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Assessing the Availability and Accessibility to Improved Public Water Sources in Eastern Province A Case of Musheri Sector in Nyagatare District

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Abstract

In this comprehensive study, we assessed the accessibility and availability of potable water in specific communities within the Musheri sector of Nyagatare district, Eastern Province, Rwanda. We systematically selected 95 households using random sampling from various cells within the sector. Utilizing advanced Global Positioning System (GPS) and ArcGIS pro, we precisely documented and analyzed the distribution of public water taps and reservoirs. Rigorous statistical analysis was employed to uncover the correlation between factors influencing accessibility and those affecting water availability. Our findings from respondents revealed that a significant majority 42% of households relied on public water kiosks for safe drinking water from diverse improved public water sources (IPWS) while using ArcGIS Pro multi buffer analysis, we found that 33.87% of households are proximity of 500 m from the public tapes while 66.13% are out of 500m recommended in rural areas . Additionally, 11.58% of respondents reported traveling more than 500 meters to reach a water source, with 18.98% traveling between 20 and 30 minutes. Notably, the proximity to standard water taps in the sector exceeded the recommended 500-meter distance, posing logistical challenges. Despite the extended duration of 5 minutes per 20 liters of jerrycan to obtain water, 45.26% of respondents indicated that the available quantity met their daily needs. Most households consumed an average of 6.82 jerrycans of 20 liters per day. Furthermore, 30.53% of households traveled more than 30 minutes to reach improved public water sources, while only 8.42% could access drinking water within 30 minutes. To address these challenges, we suggest that local municipalities prioritize the provision of water taps within a 500-meter proximity in rural areas. However, this remains noneffective, as some households continue to face insufficient running water due to vandalism, dysfunctional taps, or geographical constraints like low-lying areas prone to drought conditions.

Keywords*:* Availability, accessibility, improved public water sources, Musheri sector

1. Introduction

Water management is crucial for the socioeconomic growth of Rwanda and other countries, especially better social health progress and agriculture. The development of any country depends on accessibility and availability of adequate water resources. The United Nations General Assembly (UNGA) recognized the rights of humans to water and sanitation (Meier et al., 2013; Brown et al., 2016). 1.7 billion people worldwide use drinking water sources tainted by excrement, and over two billion people live in water-stressed areas (WHO, 2021). Water shortage issues are common in sub-Saharan Africa, where 46% of people do not have access to better water supplies in 2020.

The Demographic Health Survey (DHS) reports that between 2019 and 2022, the percentage of people who access improved public water sources climbed from 56% to 70% respectively. Budgets are allocated for infrastructure that provides about 20 L of drinking water per person per day within 500 m of a dwelling, with a minimum flow rate of 10 L per minute. (UNICEF Rwanda, 2023), ongoing conversations lead to new public policy in the water sector. (Aleixo et al., 2019) found that water infrastructure in underdeveloped nations is often insufficient to enable appropriate access. According to Shaheed et al. 2014), water supply infrastructures vary in availability, safety, and accessibility throughout time and geography. According to Majuru et al.2012) communities may experience unreliable and unsafe piped water supplies.

It's crucial to address gaps in both development and service delivery. Disasters including drought, floods, and unavailability of the technological know-how in the treatment and management of pure water also contribute to the lack of social and economic development of the water sector in developing countries. The inclusion of this type of analysis in the Sustainable Development Goals (SDGs) has increased its importance and global attention. Goal 6 aims to ensure sustainable management of water and sanitation for all by 2030 and 100% access to improved public water sources by vision 2050. In Rwanda national strategy for transformation (NST1) shall play a pivotal role in achieving vision 2050 so called "Rwanda we want" which envisions at ensuring 100% of population access improved water and 99% per household. Eastern province of Rwanda is one of the rainwater scarce regions, with an average annual rainfall of approximately 800mm. Rainfall is seasonal and significantly lower than the district's average of 800 mm per year. The hot heat and rising water shortages lead to very unpredictable rainfall patterns and significant evaporation. Due to the poor service level, residents queue for long periods at access water points which may have erratic or irregular supply. The residents also travel long distances carrying water home. The difficulty of getting water from standpipes forces people to resort to any available surface water like rivers. Musheri sector faces a severe lack of clean, pure water primarily due to dysfunction IPWS and poor distribution. Other factors contributing to this include population growth, increasing economic activities, and insufficient water delivery infrastructures. This research evaluated the accessibility and availability of water supplies in Musheri sector of Nyagatare district.

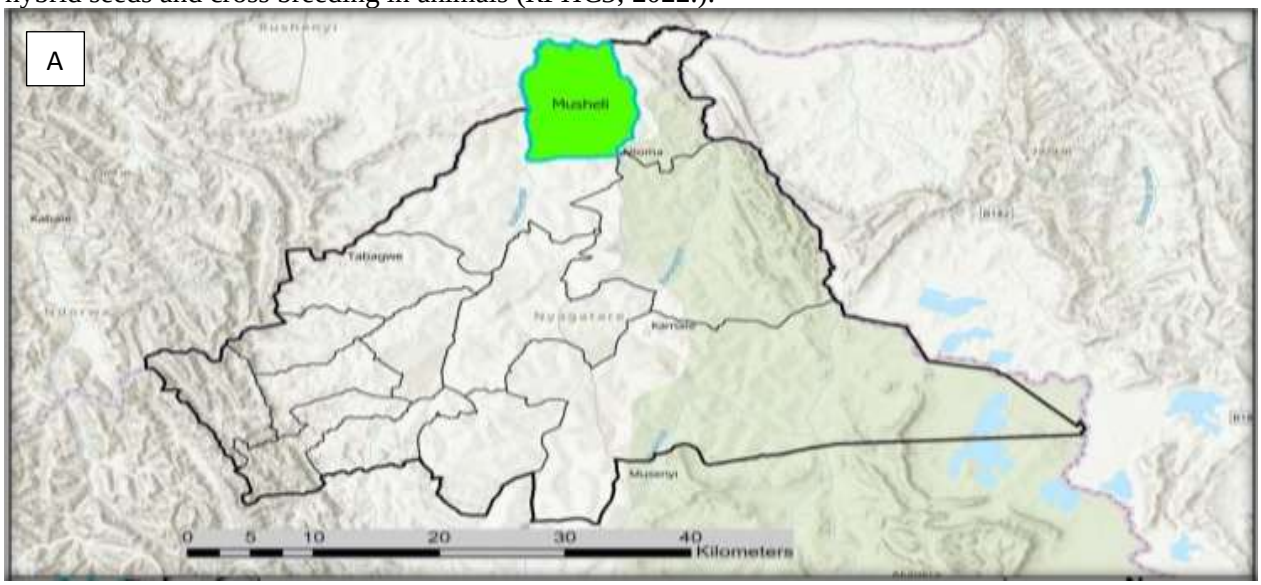
2. Materials and Methods

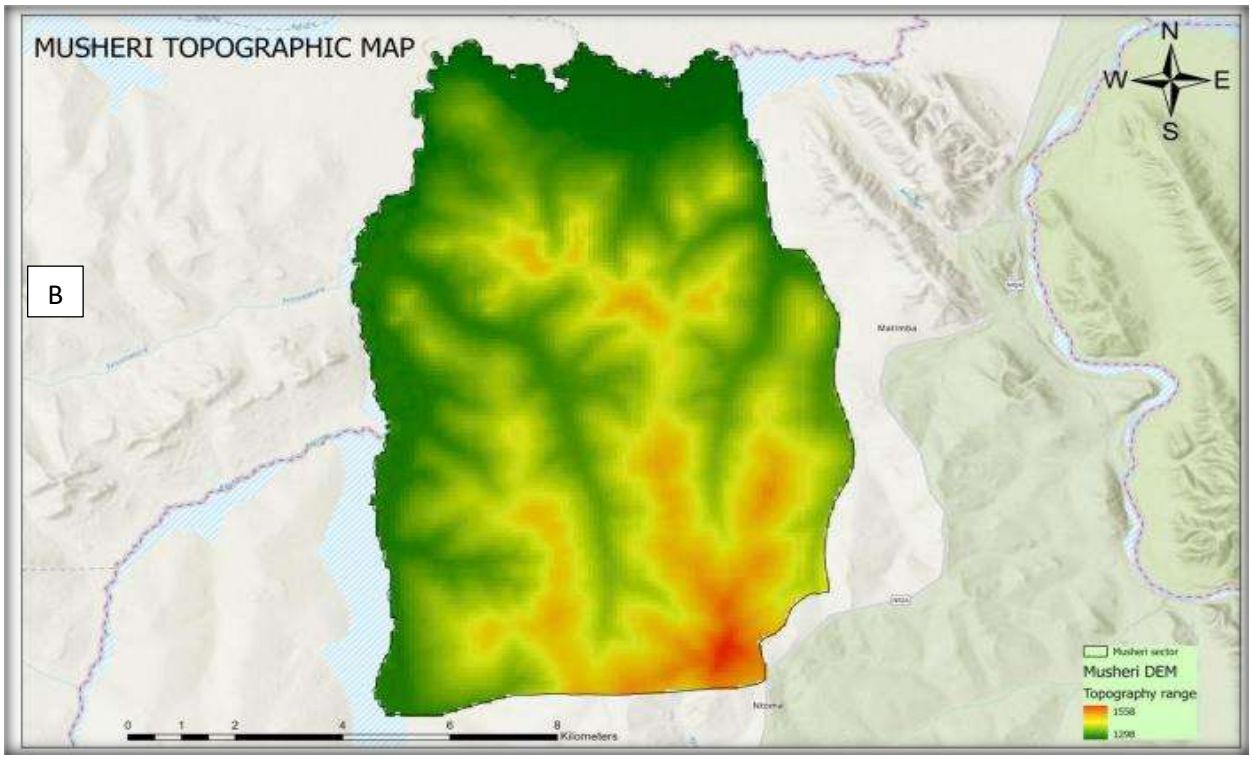
2.1 Study Area Description

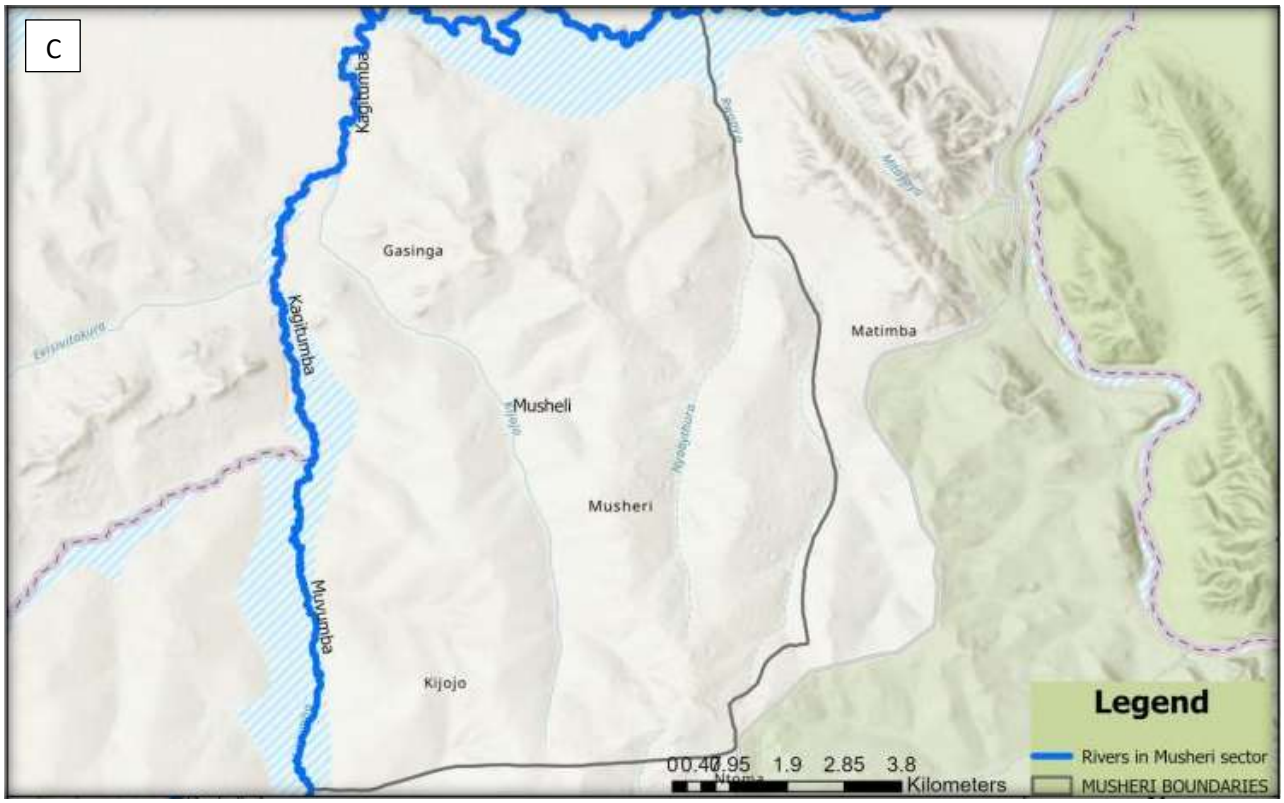
Musheri is one of 14 sectors in Nyagatare district, located in eastern Rwanda. It is subdivided into 8 cells: Kibirizi, Kijojo, Musheli, Ntoma, Nyagatabire, Nyamiyonga, Rugarama 1 and Rugarama 2, and 21 villages namely Nyamisange, Kibirizi, Nyamenge, Kijuju1, Kagwegwe, Kijuju2, Musheli, Gakiri, Ntoma1, Ntoma2, Murisanga, Nyagatabire, Gikunyu, Cyenombe, Nyamiyonga 1, Nyamiyonga2, Humure, Karambi, Karuca, Rugarama. Its Nyagatare district's largest sector consists of 96.41 km² comprising cells and settlements (Nyagatare, 2022). It borders UGANDA country in north and MATIMBA sector in west and RWEMPASHA sector in the south (figure A). Musheri sector is among the highly populated sector in Nyagatare district with 32,204 people of both sexes where 15,768 are male and 16,436 are female and as the majority of the whole districts population, Musheri sector population majority of them are engaged in farming activities mainly livestock farming and crop cultivation (NISR, 2022.). It is located in low altitude of the district of 1513.5 m in eastern lowlands. Its topography ranges from 1298.001 to 1558 meters above sea level as stipulated in the (figure B) below (NLA, 2020). Musheri sector is supplied by Umuvumba chart of water streams and across the district. The weak river network in the entire district constitutes a serious problem to respond to the needs of water for people and animals (Republic of Rwanda, Rwanda national water resources master plan, 2023) as shown in (figure C) below.

Musheri sector's flora and fauna is mainly characterized by its abundant grassland that mainly favors cattle and small domestic animals rearing such as caws, goats and sheep (figure D). The availability of plains and low inclined hills make them suitable for agriculture modernization. The sector is also known for its high soil fertility, cattle breeding and thereby dairy production. Like other sectors within the district, Musheri sectors are also known for high yield of milk(*RPHC5, 2022*). In Musheri sector the total population

proportion who are engaged in agriculture are 67% out of 8532 HHS where 59.6% are engaged in crop farming while 40.4% are engaged in livestock husbandry. Musheri sector has increased agricultural production to enhance food security and increased the value of livestock products through various ways (*RPHC5*, 2022.). That increase of agricultural and farming productivity increase has resulted from agricultural mechanization and use improved farming techniques such as irrigation, fertilizers and use of hybrid seeds and cross breeding in animals (*RPHC5*, 2022.).



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Rivers in Musheri sector
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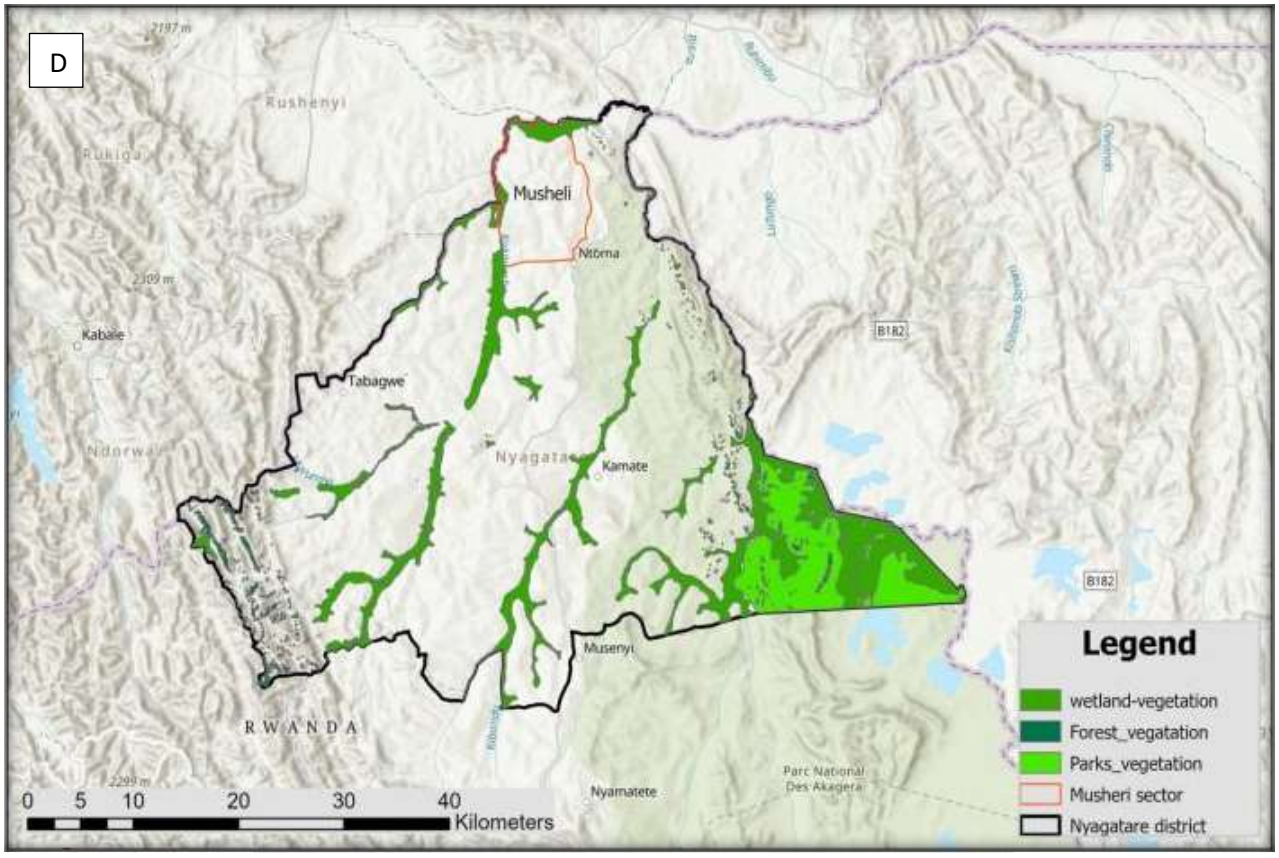
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Kilometers

2.2 Sampling Technique

Spatial Clustering in rural and peri-urban regions associated with spatial systematic random selection technique, focusing on the Musheri sector area was integrated for data collection procedure. This selection sought to study advances in water availability and accessibility within Musheri sector, we thoroughly sampled 95 households using Raosoft sample size formulae, the sampled households constituted above 700 members and were selected based on their proximity from the IPWS and how they were severely affected by the lack of drinking water. They were asked questions regarding water availability and accessibility from the IPWS in their location. This approach utilizes non-random criteria, specifically targeting respondents who have been severely affected by lack of drinking water and are located in proximity of public water sources due to various spatial factors. The sample size was calculated based on the Raosoft sample size calculator, as demonstrated by the formulae provided below.

$$\mathbf{N}=\frac{N(\frac{zs}{e})2}{N-1+(\frac{zs}{e})2}$$

z= 1.645 for 9% level of confidence
s = p(1-p) p = estimated proportion
e = desired margin of error
N = population size

with a sample size of around 12 HHS per cell, where the margin of error is 9% and the confidence level is evaluated at 91%. Consequently, the total study's sample size is equivalent to 95 HHS in 8 cells of Musheri sector

2.3 Data Collection

Data was acquired utilizing primary and secondary methods, including field observation, point collection, and pilot research. Primary data was acquired using a questionnaire. The questionnaire as the primary data collection method, included both open and closed-ended questions. The survey consisted of 35 questions, 23 closed-ended and 12 open-ended. The questionnaires were self-administered to the home head or an elder family member only. The questionnaire assessed socioeconomic factors, water supply accessibility and availability, water shortage coping techniques, and perceptions of water supply in Musheri sector. The local sector executive was interviewed on the strategies which were used to minimize water shortage and scarcity within the sector.

The survey also as the primary data collection method, included open-ended questions about community awareness efforts and citizen engagement in water provision. The survey asked about community perceptions on water scarcity, the situation in the region, the impact on the community, water supply initiatives, and the success and problems of existing initiatives. GPS embedded in Kobo collect app, was employed to pinpoint the exact position of the improved public water sources and the reservoir in Musheri sector, in addition Kobo collect app was utilized for both qualitative and quantitative data collection and later aided in data analysis and comparison. The slope information was collected from the 10 m spatial resolution of Sentinel 8 image using ArcGIS pro software. Points were recorded in an excel file and then plotted using ArcGIS Pro software. Sentinel 8 employed polygon river data and building count to narrow regions to eligible places. Thematic maps were created for each parameter. All maps were Geo-referenced using the Universal Transverse Mercator coordinate system (UTM).

Secondary data such as the number of households in Musheri sector was acquired from District Development Strategies (DDS, 2020), National Institute of Statistics of Rwanda (NISR, 2022), and Ministry of infrastructure (MINENFRA), using secondary data collection methods especially literature review. Furthermore, through using literature review technique, the water distribution per district, Sector and per household level was acquired from Water and Sanitation Cooperation (WASAC, 2022) reports and Nyagatare district.

2.4 Data Analysis

Data was collected by surveys with two categories of questions: closed-ended inquiries on community socioeconomic features, water supply accessibility and availability, and water shortage coping mechanisms. Descriptive statistics were used in statistical software namely Microsoft excel to analyze replies to various queries, providing average and graphical results. The acquired data was described using descriptive statistics, including frequencies and means. Descriptive statistics were used to analyze families' coping techniques during water shortage, access to water supply in the Musheri sector. These responses were compared for similarities or differences using Pearson Chi-square test method (Equation).

$$\mathbf{x} = \sum \frac{(\mathbf{0} - \boldsymbol{e})^{\mathbf{2}}}{\boldsymbol{e}}$$

where **O** = Observed frequency, **E** = Expected frequency, ∑ = Summation and $\mathbf{X_2}$ **=** Chi Square value

ArcGIS pro was also used for the analysis of spatial variation of water accessibility and availability within the study area. We used a variety of key tools in ArcGIS Pro to analyze the accessibility and availability of enhanced public water sources to obtain thorough insights. First, we can clearly see the coverage regions by using the "multi-buffer" tool in order to establish concentric zones around water sources (figure 1). The "Euclidean" tool provides exact spatial information by computing straight-line lengths between places, which is useful for measuring distances correctly. Furthermore, proximity analysis was conducted using ArcGIS Pro where we showcased the current development of population growth and the development of improved water infrastructures, this could enable us to assess whether both developments align with each other (figure 4). Unfortunately, they both run in opposite direction, one in north east and the other in south west respectively. Also, IPWS infrastructural development is in opposite direction of the highly populated regions in south east of the study area.

1. Multi-Criteria Evaluation and GIS

Multi-criteria evaluation (MCE) in GIS was used; this is a GIS evaluation analysis which helps with the allocation of land to suit a specific objective on the basis of a variety of attributes that the selected areas should possess. The suitability criteria (Multi-criteria evaluation in GIS) was used to analyse factors based on the following: suitability and restriction criteria. The suitability analysis was decided based on the municipal and provincial by-laws principles and engaging with the municipal planning department for both the factor and restriction criteria. The factor criterion enhances or detracts from the suitability of a specific alternative for the activity under consideration e.g. distance to water taps (near = most suitable; far = least suitable). The second one was the restriction criteria, which serve to limit the alternatives under consideration such as an element or a feature that represents limitations or restrictions and area that is not preferred in any way or considered unsuitable e.g. protected area, water body etc.

The following formula was used: $\mathbf{S = \Sigma\, w_i x_i \Pi r_j}$

where **Σ** = sum of weighted factors; **S** =Suitability to the objective being considered, $\mathbf{W_i}$ = Weight assigned to factor; $\mathbf{X_i}$ = Criterion score of factors i and $\mathbf{r_j}$ = Constraints.

2. Results

2.1 Demographic Characteristics of Musheri Sector

In the Musheri sector, the respondents average of years was 45 where the maximum age was 87 and minimum age was 20 years. The main criteria for choosing respondents were the years he/she spent living in the vicinity and possessing a household or lived in for a considerable couple of years.

2.2 Coverage Areas of Households with Respect to Improved Public Water Sources (IPWS)

Household coverage areas for improved public water sources (IPWS) are geographic zones or polygons in which households have access to improved public water sources. These locations are often defined by the closeness of homes to improved public water sources such piped water, boreholes, or protected wells. By mapping these coverage regions, regulators and planners may detect gaps in access to better water sources

and devise plans to expand coverage to undeserved areas. Furthermore, identifying the coverage regions aids in evaluating the efficacy of water supply measures and allocating resources to areas with limited access to better water sources. (Wolf, 2022).

For Musheri scenario, 66 sampled households were found to be in proximity of required 500m distance making 70% of the total coverage, for our analysis this distribution is almost good due to the fact that Musheri sector population are settled in planned grouped settlement pattern, however few people lives within their farmlands which even occupies a large area of Musheri sector, also we found that more sources are there though some of them do not provide clean water worth of being drunk and majority of sources are no longer in service due to few water and even no water. In this sector we found only 2 main supplying facilities namely Cyondo PS and Kiyombe PS which are even located far away from the sector, also pumping stations and reservoirs are still insufficient hence leads to water scarcity within the entire community. (Bayingana, 2021).

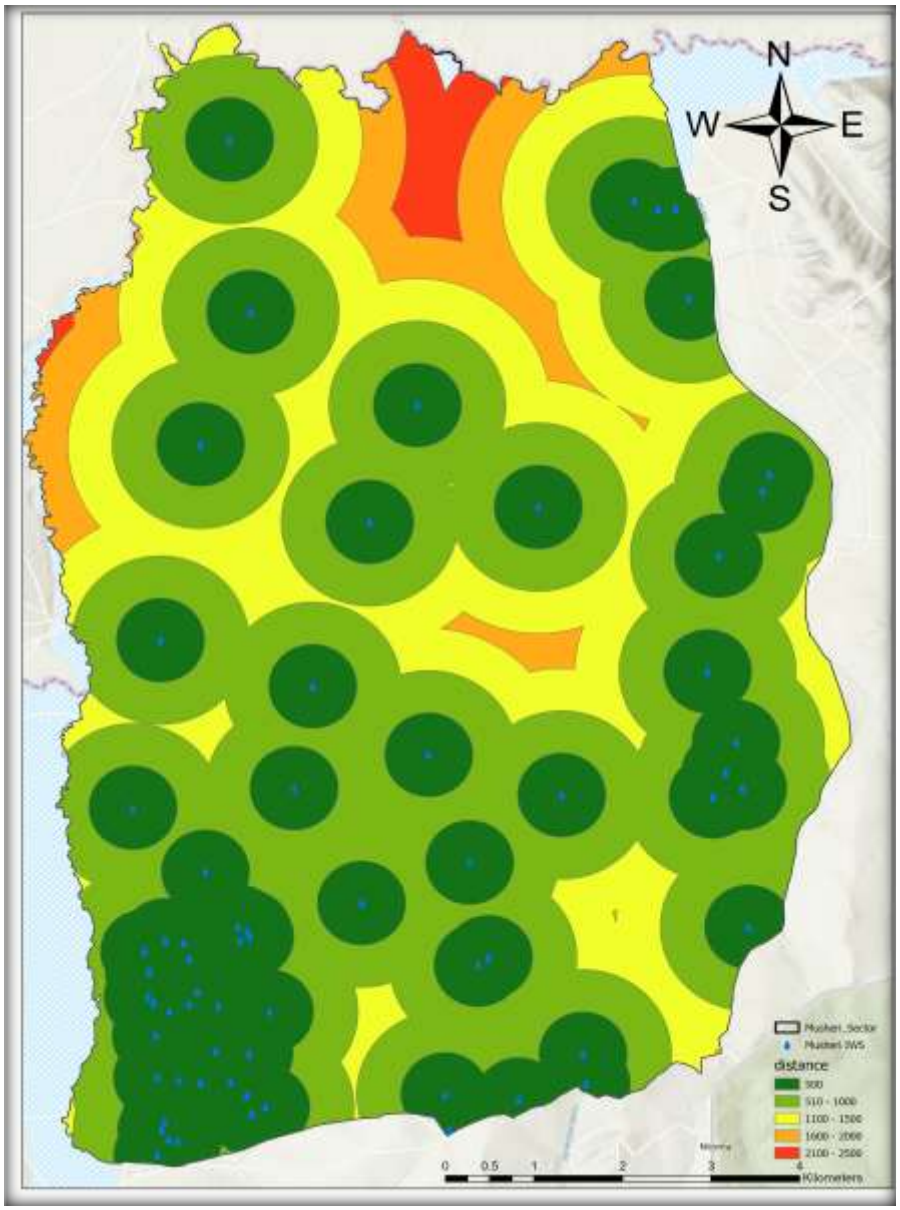

Figure 1: Coverage of IPWS in Musheri sector

2.3 Distribution of Improved Public Water in Musheri Sector

Normally as we witnessed during the field data collection which was conducted in April 2024, water distribution in Musheri sector is fair especially obvious when you see some IPWS found within the vicinity, you find that more taps are there and some boreholes are within proximal distance, however, a big percentage of them do not serve their purpose due to the dysfunction of much of them, not only that but also lack of water within those tapes dominates within the region. Also boreholes are not efficiently used as the source of water since people claims that water from them are salty at level to which even caws can't drink them(Gross, 2019).

We also witnessed that water reservoirs are still few which in turn leads to poor supply of water weekly, local settlers argued that they only get water on Thursday only but this where water taps are still in service while for many regions drinking water is a myth though those infrastructures are provided. In short water some water distribution infrastructure such as water taps and boreholes are there but still others like reservoirs and strong water pipes are still lacking which generally reflects that distribution on side of infrastructures is somehow fair offside the water supply which is still a plight within the region and its normally accelerated by diverse factors discussed within this document.

The diagram illustrates the proximity of households within the Musheri sector to water kiosks. Instead of using interpolation, Thiessen polygons, also known as proximal polygons, are employed to delineate areas where households are closest to water kiosks. This method aids in identifying the households served by public water supply and modeling catchment areas for households near the kiosks in the Musheri sector. By utilizing multiple distance buffer, we can effectively visualize the distribution of households in relation to the distance from the water kiosks which is recommended to be 500m in rural areas. It becomes apparent that some households are situated nearer to the public water infrastructure while others are more distant, indicating an uneven distribution of these facilities within the sector. The figure 2 below shows the percentage of respondents who access IPWS and their types while figure 3 shows the distance that respondents travel to access IPWS.

The figure 4 below indicates the direction of population growth and the direction of IPWS growth on the left side, according to that distribution analysis, population growth is in counter direction of IPWS development and this showcases poor pro active planning since the development of improved public water sources should follow the development of population. In turn people tends to use other sources like rain water, boreholes and others due such poor accessibility and availability.

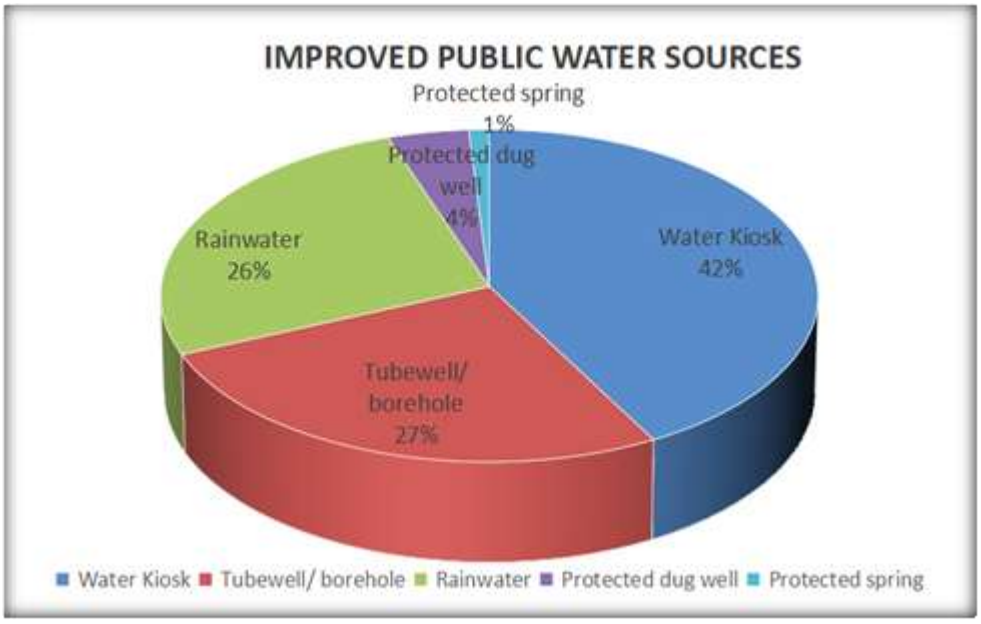

Figure 2: improved public water sources in Musheri sector

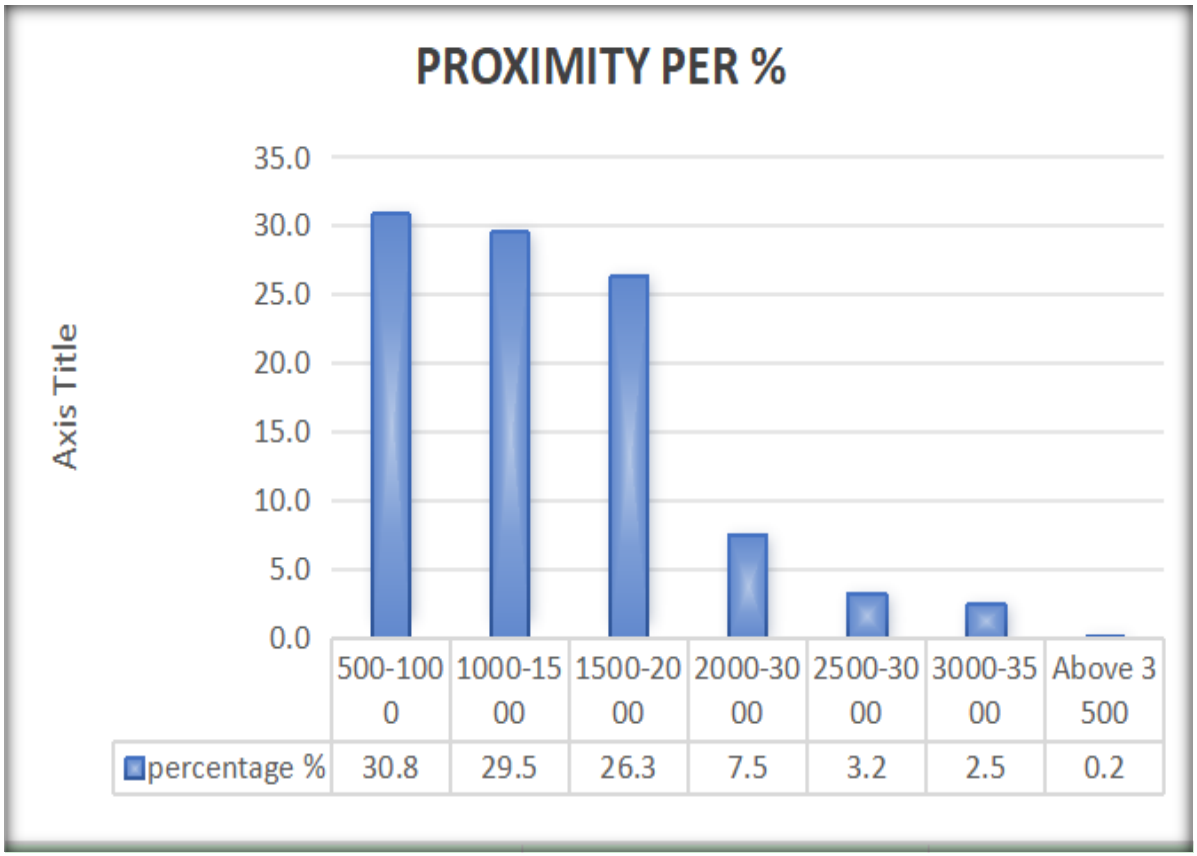

Figure 3: Distribution of water users per distance range from IPWS

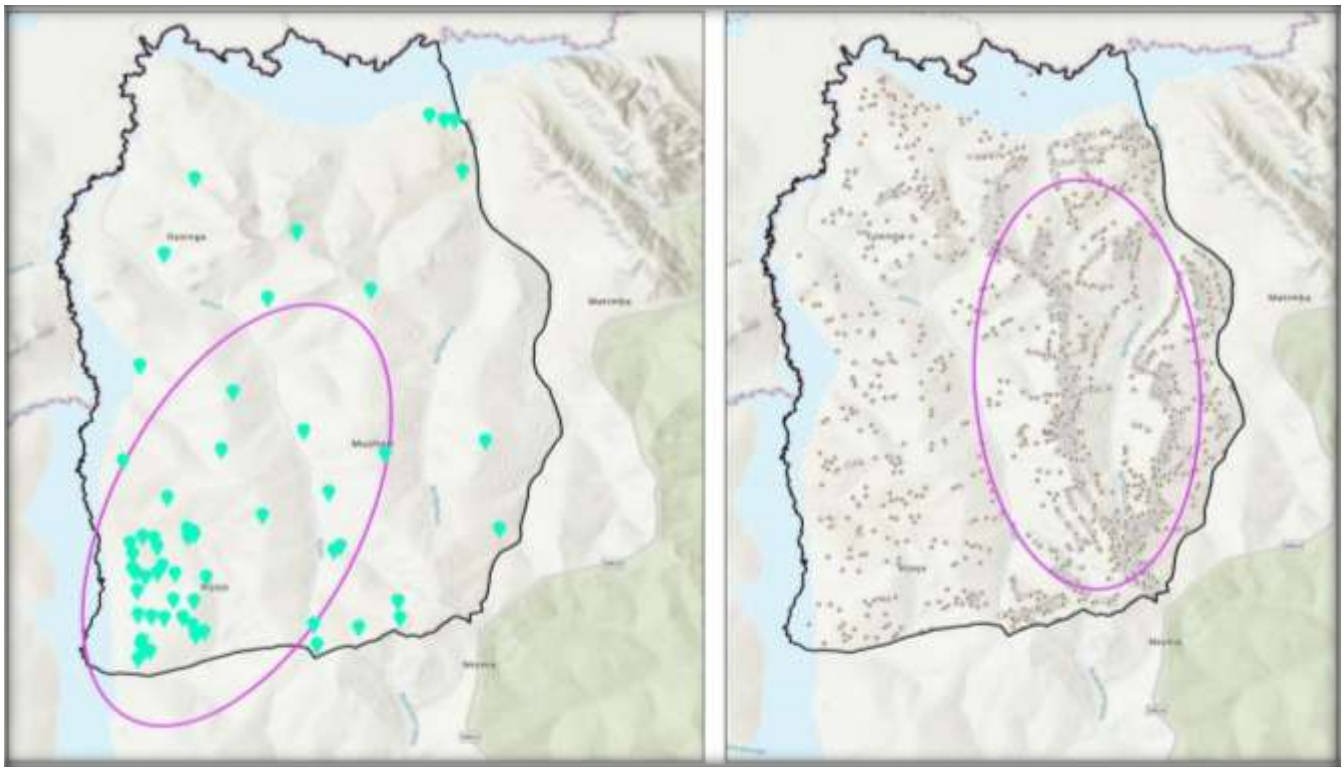

Figure 4: Development of IPWS infrastructures & Development of settlement

2.4 Level of Accessibility to Improved Public Water Sources in Musheri Sector

Regarding global view of distribution of public water supply, the phrase "water distribution network" refers to the section of a water distribution system that connects to the service points of bulk water consumers or demand nodes, where several users are combined(WHO,2021). In Nyagatare district, PVC, HDPE, ductile iron, and steel are common reticulation materials. The water supply distribution network spans around 205 kilometers. According to service data, 81% of Nyagatare consumers have access to improved public water sources.

Expanding the network is necessary to achieve the national aim of 100% access. The network system has several issues, including aging pipes that frequently burst and leak, unauthorized connections, insufficient pressure control, and rusted steel pipes. In Musheri sector, the research conducted revealed that 42% of respondents access water from pipelines and 33.87% houses are in proximity of 500m from IPWS while 67.3% (table 4) are out of required distance from IPWS and this pushes them to acquire water from diverse sources as depicted in the figure 14 and table 4.

Table 1: Physical accessibility of IPWS from houses in Musheri sector

Distance range per household	Number of house holds	Percentage %	Cumulative Percentage %
500-1000	2000	34.87	**33.87**
1000-1500	1940	33.88	**66.6**
1500-2000	1951	33.09	**96.6**
2000-3000	4	0.006	**96.7**
2500-Above	6	0.01	**100**
TOTAL	**5901**		

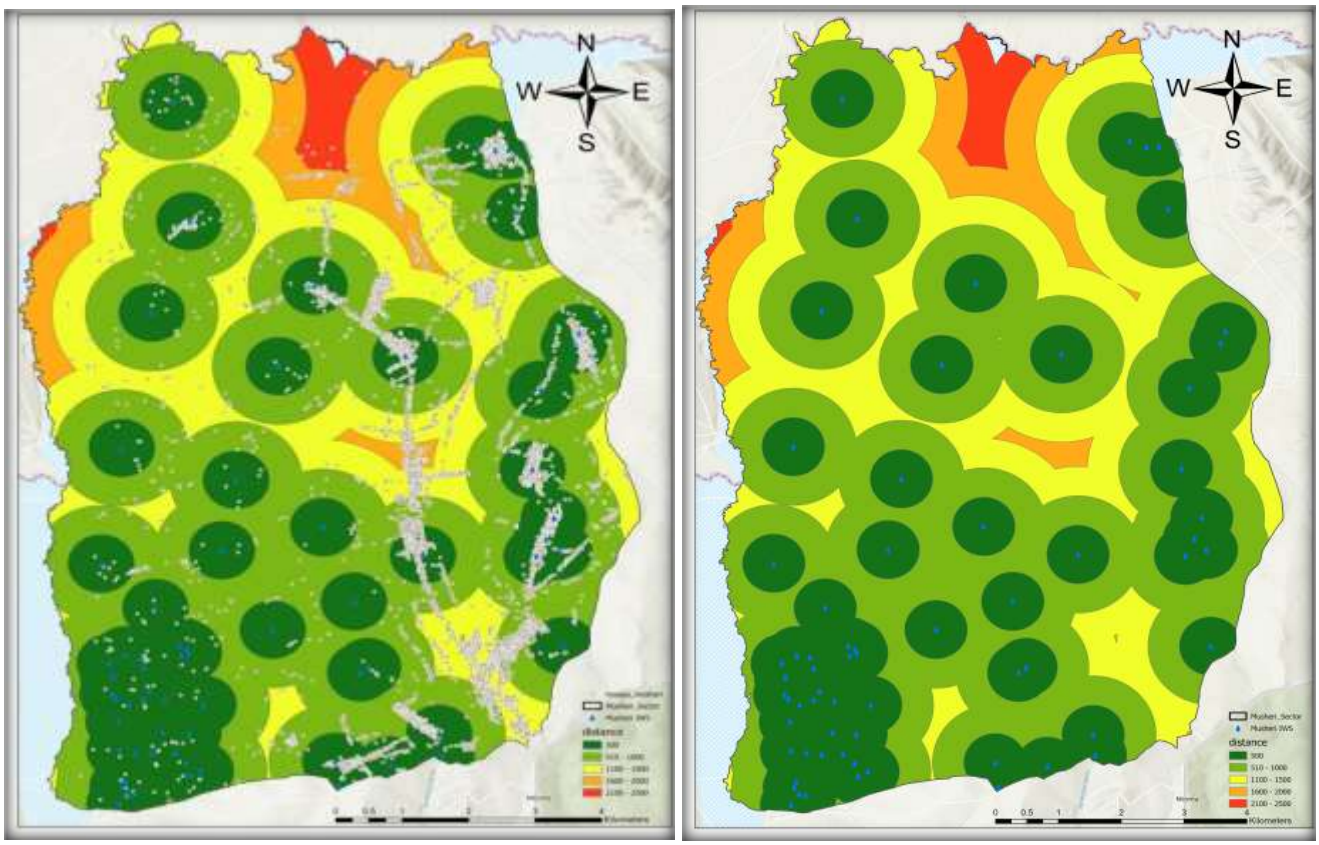

Figure 5: Level of accessibility of IPWS in Musheri sector per house hold

2.6 Quantity of Drinking Water Per Capita Per Day in Musheri Sector

Accessibility, continuity, dependability, and pricing all have an impact on domestic water consumption. Inadequate access and irregular supply diminish consumption, especially in the absence of coping methods such as storage. Water prices that are over the affordability threshold have an impact on consumption. The estimated daily drinking water need is 5.3 L/person/day, which is acceptable for nursing mothers in warm regions. For basic hygiene, 20 L/person/day is suggested, however this might vary depending on environment and cultural variables (WHO, 2021). During disease outbreaks, improved hygiene needs flowing water, preferably with touchless systems. Piped water supplies administered by the utility, or a municipality are ideal, but household sources may be sufficient. Intermediate access levels may not allow for improved cleanliness without sacrificing other water usage.

Accessibility to public water supply in the Musheri sector is determined by the distance, time, and financial means by which individuals reach public water sources. These criteria are close, medium, and further. The study assessed the physical accessibility of public water sources in the Musheri Sector area. These requirements were validated and required to ensure that the Musheri sector's population had access to improved public water sources. In urban areas, public water kiosks are typically 500 meters away from residences while situated in 500m from residence in rural areas, with a waiting period of 5-30 minutes and a fee of no more than 20 Rwandan Francs every 20 liters.

Approximately 42% of people in Musheri sector rely on public water sources, but more than 54.74 % are committed to pay for it(figure 6). Also, during the analysis of quantity of water used per household, we found that all households in Musheri sector use an average of 6.8 jerrycans a day. This varies due to the family size and distance travelled to the water sources. The more the source is far, a lower water quantity is used and vice versa to the nearest households. By assessing the impact of drinking water scarcity in Musheri district, we heard the responses of respondent's about where that problem impacts them mostly between financial and health. As results show below (figure 7), an incredible number of 78.98% showed that lacking drinking water poses health problems to them.

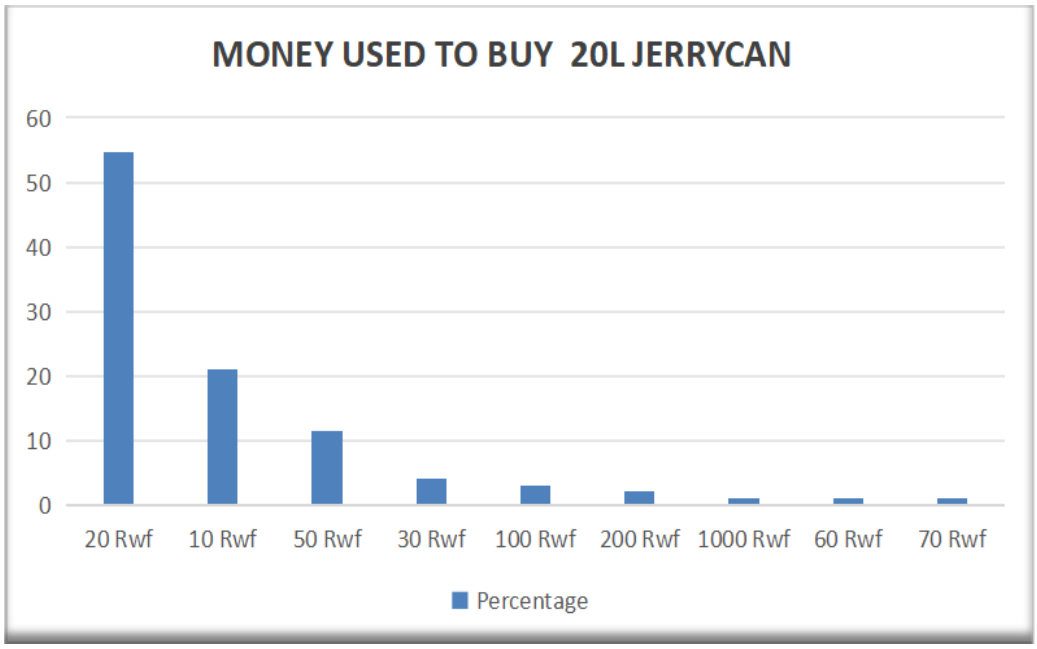

Figure 6: Money used to buy 20 litters jerrycan

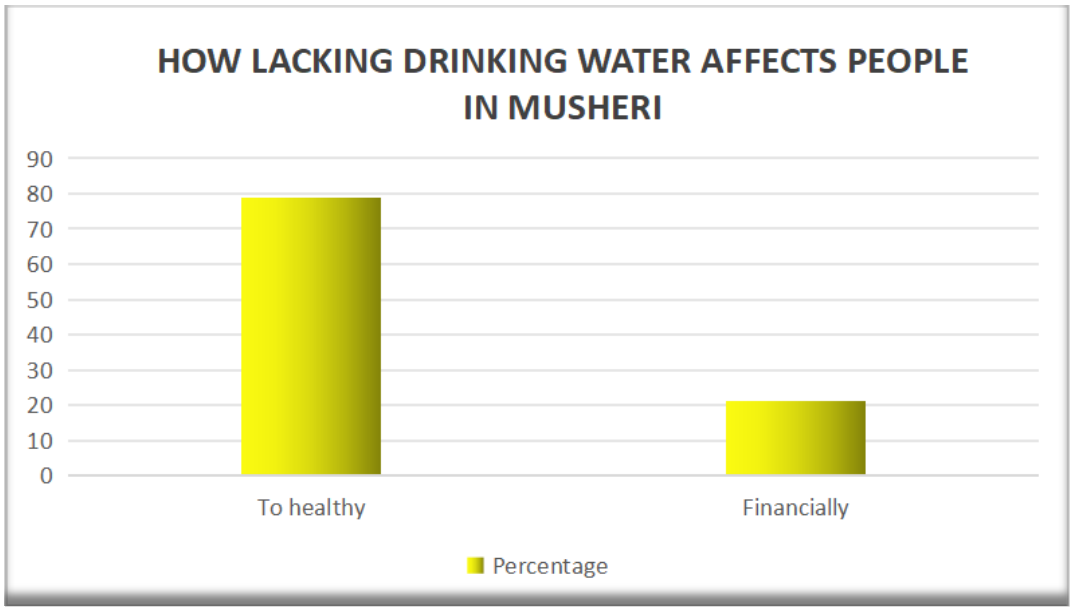

Figure 7: How lacking drinking water affects people in Musheri sector

2.7 Availability of Improved Public Water Sources in Musheri Sector

In Rwanda, urban residents are required to have access to public water sources within a 500-meter radius(NST1,2017). This discovery enables us to promptly install new public water kiosks in regions with both high and low availability of public water supply, thereby enhancing proximity to infrastructure in Nyagatare District, especially in the Musheri sector. Also the traveled distance and time used to reach to the improved water source, revealed by the respondents during the field survey gives an insight on how water sources are accessed (figure 8), this shows that more than 15% travels a long distance than the required 500m in rural areas while more than 4% uses above 30 minutes to reach and return from the improved water source, also the majority of them uses 21% uses 20 minutes. This reflects that the coverage is normally good but still drinking water is a problem since the availability is low as the next analysis shows. Enhancing drinking water supply infrastructure serves as a crucial catalyst for our country's socioeconomic advancement. It effectively addresses concerns about poor hygiene resulting from inaccessible public water supply facilities (Mwitirehe, 2024).

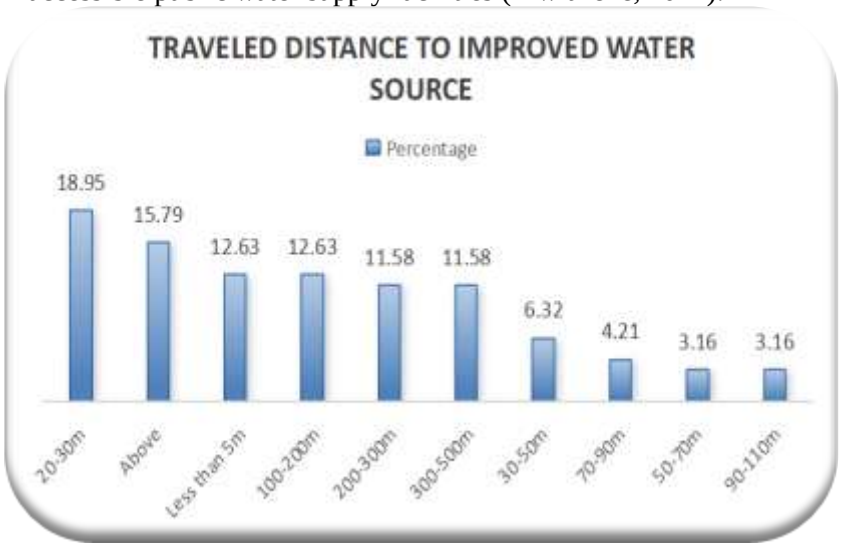

Figure 8: Traveled distance to improved public water sources. (author April 2024)

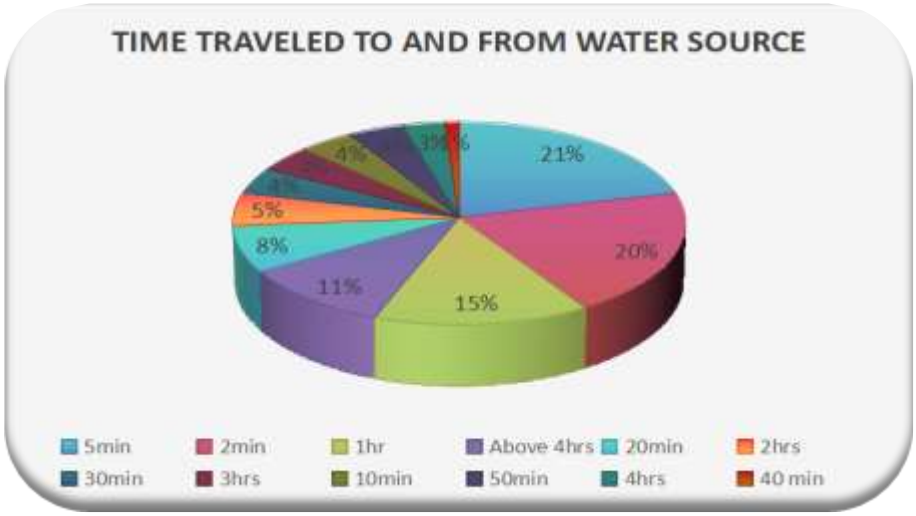

Figure 9: Traveled time to and from improved public water sources (author April 2024)

2.8 Duration of Accessing Drinking Water Supply

In the Musheri sector, only 84.21% of households live within the effective and permissible which is 500m distance to public water sources. However, many houses are placed in considerable distances to public water kiosks. To access a public water kiosk, people often walk 500 meters, 500-1000 meters, or more than one kilometer and this proportion holds 15.79%. According to our personal observation this gap is due to animal rearing within large farms which in turn isolates more people from the improved public water sources.

The chart below shows the distribution of households in Musheri sector, and their time used to fill 20l jerrycan after reaching improved public water sources/public water kiosks within 500,1000 meters and above. Many individuals in this area walk significant distances and use more time to fetch it from public water sources due to unequal distribution and dysfunction of public water kiosks and settlement patterns, with some residences being compact and others isolated. The data below shows that there are just a few water kiosks in the sector, which is insufficient given the number of houses and also majority marking 31% of respondents argued that time spent to go and return to the water sources is tiresome while 27% said that its moderate long. Figure 8 depicts that, however the time spent to fill the jerrycan is moderate since its 5 minutes as used by 45% of total respondents. This crucial issue in the sector might cause water stress for many folks if nothing is changed or upheld.

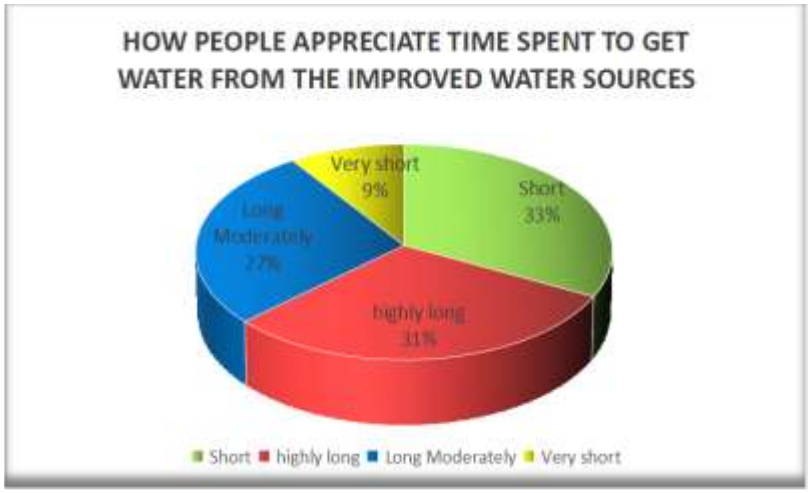

Figure 10: How people appreciate the time spent to get water

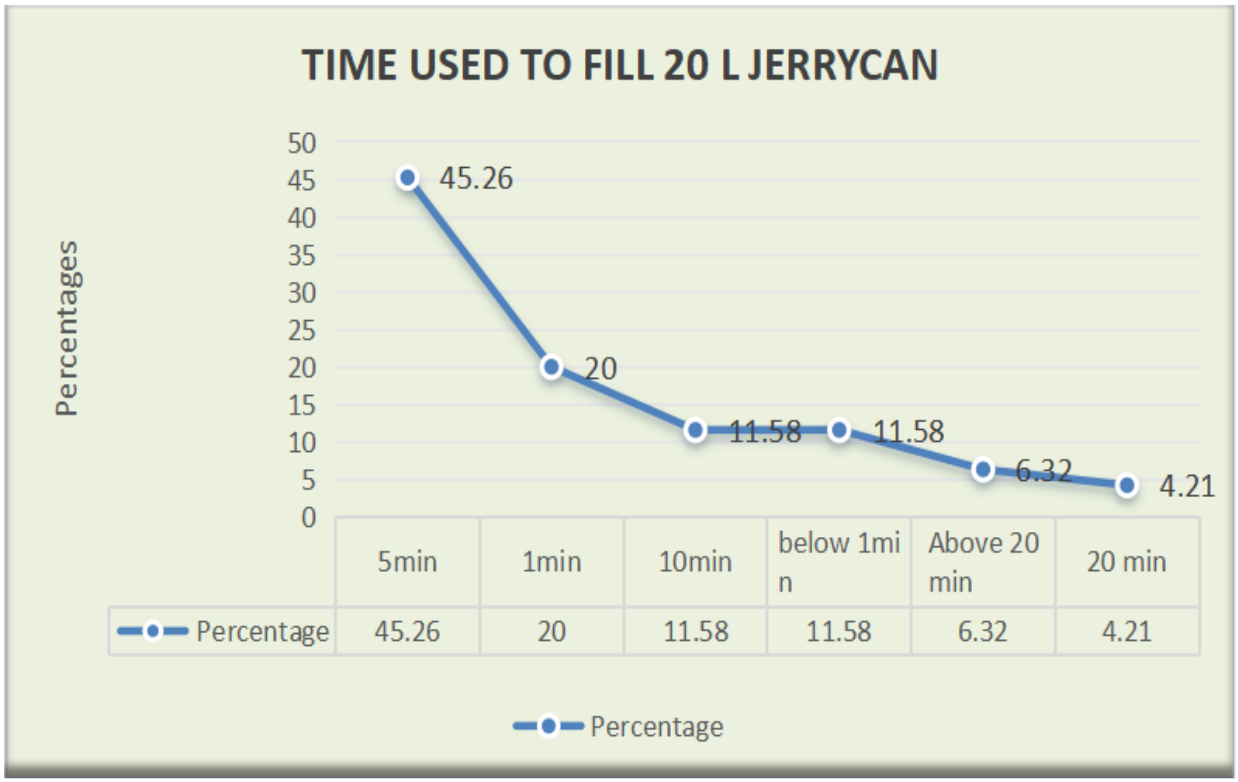

Figure 11: Time used to fill 20 litters jerrycan

3. Discussions

According to the Water Service Act of 1997, water availability refers to the right to obtain basic water supplies (Local authority). The Musheri neighborhood requested that water taps be installed in their yards rather than on the street. The municipality's decision to install street taps was part of a broader water project (Nyagatare. 2021). The aim was to install standpipes, water taps in yards, and water meters. Respondents reported more taps on some streets compared to others in the vicinity. Furthermore, several taps and public water kiosks had been vandalized and were not operational as worse as water supply during the night time was still a plight.

Water supply from standpipes varies in Musheri sector. According to (Adewumi et al. 2012) and Berger (2004), some areas ceased using tap water, while others received standpipe water every two days per month. In certain areas, standpipe water was only accessible during the daytime. The new stands do not receive standpipe water due to insufficient from the main supply. The water supply to the people falls below the RDP standard. Villagers frequently wait in large lines to get water from the IPWS. The flow rate must be 20 L of water per 5 minutes however its still beyond this guideline and even antithetical to the RDP standard which is 10 L of water each minute (200 L per 20 minutes). Water scarcity is a major issue in Musheri sector. Sometimes water taps run dry while people are still waiting in line. According to the NWRS (2013), there is insufficient water to supply all needs, indicating a physical shortage. Local communities anticipate everyday access to water. Many uses public tap water which is still insufficient to their daily needs.

Water use varies by family size. The World Health Organization (2006) recommends a minimum of 25 L of water per person per day, totaling 750 L per month. Respondents in the research region consumed varying amounts of water each month, ranging from 250 to 8001 L per home. In Musheri sector, respondents consume 4080L of water per month (equivalent to 136L per day per family), which is much lower than the World Health Organization's (2006) recommended minimum. The survey found that respondents would consume 4080L per month and 136L per day per family. The study found that households with better access

to water drink more than the minimal criteria for Free Basic. According to Moller (2008), the Free Basic Water program provides 6000 L per month for every home of 8 persons, or 200 L per day, or 25 L per person per day. Households without better water access consume less than the minimal norm.

Based on crucial gathered data results, it's evident that 63.11% of respondents indicated that water sources can be accessed 24 hours a day, while 36.89% access them for less than 24 hours. This suggests favorable availability of drinking water in terms of accessibility. During our field data collection, we surveyed individuals regarding the repair of broken taps. Shockingly, 51.58% of respondents reported encountering broken water taps, yet the more concerning fact was that they remained unfixed. Consequently, the majority resorted to alternative sources such as dam sheets and the Umuvumba river. Sector leaders further informed us that Musheri sector typically receives water service once a week, specifically on Thursdays. However, the reality on the ground contradicts this as many of the taps we inspected were damaged and left unattended.

Regarding water affordability, it was generally perceived as fair, with 48.42% of respondents expressing approval. However, a significant portion noted that sourcing drinking water from distant alternative sources incurred both financial and time costs. A staggering 90.51% of respondents expressed that water accessibility posed a burden, particularly due to the dysfunction of many water kiosks. Similarly, 91.58% agreed that water accessibility remains a challenge, even though physical sources exist, indicating their insufficiency to meet the populace's needs.

Furthermore, the research highlighted the heightened difficulty of accessing available improved public water sources in the morning, as attested by 40% of respondents. Additionally, 41.06% of those fetching water from these sources were children, both male and female. Failure to address these challenges promptly could potentially lead to school dropouts or negatively impact children in the vicinity.

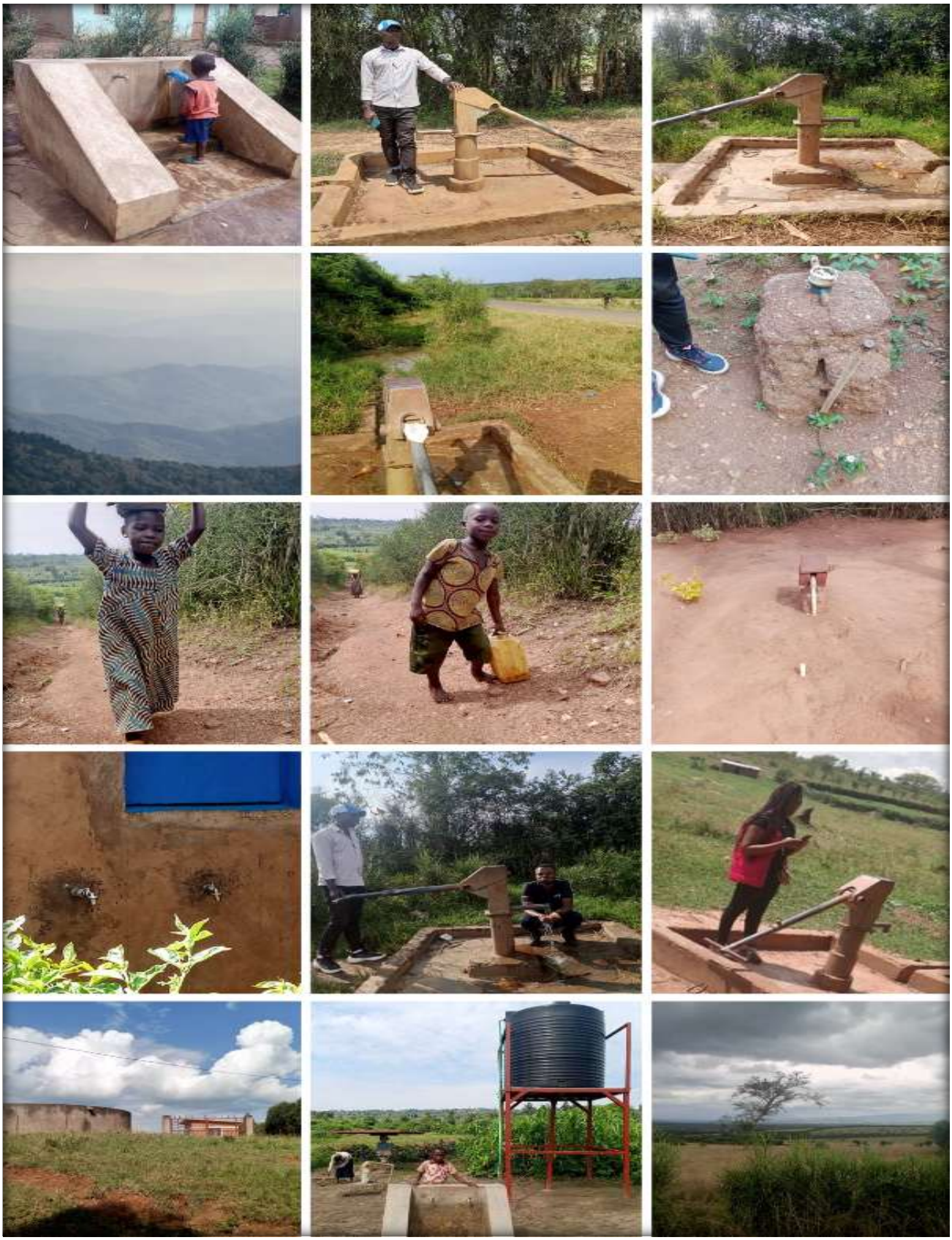

Figure 12: Some pictures of improved public water sources in Musheri sector (author April 2024).

4. Conclusion

The major goal of this research was to assess the availability and accessibility of improved public water sources in the Musheri area. The study found that Musheri's closeness to water delivery infrastructure is inadequate especially for water distribution tanks. Based on the interpretation and analysis of the data collected in April 2024, it is clear that access to water in Nyagatare District's rural areas, particularly in the Musheri sector, has become a serious issue that must be addressed. The large number of inhabitants going great distances to obtain public water kiosks and household taps, along with the scarcity of existing public water kiosks and dysfunctions, emphasizes the gravity of the situation. These findings highlight the critical problem of accessibility to water supply infrastructure in this metropolitan region, which impedes the district's overall socioeconomic growth. As a result, the government and other relevant organizations responsible for water delivery must evaluate national criteria governing access to water in order handle these key challenges effectively.

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