/person/day is significantly higher than the less than 30 L/person/day of the other town blocks. Firstly, this shows the effect of pricing as Juba pays the least (350 – 500 SSP), while Gudele pays the most (800 – 1000 SSP). Juba town areas within Juba Payam pay the least as they are closest to water collection points. Although Kator has the second-highest consumption, it is only 27.67 L/person/day. As most areas in Juba Payam pay the same as Kator, pricing per zone is not the only determinant in water use. Juba Payam has the highest proportion of those with storage tanks while Kator has the least. A comparison of consumption of those with storage tanks versus those without indicates that those with storage tanks have 1.5 times the consumption of those without. People with storage tanks get a discounted 50-100 SSP hence the higher consumption is possible because of the pricing. As the presence of storage tanks is taken as an indicator of socioeconomic status, a second possible reason for the higher consumption are those at a better socioeconomic standing consume more water.

The consumption patterns of the four Payams reflect the effect of pricing and socioeconomic status on water consumption. Prices and socioeconomic status are measures of affordability. Hence, it can be summed up that when the water is not affordable for households, they consume less water. More than 65% of the respondents find the water unaffordable. The findings imply that unaffordability, coupled with the issues of unreliability and limited availability account for Juba's low average consumption rate of 30 L/person/day. This is consistent with what is universally accepted about factors that affect access to adequate water.

One of the most contentious issues in the literature regarding private water vendors including water tankers is the issue of pricing. The pricing in most cities is known to be high which has led researchers to question whether the profits obtained are exploitive. Anecdotal evidence of water vending in Juba suggests that it is a highly profitable business as although tankers are sometimes owned by South Sudanese, the operators are mainly foreigners. Foreigners come to Juba to pursue economic opportunities hence the business must be making enough profits for the tank owner to pay the operators a competitive salary that keeps them in the business. Due to a lack of economic data on tanker operations, it is difficult to gauge whether the business is exploitive. However, whether the water tanker business in Juba is exploitive or not, the important conclusion on pricing is that affordability is a major constraint that needs to be addressed as it impedes the social, human, and economic development aimed for by the plans and strategies developed for the sector.

More than 70% of the respondents depend on tanker water as their main drinking water source. Of this, half do not treat the water as the common knowledge that tanker water is treated using chlorine is enough assurance for them. However, when they have an incidence of unclean water delivered, they treat the water themselves using coagulant and chlorine tablets. The judgment of clean versus unclean water is based on a comparison of the currently delivered water and the raw, untreated water delivered years ago. For the ones that treat the tanker water before drinking, they express doubt in the cleanliness of the water source or the cleanliness of the water tanker, or both. As water quality data is not widely available, respondents are judging their water quality by its physical attributes. Physical attributes alone are not an adequate measure of water quality.

Water tankers normally collect water from treatment centers which treat the raw water from River Nile with coagulants and chlorine. The water treatment processes in such treatment centers are not as rigorous as the processes followed in a conventional water treatment plant. Hence, it is possible that although the water is treated, it is not at drinking water standards. Water is also known to get contaminated with increased handling and storage therefore it is also probable that the water gets contaminated during handling by water tankers and subsequently during storage and use at the point of consumption. Households with piped water are not exempt from possible contamination as they also drink piped water without treatment. Piped water is by nature of its construction, clean but when the supply is unreliable/intermittent, there is the risk of ingress from the environment which leads to contamination. In sum, Juba residents are likely at risk of contamination from multiple points in the water supply chain and

without water quality data it is difficult to gauge the extent of this. Rather than blindly embracing the water as clean, a critical analysis by the relevant authorities using the relevant water quality parameters is needed to ensure that people in Juba are accessing water that is safe for consumption.

An important aspect of tanker vending is storage capacity. Respondents with storage drums only get water from any passing tankers while those with storage tanks can get water from vendors, they are familiar with. Firstly, storage tank users usually get a discount. This is not discriminatory rather a consequence of the marginal costs of delivering different quantities of water. But the effect is a higher financial burden on those without storage tanks and therefore, lower consumption. Secondly, as storage tank owners are familiar with their vendors, they are unlikely to get "dirty water" although this is based on physical attributes. Water in storage tanks is also less likely to get contaminated during the point of consumption because storage tanks once filled can be securely closed when water is drawn using the attached tap or the better, storage tank users have indoor plumbing. Whereas storage drums lids are not secure and there is no tap. The disparities in water access issues between those with and without storage tanks suggest that richer households have better water access as compared to poorer households.

14.2. Determining the role of Juba City Council and other authorities in regulating the business

In a 2008 JICA study, water vendors were not being regulated. The WASH Strategic Framework encouraged the role of water vendors in water provision and recommended the setting up of mechanisms to regulate them. Water tankers are now supervised by the Juba City Council. The trucks need to be registered by the Juba City Council's Public Health Department before they can start operating. The requirements from the operators are a trading license, a public health card that needs to be renewed every 6 months, and a sanitary license. Once the requirements are met, truck operators receive their registration licenses. Part of it is a sticker that is attached to the truck and has the registration number and service area delegated by the city council i.e., Juba, Munuki, Gudele, Kator. Approximately 1000 registered water trucks are operating in the city. The typical water tanker is a truck with a bowser attached to it. The truck is usually white or blue while the bowser is painted blue. It has the words clean water labeled across it in white, bold print. This has helped to differentiate between trucks hauling water and exhausters, reducing the risks associated with domestic use of focally contaminated water.

The pricing of water tankers in Juba varies by zone but is fixed for locations within the same zone. All the tankers obtain water from the same filling points, hence, the variation of pricing with zone reflects the increase in the cost of supplying water due to distance i.e., more fuel consumed. Even though most of the customers are not set, they are aware of the pricing for their zone hence incidences of overcharging are few. In this regard, Juba differs from cities where mobile vendors don't have set routes, set customers, and don't obtain water from a central point, leading to a variation in the pricing within the same location. However, just because pricing in Juba is fixed does not mean that regulation in pricing is effective/existent.

Regulation of pricing seeks to thwart monopolistic pricing and address pro-poor objectives, including affordability by the establishment of tariff schedules that specify the price of bulk water paid by vendors and restrict the price vendors can charge end users (World Bank, 2019). Water tankers in Juba are essentially a monopoly, as they face little to no competition in water provision to households. Following the initial increase in the dollar rate, the prices in each neighborhood increased by 100 SSP which was decried by citizens as too high. The city council and the water tanker association agreed to reduce the price by 50 SSP. However, despite the prescribed price, water tanker operators did not reduce their prices, arguing that they would be incurring losses rather than profit at the agreed prices. Since then, the pricing has continued to increase to almost double the initial price and the City Council has not been able to enforce a price reduction. Although more than 65% find the pricing unaffordable, the water tankers were able to enforce their new pricing on citizens by going on strike, making citizens realize that they either pay the price or go without water. Thus, the recent economic situation demonstrated the ability of this monopoly to exercise its market power.

About 2 to 3 years ago, water tankers delivered raw water from the River Nile. Since then, treatment centers have been set up to chlorinate the water before its delivered. Water tankers can also get water from the SSUWC standpipe. With chlorination centers and standpipes present, tankers are not supposed to deliver raw water. To curb the drawing of raw water, operators found drawing untreated water is fine. Despite these efforts, there are still incidences of dirty tanker water being delivered as 84% of respondents say they've received dirty water at least once within the year 2020. Higher earnings are the motivation to fetch untreated water. This may be from time savings due to less time spent queuing or cost savings due to not buying water from treatment centers/SSUWC standpipe.

Neither the SSUWC nor the Juba City council monitor nor regulate the water quality of the treatment center. The representatives of the two entities also couldn't shed more light on whether water quality in the centers is regulated and by who. SSUWC says that it only regulates the water which it supplies while Juba City Council regulates the cleanliness of the water tankers. Every three to six months, Juba City Council visually inspects the cleanliness of the bowsers, checks the condition of the hoses for rust, etc. Dirty water tankers are fined a sum of money and required to repaint their bowsers and buy new pipes before they can resume operation. Without water quality data, it is difficult to determine whether this mechanism is enough to ensure minimal contamination of water during handling and storage. Additionally, the day-to-day cleaning procedure used by water tankers is not monitored. According to WHO and other countries' water hauling guidelines, water at the point of delivery should have a chlorine residual of about 0.5-2.0 mg/L. This means that there needs to be frequent monitoring and sampling of water at the delivery point, which is not being done. In sum, water quality data across the supply chain is not available and the mechanisms to address quality are not robust enough to ensure safe drinking water.

14.3. Identifying government plans to put in place a modern water supply system

The government of South Sudan plans to improve the existing piped water system through the Japan International Cooperation Agency's (JICA) Juba Urban Water Supply and Capacity Building Development Plan. It is a water supply master plan for Juba City to be implemented in phases starting in 2009 and to be completed by 2025. Although the project had started, it has been suspended several times because of the 2013 conflict, 2016 conflict, and most recently Coronavirus. Thus, Phase 2 that was supposed to be completed in 2011-2013 is yet to be completed and is projected to be completed in 2022. By the end of phase 2, the treatment capacity would increase to 18000 m3/day and the old transmission and distribution network will be replaced.

The JICA plan consists of an expansion of the existing treatment plant capacity, construction of two more treatment plants in the West and East Bank, construction of four service reservoirs, construction of transmission pipelines and 2 transmission pumping stations, replacement and expansion of the existing distribution network. By 2025, the total treatment capacity will be 235, 000 m3/day. The plan also identifies the limited capacity of SSUWC, especially financially as a constraint to adequate water supply service. Thus, the plan also consists of capacity building of the institution with financial strengthening being a priority. This is to be achieved through an improved billing system, improved tariff structure, enhancing customer

service and reduction of nonpaying customers, strengthening of debt management. By the end of the project, the SSUWC is expected to be a self-sustaining autonomous organization with a strong financial basis.

The JICA 2009 plan also includes the private management sector in water supply both in the interim and after the final phase. It is their objective that by the end of 2025, all the residents of Juba shall have water supply either by a household connection, public standpipe, and water tankers. Thus, piped water coverage through household connections will not be 100% and the private sector comes in through a licensed tanker, community-based management, and water kiosks.

This investigation reveals that tanker water supply under the current model is not sustainable to achieving access to affordable, reliable, and clean water as it is unreliable, unaffordable and the water quality is questionable. This is not unique to Juba as the literature on water vending in Kenya, Ghana, Tanzania, and other developing countries has shown. The difference between the current situation in Juba and the other cities in developing countries featured in this study is that in Juba, the majority of the population is currently underserved, regardless of the socioeconomic status while for the other cities, the underserved populations were usually the urban poor. This has led to inequity in the water access of these cities. With the end of JICA's project not leading to the complete phasing out of water tankers, it is evident that the current model needs to be changed to ensure that the underserved population will access water at the right price and the right quality. This means effective regulation and management, as well as efficient monitoring of the systems that will be in place for the underserved population, will need to be implemented by the relevant authorities.

There is no substitute for reliable, piped water that delivers clean water on the premises. Even where the new model for the underserved population is effective in delivering water at the right price and quality, consumption will still not be on par with piped water as no other water delivery mechanism is as convenient. Secondly, tanker water is expensive as the transactional costs are very high due to the use of fuel. Therefore, it would need to be subsidized to make the prices affordable for the underserved. Water tanker trucks also cause urban congestion, destroy road infrastructure especially unpaved roads, are road safety hazards and their excessive use of fuel means they are environmentally unsustainable. In sum, the proposed use of water tankers, water kiosks, etc. should be applied as a short-term measure as they are not sustainable in the long term. Post completion of the JICA project, the utility should continue to

make efforts to bring in the underserved population to piped water and through proper planning, ensure that it can match the piped water demand of the ever-growing population.

15. CONCLUSIONS AND RECOMENDATIONS

Only about 2% of the Juba population is connected to piped water and the service is unreliable. Water tankers have been critical in filling this gap as they are the primary source of water for the majority of the residents and a secondary source for the rest. However, affordability is a major constraint to adequate water consumption and financial flexibility of households, especially those of low income. Water quality is also questionable due to limited information/data on the chlorination treatment, water tanker handling and cleaning techniques, and household storage practices. Additionally, the incidences of untreated water being delivered are common despite the interventions to curb this. It is concerning that a good proportion of the population only treat their water when they perceive it to be dirty as physical attributes are not a proxy for water quality data. There is no regulatory framework for the water sector. Currently, tanker water is Juba City Council's oversight. Although they prescribe pricing and routinely inspect water tanker cleanliness, water tankers are currently selling water above prescribed prices and routine inspection alone is not a sufficient assurance of water quality.

The main plan to address water access issues in Juba is through JICA's urban water supply plan which was to be completed in 2025. However, the plan's implementation has been slowed down by conflict and most recently, the coronavirus. The plan envisages water tankers continuing to play an important role in the water supply chain even upon completion but this study shows that the current tanker water system is not safe, affordable, or reliable. Therefore, there are two challenges to be addressed: accelerating JICA's plan and achieving safe, affordable, and reliable water for all. Some policy implications/recommendations to help address these are:

- Create an enabling environment for development in the water sector through peace and stability and a true commitment to development. The main hindrance to the implementation of development plans in the water sector has been conflicting and instability. Beyond that, the popular success story of Phnom Penh water utility in Cambodia and other successful utilities in developing countries shows the importance of sincere and committed reforms within the water utility with political, government, and Donor support to make a major improvement to water access.
- Establishment of a regulatory framework through the enactment of the Draft Bill of 2013. The regulatory needs to ensure safe, affordable, and reliable access for both those

with piped water on-premises and those relying on other means i.e water tankers, CBOs, and water kiosks.

- Capacity building of the institutions involved in the water sector. The institutions in the water sector have so far been characterized as having weak institutional capacities which have hindered service delivery. While JICA's plan covers the capacity building of the SSUWC, it is also important that all the institutions in the water sector including the regulatory body that is to be formed, have the institutional capacities to fulfill their mandates effectively and efficiently.
- Master infrastructure plan and coordination of efforts between the relevant actors. The destruction of the recently rehabilitated water distribution network in 2009 reflects the importance of urban planning and coordination of infrastructure improvement efforts. The JICA plan focuses primarily on infrastructure for the drinking water supply. However, water supply infrastructure in urban planning usually goes alongside sewerage infrastructure. From an infrastructure standpoint, it is more cost-effective to have them done at the same time or at least be put into consideration during the planning phase.
- Effective water quality assurance system that routinely tests and monitors water quality across all points of the supply chain including point of consumption to ensure safe drinking water to all.
- Multidisciplinary research on water access. Water Access is a complex issue that encompasses multiple disciplines. This study only scratched the surface of water access issues in Juba. More research is needed to highlight, address and mitigate issues/problems.

The main limitation of the study is the use of non-probability sampling which limits the generalizability of the study to the entire Juba population. Although the study highlighted key issues such as affordability, it is difficult to adequately estimate the extent of these issues within Juba. The second limitation is the lack of water quality data which would have substantiated claims of the water being of questionable quality. Also, evaluating the water quality data against recognized drinking water standards would have given a fuller picture of the health risks associated with the water consumed in Juba. The third limitation is water tanker operators and water treatment centers were not engaged. Engaging them especially with regards to the pricing would have informed how and why the pricing increases across the supply chain which would help to identify possible solutions to address the issue of affordability. The fourth

limitation is the time allocated and use of one researcher is not enough to address the scope of such a complex, multidisciplinary issue. Therefore, future research should be a Multidisciplinary approach with a detailed household survey and engagement of all the stakeholders in the water supply chain to adequately gauge water access in Juba. This study is useful to highlight key issues that future research should focus on.

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SOUTH SUDAN CENTER FOR STRATEGIC AND POLICY STUDIES (CSPS)

P.O.Box 619
Hai Jebrona, Adjacent to Martyrs School,
Opposite Simba Playground-Juba, South Sudan.
+211 (0) 920 310 415 | +211 (0) 915 652 847
info@csps.org.ss
https//csps.org.ss
CSPSJuba