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DEPARTMENT OF CIVIL, ENVIRONMENTAL AND GEOMATIC ENGINEERING

P.O. Box: 3900 Kigali, Rwanda.

ANALYSIS OF WATER SERVICES IN LOW-INCOME URBAN AREAS OF RWANDA: CASE STUDY OF KIMISAGARA SECTOR

A PROJECT REPORT

Submitted in partial fulfilment of the requirements for the award of

MASTER'S IN WATER RESSOURCES AND ENVIRONMENT MANAGEMENT (WREM)

Submitted by

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Under the Guidance of

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COLLEGE OF SCIENCE AND TECHNOLOGY

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DEPARTMENT OF CIVIL, ENVIRONMENTAL AND GEOMATIC ENGINEERING

CERTIFICATE

This is to certify that the Project Work entitled ***"ANALYSIS OF WATER SERVICES IN LOW-INCOME URBAN AREAS OF RWANDA: CASE STUDY OF KIMISAGARA SECTOR"*** *is a record of the original bonafide work done by KWIZERA PLACIDE (REG.No: 221032001) in partial fulfilment of the requirement for the award of MASTERS IN WATER RESSOURCES AND ENVIRONMENT MANAGEMENT of College of Science and Technology, University of Rwanda during the Academic Year 2022-2023.*

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Submitted for the final Project Examination/Evaluation held at College of Science and Technology, on 29th August 2024.

DECLARATION

I declare that this thesis/dissertation entitled **"ANALYSIS OF WATER SERVICES IN LOW-INCOME UBARN AREAS OF RWANDA: Case Study of Kimisagara sector"** is the results of my work and has never been submitted for any other University of Rwanda or other Institutions.

KWIZERA PLACIDE

ABSTRACT

The majority of Rwanda's focus on ensuring that every household has access to high quality water services, particularly in urban areas. Ensuring that everyone has a safe, dependable, and reasonably priced source of water. Pertaining individual household connections or in 200 meters where it not possible for home connections, with an average daily consumption of 80–100 liters. Despite this, there are still issues with water service delivery mainly regarding water accessibility and consistency of consistent water supply. In addition, the area has water supply systems that are currently unable to meet the needs of every household; due to factors like informal settlements, inability to pay capital investment costs to connect, and insufficient water supply compared to demand. The purpose of this study was to analyze water services in low-income districts of Kimisagara in Kigali City, Rwanda. Thus, 241 households was surveyed using questionnaire to identify the existing situation. Moreover, three water sample of alternative water source were assessed and tested in laboratory to assess status their quality and it was found that are not safe to drink because they do not met drinking water quality standards. Challenges include intermittent supply, a large population without water system connections, insufficient public taps, and irregular functioning of existing public taps. Those who fetch water from their neighbors pay approximately about three times higher than the standard rate, while 53.112% of respondents are freelancers without regular income. It is recommended to Prioritize given to the areas having low access to water supply. Due attention will also be given to affordability considerations to achieve equal right to access basic water services, promote delegated management through private operators, which is the key strategy to enhance the sustainability of rural water infrastructure as well as increase of public water taps based of at household level base on updated Kigali master plan

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LIST OF ABBREVIATIONS

DDS	District Development Strategies
ECD	Early Childhood Development
DGPS	Differential Global Positioning System
GoR	Government of Rwanda
MINIFRA	Ministry of Infrastructure
NST	Nation Strategies for Transformation
EICV	Integrated Household Living Conditions Survey
WASAC	Water and Sanitation Corporation
UNICEF	United Nations Children's Fund
WHO	World Health Organization
RHA	Rwanda Housing Authority
%	Percentage
SDGs	Sustainable Development Goals
NISR	National Institute of Statistics Rwanda
RURA	Rwanda Utilities Regulatory Agency
NRW	Non-Revenue Water
WSS	Water Supply System
RRA	Rwanda Revenue Authority
WPT	Water Treatment Plant
AfWA	African Water Association
TVC	Total Viable Counts
FRW	Rwandan Francs
WSS	Water supply system
PH	Potential of Hydrogen

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Finally, I dedicated this dissertation to the Almighty God, my brothers and sisters.

DEDICATION

I dedicate this thesis to Almighty God, My family, my lovely Ingabire Uwase Pacifique to her support and motivation during my whole studies, My Supervisors and classmates

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1. INTRODUCTION

Water is essential for daily life of human being. As water supply service is municipal service of procuring, treating, selling and delivering water to members of the public, Water and Sanitation Corporation (WASAC) is the institutional responsible for providing quantity, reliable and affordable water and services in Rwanda. NISR 2022, States that Urbanization is a growing trend in Rwanda, particularly in the capital city of Kigali. It is projected that Kigali's population will increase rapidly from around 3.7 million in 2012 to 16.5 million by 2052, largely due to significant migration from rural areas. It is also estimated that water supply coverage is 80% of households have access to an improved water source, with urban households having much better access (96%) than rural households (77%) and specifically Kigali city stands at approximately 87%.

The main source of drinking water in urban area are water piped into households, plot or neighbor yard (50%) and public taps (26%) while in rural area, the main sources of drinking water are protected wells or springs (36%) and the public taps (31%) [1].

The targets were set by Government of Rwanda (GoR) to achieve the universal access to water and sanitation services by 2024 regarding to the cumulative population growth [2].

However, significant challenges loom for the Study Area in meeting the emerging demand driven by the rapidly growing population and improving the water supply quality to a satisfactory level for users. Issues include insufficient water production, substantial water leakages leading to intermittent supply in study areas imposes a greater challenges of water services.

Improving water service levels requires both acceleration of progress and sustaining the gains made. In turn, this requires improved performance, efficiency, and efficacy of the national and decentralized systems for planning, financing, providing, and maintaining these services while ensuring they are equitable. For that reason, the sector has focused over the past years on strengthening the systems for service delivery.

1.1. Problem statement

In Kimisagara, frequently face numerous water service issues that detrimentally impact their health, economic well-being, and overall quality of life. These challenges include insufficient infrastructure for water distribution mainly for insufficient household connection due to informal settlements and insufficient public taps, which results in irregular supply and long distances to water sources as well improper ones and an unreliable water supply characterized by frequent

interruptions and erratic schedules. Additionally, water contamination from unsafe sources introduces pathogens, chemicals, and other pollutants, posing significant health risks. The high cost of water is another major issue, as low-income households often have to purchase water from neighbors at significantly higher prices than those charged by service providers. This financial burden is compounded by irregular incomes, making it difficult for residents to pay regular water bills and leading to service disconnections and increased reliance on expensive alternatives. Limited access to clean water hinders proper hygiene practices, contributing to the spread of waterborne diseases.

Furthermore, a lack of community engagement in planning and decision-making processes results in misaligned priorities and ineffective interventions. Poor water quality and inadequate sanitation contribute to high rates of waterborne diseases such as diarrhea, cholera, and typhoid leading to substantial medical expenses and loss of income. Lastly, the significant time spent collecting water from distant sources reduces the time available for work, education, and other productive activities, further exacerbating the community's challenges.

1.2. Objectives of study

1.2.1. Overall Objective of the study

The overall objective of this project is to assess water service sustainability to the community in urban area with low-income using Kimisagara sector, Kigali city in Rwanda as a case.

1.2.2. Specific objectives

To achieve the main objective of this research, this project intends to achieve the following specific objectives:

- Evaluate the accessibility and reliability of water services
- Analyse affordability and community perceptions of water services
- Assess of alternative water source water quality

2. Literature review

Conduct a comprehensive review of existing literature, studies, and reports related to water supply services in low-income areas, specifically focusing on Kigali City, Rwanda. This will provide a theoretical foundation and help identify gaps and key areas for investigation.

2.1. Overview

This aspect of the study reviews the various literatures related to the topic under consideration, in order to uncover critical facts and findings which have already been identified by previous researchers. Numerous studies in and around the current situation, effects and economic implications of improved water services. This chapter is based on published books, journals, reports and opinions prior collected.

2.2. Definition of terms

- ✓ **Water supply**: provision of water by public utilities, commercial organizations, community endeavors or by individuals, usually via a system of pumps and pipes [3].
- ✓ **Service**: Something that the public needs, such as transport, communications facilities, hospitals, water or energy supplies
- ✓ **Water supply service**: The municipal service of procuring, treating, selling and delivering water to members of the public [4]
- ✓ **Low-income community**: Low-income earners (persons at risk of poverty) are considered those whose household's disposable money income per consumption unit (so-called equivalent income) is lower than 60 per cent of the equivalent median money income of all households. The proportion of the population falling below this income limit is called the low-income rate (at-risk-of-poverty-rate).

2.3. Site topography

The topographic analysis of Nyarugenge District identifies 4 distinct features: Areas of gentle slopes (less than 20 percent gradient) on the ridges and along the wetlands; areas with steep slopes (more than 20 percent gradient); linear ridges running along the length of the sectors; alluvial plains along the rivers Nyabarongo and Nyabugogo. The average elevation of Nyarugenge District is 1,000 m above the sea level. Mount Kigali, the highest point in Kigali, has an elevation of 1,853m and the highest spot in Mageragere Sector has an elevation of

1,810 m. Due to such hilly topography coupled with large scale deforestation, soil erosion and landslides in the District are key recurrent problems faced by the City, which requires adequate soil protection measures to address this issue [5].

2.4. Rainfall and climate

Nyarugenge district's yearly temperature is 21.870C (71.370F) and it is 1.43% higher than Rwanda's averages. Nyarugenge typically receives about 213.59 millimeters (8.41 inches) of precipitation and has 263.26 rainy days (72.13% of the time) annually [6].

2.5. Hydrography

The hydrology of the District of Nyarugenge mainly consists of rivers and brooks which belong to the Akagera River basin, the beginning of the Nile River. The principal rivers of Nyarugenge District are: the Nyabarongo River which flows from the north-east and runs along the west and south of Nyarugenge District, eventually emptying into the Akagera River basin; the Nyabugogo River which originates from Lake Muhazi basin and flows into Nyabarongo River; Agashiha, which originates from Gikondo and flows into Nyabugogo River; the Rwampara brook which originates from Nyarurama hill and flows into Nyabugogo River; the Mpazi brook which originates in Nyamirambo and flows into Nyabugogo River. The wetlands cover 15% of area in the Nyarugenge district [5].

2.6. Land cover

Large areas of the Nyarugenge district have been cleared of forests, to make way for agriculture. However, pockets of dense and sparse forests still exist, especially along the District's ridges, steep slope areas and along sources of water. Systematic afforestation programmers need to be put in place to balance out the large scale urban developments that is anticipated in the District. 2 types of agricultural practices are seen prevalent in the District, based on their location. Large crop fields are seen in the low lying areas along the wetlands, and small fields, some times in the form of terraces, are seen on the higher slopes [7].

2.7. Land use

Kimisagara sector is characterized by high-density spontaneous housing settlements, interspersed with numerous civic amenities such as schools, health centers, churches etc. Another important

street runs along Avenue du Mont Kigali, in the valley from Nyabugogo Taxi Park up to the stadium. A host of important civic and cultural developments are located along these streets[7].

2.8. Access to service and type of drinking water supply

The focus is on access to water services at household level where the access to improved source of drinking water is considered once access is within 200 meters in urban areas and 500 meters in rural areas with time not exceeding 30 minutes for round trip. In addition, the water quantity per capita considered is 40 liter per day per capita in rural area and 80 liter per day capita in urban areas [8].

2.9. Urban water supply

Urban water supply services in Rwanda are exclusively provided by WASAC, a public utility operating on a commercial basis. WASAC will therefore be the key implementer of the policy and strategic plan, under the oversight of MININFRA and regulation by RURA.

The trends in annual total urban water production capacity still fall short of the demand for increasing urban population and the growing pace of urbanization. The reasoning behind is that WASAC like other water utilities across the world and mainly in Africa still facing a big challenge of having high Non-Revenue Water. The main causes of water losses are technical (due to leaks and burst of water pipes, old water network and high pressure in the water network) and commercial losses due to (meters inaccuracy, water theft by customers and error in data processing in billing). A large part of WASAC water networks is old and undersized and still not yet rehabilitated due to budget constraint. According to the Water Resources Management Sub-Sector Strategic Plan [9], the main drivers for water demand in Rwanda are rapid population growth, poverty and climate change. Environmental degradation in wetlands is high due to uncontrolled poor settlements, and water pollution is abundant especially when it comes to floods, as storm water protection systems and disaster management is barely existent.

The Water and Sanitation Corporation (WASAC), who has the responsibility for the water supply under the supervision of the Ministry of Infrastructure (MININFRA), is planning to increase the water supply amount in Kigali City based on the construction plan of new water treatment plants and the expansion plan of the existing water treatment plants through Public-Private Partnerships (hereinafter referred to as “PPP”). Furthermore, the pipe length (2,500 km) in Kigali City is accounting for 40% of the urban water supply network nationwide. The Government of Rwanda

is planning to develop the water supply network to meet the increasing water demand; however, its implementation is behind schedule according to the plan for increasing water supply [10]. Historically, water resources management and water supply and sanitation were managed by one 'Water unit'; however, since the separation of water supply and sanitation (under MININFRA) and water resources management (under MINIRENA, established in 2011) the different mandates are clearly defined and anchored in relevant enabling policies and strategies for each water sub-sector.

2.10. Water service challenges

Despite positive gains, critical challenges remain that continue to prevent Rwanda's Poorest people from gaining sustainable access to even basic water supply and sanitation services and these include; i) the access gap and the related funding gap for increasing the levels of service, particularly in unplanned and scattered settlements in difficult, hilly terrain; ii) depleting water resources, resulting in high costs of service provision; iii) gaps in human resource capacity in areas of planning, project management and operation and maintenance; iv) consolidation and strengthening of institutional responsibilities in the sector; and v) insufficient water and wastewater treatment as well as solid waste management; vi) technical and financial capacity issues from government, private sector, civil society and communities to advance water and sanitation investment as well as operations and maintenance. vii) Capacity issues are also noticed at district level both in terms of human capacity viii) insufficient sector performance and accountability ix) weak monitoring system [8].

2.11. Water demand

Current and future water demands are estimated considering several factors, including population, land use, timing of development, per capita consumption, service level, water needs, NRW ratio, seasonal peak factor, type of water use, and socio-economic conditions prevailing in the target area.

The population of Rwanda is steadily increasing, especially in Kigali City, the population at "high growth scenario", it is estimated that in 2014 Kigali has a population of 1.3million which is projected to grow to 3.8 million in 2050 [11].

The water supply in Kigali City has not been able to keep up with the rapid pace of population growth. As a result, due to insufficient amount of water supply and water outages the daily average

water supply time is 8 hours, which is extremely short. Consequently, Kigali City has been forced to perform constant water restrictions and suspend the water supply to some areas.

Moreover, each water treatment plant has a fixed water supply area, and no interconnecting water supply network has been developed to cover for shortages in another water supply areas. Therefore, a planned and efficient water supply is not possible.

2.11.1. Factors affecting water demand

Water demand is a volume of water, which has to be put into a supply and distribution system to satisfy the requirements of consumers plus leakage and other waste, which may be incurred in the process. The demand for water by a household may be affected by many factors like population growth and water losses are the main factors to be taken into account when forecasting domestic water demand. In additional water tariff as well as the income level of a household also are to be considered because water consumption may increase due to the ability to pay water bill and to the increase of purchases as well as the use of water using appliances such as washing machines, dish washers and garbage disposals; gardening irrigation; etc [12].

2.12. Effect of poverty on safe water accessibility

A poor family, living in an illegal settlement, waits for the water supply to arrive. When it does, the family members fill a few buckets with water of dubious quality, paying a certain amount per cubic meter, which often amounts to a high percentage of household income. Because the price is so high, they use little water, cutting down, particularly, on "discretionary uses," such as washing and bathing. They defecate in a fly- and insect-infested open toilet. The economic, health, and human consequences of these miserable sanitary conditions are tremendous. As a result of diarrhea and other hygiene-related diseases, for example, almost one in ten children dies before its first birthday [13].

2.13. Non-Revenue water

High NRW, with nearly 41%, makes it difficult for WASAC to maintain a stable water supply. It is one of the main factors that force WASAC to provide intermittent water supply for some residents) because many of the existing pipe lines were laid in the 1970s or earlier; therefore, significantly aging of the distribution facilities can be seen, and also the proper maintenance and management of these pipe lines have not been performed resulting the increase of Non-Revenue

Water [10].

2.14. Water pricing

According to WASAC as water service provider, the water tariff are categorized base on type of consumers as well as the quantity consumed. The pricing range are shown in the table below:

Table2-1: Water price protocol in Rwanda

Customer category	Block of Consumption per month	Applied Tariff in FRW(VAT exclusive)
Public tap	Flat rate per m3	323
Residential	0-5m3	340
	6-20m3	720
	21-50m3	845
	Above 50m3	877
Non-Residential	0-50m3	877
	Above 50m3	895
Industries	N/A	736

Source: WASAC [15]

3. Methodology

3.1. Overview

To gather the necessary information for the study's objectives, six primary techniques were employed: household survey questionnaires, key informant interviews, personal observation, field data collection, water source sampling and water quality analysis, and secondary data or document review.

The household survey aimed to collect data on potable drinking water practices in 48 villages across three cells in the Kimisagara sector. A total of 241 households were purposively selected for this survey. These households were chosen randomly within the purposive sampling framework, targeting the community in the peasant sector, which is significantly affected by poor access to potable water services.

3.2. Study area Localisation

3.2.1. STUDY AREA DESCRIPTION

The study was carried out in Kimisagara sector in Nyarugenge district of Kigali city. It is one of 35 sectors within three district which consist of Kigali city. It is located in the middle east of the city and it is one ten sectors of Nyarugenge district with 3.313 km^2 of area.

3.2.2. Site localization

The study was carried out in Kimisagara sector in Nyarugenge district of Kigali city. Kimisagara Sector is one of the ten sectors that make up Nyarugenge District. It is located in the middle east of the city.

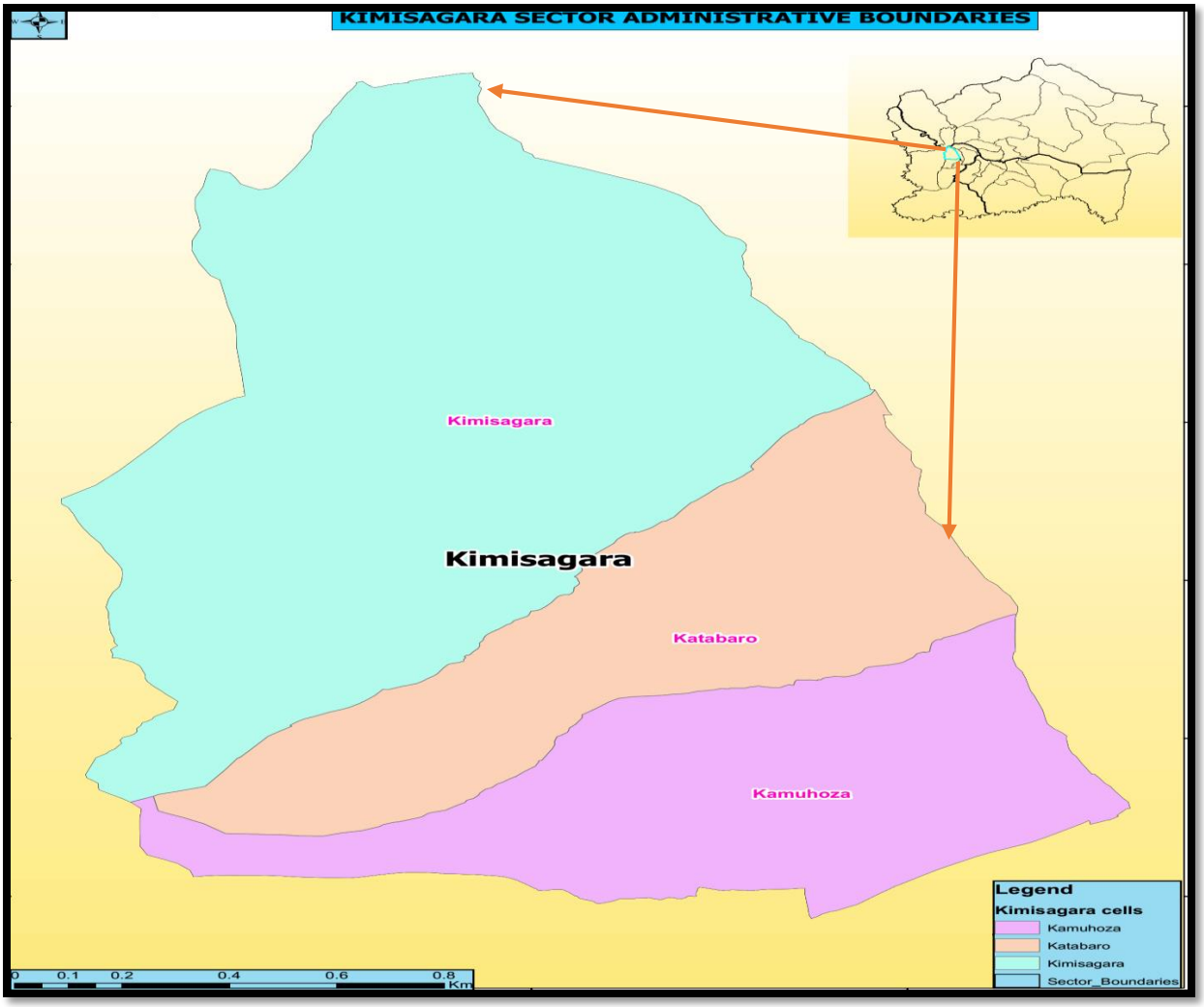

Figure 3-1**:** Map of Kimisagara sector localization

3.2.3. Administrative boundaries and demography

Kimisagara borders the Sectors of Kigali in West; Gatsata in North; Gitega and Muhima in East; Nyakabanda and Rwezamneyo in South. It also consists of three cells namely Kimisagara, Katabaro and Kamuhoza with 48 villages. Kimisagara sector has 3.313 km2 of area with a number of 11,648 household with 45,699 population while 25,648 are male and 20,053 are female.

3.3. Field data collection Survey

Water service provider billing officers and plumbers have direct contact with the community in providing them with access to potable water. Thus, the researcher has addressed these groups of individuals as well as local authorities to help the whole process of household survey and other relevant data collection like localization of public taps in the study area using DGPS.

In order to minimize errors stemming from interviewer inconsistency, the researcher designed structured interviews or questionnaires and distributed them to two trained research assistants for conducting household survey. These assistants, chosen from the local communities, were highly skilled and familiar with the community's language and culture. This ensured that respondents did not encounter any language barriers or unintentional cultural disrespect. The sample respondents were selected through systematic sampling from 11,648 households in the Kimisagara sector, resulting in 241 selected households. Structured interviews were then conducted with these 241 sample residents.

Because the interviewers were locals, they could tailor the questions to the community's level of understanding. The data collection was carried out questionnaire survey, with the researcher and research assistants conducting surveys in the selected households. As 'Kinyarwanda' is both the national working language and the native language, and since the research assistants were skilled and trained beforehand, there were no complications during the survey process.

3.3.1. Data collection

3.3.1.1. Questionnaire survey

Design and administer surveys to collect primary data on water access, affordability, quality, and reliability from residents in Kimisagara the selected low-income areas of Kigali. The survey was done based on structured questionnaire and the questionnaire was included questions about socio-economic factors, water usage patterns, and perceptions of water supply services.

3.3.1.2. Sampling techniques and sample size determination

To get representative sample household heads from the villages, a two-stage random sampling procedure was adopted. In the first stage, villages which directly and/or indirectly get benefit from water service were purposively selected. In the second stage, households in these villages were randomly selected using simple random sampling method. For this purpose, the sample size was

determined by using a simplified formula developed by [16].

$$\mathbf{n} = \frac{\boldsymbol{N}}{\mathbf{1} + \boldsymbol{N}(\boldsymbol{e^2})}$$

Where:

n= sample size,

N= Household size,

E=Level of precision or the error in which the research will tolerate

As the population in the study area is homogenous in many characteristics, such as live hood strategy, cultural and other socioeconomic and institutional setups, the precision level use was 6.37%. Therefore, the sample size was determined to be 241 Kimisagara population based on households.

$$\mathbf{n} = \frac{\mathbf{11648}}{\mathbf{1} + \mathbf{11648}(\mathbf{0.0635^2})} = \mathbf{241}$$

3.3.1.3. Pre-Testing of Instruments for Data Collection

The questionnaire incorporated the contingent valuation scenarios and debriefing questions. In order to ensure that the data collected was valid; the questionnaire was pre-tested for validity, comprehensiveness, and reliability pretested using 5 randomly selected households in Kimisagara sector. After pretesting the questionnaire, some imminent modifications were done. Finally, the data from the all villages were collected from 241 randomly selected local households.

3.3.2. Alternative water source sampling and water quality analysis

Spring water source sampling and water quality analysis involves by identification and mapping of the locations of the springs usable as alternative of potable water using differential DGPS as well as selection of which source are going to be sampled. Use appropriate clean and sterilized bottles for water collection, the three samples have been collected and accordingly and the transported to the laboratory for being tested after test results is compared to the WHO drinking water standards to how the water from the springs are safe to drink. The following are the parameters measured:

3.3.3. Physical Parameters

- **Turbidity using turbid meter**

It was done by calibrate the meter with standard cuvettes and then fill a cuvette with your sample. After clean the cuvette was placed in millimeter. Press the measure button. Leave the sample for 1-2 minutes to ensure an accurate Turbidity reading can take place.

3.3.4. Chemical Parameters

- **PH Multi-meter with Probes**

Place the electrode into the solution sample to be measured. Press the measure button. Leave the electrode in the solution for 1-2 minutes to ensure an accurate reading can take place. Once the reading has stabilised, set the pH level.

- **Electrical Conductivity (EC) Multi-meter**

It was done by calibrate the meter with standard cuvettes and then fill a cuvette with your sample. After clean the cuvette was placed in multi-meter. Press the measure button. Leave the sample for 1-2 minutes to ensure an accurate conductivity reading can take place.

- **Total Dissolved Solids (TDS) Multi-meter**

Place the electrode into the solution sample to be measured. Press the measure button. Leave the electrode in the solution for 1-2 minutes to ensure an accurate reading can take place. Once the reading has stabilised, set the pH level.

- **Hardness: Measure cations (Ca^{2+}, Mg^{2+}) using EDTA Titrimetric Method**

If Eriochrome Black T is added to a water sample containing Ca and Mg ions at a pH 10.0 +0.1, the solution becomes wine red. If EDTA IS added, the Ca and Mg will be complexed and when

all of the Ca and Mg has been complexed the solution turns from wine red to blue, marking the end-point of the titration.

Mg ion must be present to yield a satisfactory end-point. To insure this, a small amount of complex metrically neutral Mg-EDTA is added to the buffer; this automatically introduces sufficient Mg. A limit of 5 min. is set for the duration of the titration to minimize the tendency toward CacO, precipitation.

- **SO_4^{2-}: turbid metric method**

$SO4^{2-}$: is precipitated in an acetic acid medium with $BaCl_2$, so as to form $BaSO_4$, crystals of uniform size. Light absorbance or scattered light is measured by a photometer. Minimum detectable concentration is approximately 1 mg/L.

- **PO_4^{3-} using ascorbic acid spectrophotometric method**

Ammoniummolybdate and potassium antimony tartrate react in acid medium with orthophosphate to form a phosphomolybdic acid that is reduced to intensely colored molybdenum blue by ascorbic acid. The minimum detectable concentration is 10 µg P/L with use of a 5 cm cell. Phosphates that respond to colorimetric test without any treatment like hydrolysis or oxidation (except filtration) are also called dissolved reactive phosphorus (DRP). This reactive P is largely a measure of orthophosphate.

- **NO_3^- using spectrophotometric method**

Determination of Nitrate levels was done by the colorimetric method (visible spectrophotometric) by using N-(1-Naphthyl) Ethylenediamine Dihydrochloride and Sulfanilic Acid as the dyes and measured at the maximum absorbance wavelength (540 nm) and on the operating time between 11 minutes to 18 minutes.

- **Chlorides using titration**

The measurement of chlorides in a sample was measured using titration methods with help of Silver Nitrate ($AgNO_3$) Solution as reagents**.**

3.3.5. Biological Parameters

- Total Coliforms, Faecal coliform, Total viable counts (TVC), and E. coli using membrane filtration or most probable number methods.

3.3.6. Personal Observation

The researcher has used observation as an additional means to the data collection which helped to have a general understanding of the area and how the community perceives the environment, to what extent the community is aware of the right to water, and how poor access to potable water affects the livelihood of the community. Additionally, the researcher has observed the alternative of water source usage by the community. Since observation comprises subjective judgment the researcher did not completely depend on the results of the observation in the empirical finding and analysis part of the study unless supported by the other data collected by other means. To perform this observation, the researcher spent time during data collection in the community which did not have water at the household and to know their usage water source alternatives.

3.3.7. Document Review

In addition to the primary data, the researcher has tried to collect written documents from the district, reports and publications on potable water worldwide, in Africa and Rwanda to compare water service in project area, as supporting means of the data collected by the primary sources.

3.3.8. Method of Data Analysis

In assessing the case of Kimisagara sector, the researcher has applied a case study design which is concerned with the complex nature of water service in which the researcher has utilised mainly a qualitative approach, although some quantification was used with percentages.

This research work has focused on the significant impact of poor access to potable water, water services in general, economic, social and the environmental situation of the study site. Thus, the use of percentages is the major mathematical tool that was used to analyse the data to show the water service in the study area and its impact, and Microsoft Excel was used for computation of the data. Then the result of the excel outcomes have been interpreted for the study.

3.3.9. Frame work for Analysis

The aim of this thesis has been to evaluate the impact of the poor water services on the economic,

environmental and social situation of the Kimisagara sector. The needs which identified are related to improved water accessibility, quantity of water used in the household, distance to the water source minimization, human dignity, community participation and responsibility. The impacts followed these unsatisfied needs were summarized in Excel (Microsoft office 2013, windows-10). Data was organized and the sum and averages for each variable was further analysed using pie charts, graph and tables. Based on these findings the room for improvement of water service is discussed.

4. RESULTS INTERPRETATION AND DISCUSSIONS

4.1. INTRODUCTION

For this study, both quantitative and qualitative data types was collected using primary and secondary data sources. The primary data were collected from local water user households using a semi- structured questionnaire and key informant interviews. On the other hand, the secondary data were collected from research articles, books, proceedings, working papers and institutional reports.

The questionnaire prepared for this study tried to solicit information about different demographic, socioeconomic and institutional characteristics of the households.

4.2. General background of respondents

Conducted household survey to Kimisagara sector in all villages to have data showing current situation and facing challenges of water survives, or any issues related to water services like affordability.

Table4-1: Proportion of respondent's socio demographic data

Variables		Frequency %
Gender	Male	48.13
	Female	51.87
Age group	≤ 19 years	1.66
	20 – 49 years	80.50
	40-59 years	13.28
	≥ 60 years	4.56
Educational level	Pre-primary	2.49
	Primary	50.21
	Junior secondary school	4.56
	Secondary school	32.78
	University	8.71
	Others	1.25

Decision maker in issue of water supply in your household	Yes	91.29
	No	8.71

Table 4-2: Proportion of respondents on Drinking water accessibility

Variables		Frequency %
The primary source of water for your village or community	Household connection	41.91
	Public tap or water Kiosk	52.28
	Borehole	-
	Well	-
	River/stream	-
	Springs	2.90
	Rainwater harvesting	-
	Other (please specify	2.5
	Neighbors	
	Not specified	0.41
Jerrycan could be sufficient for your household daily use	3 Jercans	14.94
	4 Jercans	13.28
	5 Jercans	36.93
	6 Jercans	8.71
	7 Jercans	0.41
	8 Jercans	2.49
	9 Jercans	0.83
	10	2.9
	13	0.42
	Not applicable	19.09
Distance from the primary water source from your home	Within the house	44.4
	Less than 100 meters	41.49
	100-200 meters	7.88
	200 - 500 meters to 1 kilometer	5.81

Variables		Frequency %
	More than 1 kilometer	0.42
Time that is taken to collect water from the primary source	Less than 15 minutes 15-30 minutes 30 minutes to 1 hour More than 1 hour	73.444 24.481 2.075
Vulnerable groups that are most affected by the lack of access to clean water in your village/community	Children Pregnant women Elderly People with disabilities Refugees or internally displaced persons Indigenous communities Low-income households Other (please specify)	49.38 0.83 36.10 13.69

Table4-3: Proportion of respondents on Water quality

Variables		Frequency %
Awareness of any water treatment or purification methods used in your community	Yes No Not Applicable	91.29 5.81 2.9
If yes, water treatment or purification methods are commonly used	Boiling Use of water filters Chlorination Solar disinfection	86.31 7.88 2.48 0.42

	Other (please specify) Not applicable	2.91
Treatment methods accessible and affordable for you	Yes No Not applicable	82.16 13.69 4.15
The challenges faced from using unclean water	Poor sanitation Occurrence of diseases Others	7.47 15.35 77.18
Witness the incident of any of the following water borne diseases in your village/ community	Cholera Typhoid Diarrhea Shigellogis Amoebiasis Food poisoning Other infectious diseases Leptospirosis Hepatitis Helminthiasis I don't know	2.49 4.98 21.16 - 17.43 - 0.415 - 0.83 - 52.695
Time that the children miss the class in this or current semester due to illness caused by using unclean water	Twice Triple A week Other	38.59 2.07 2.49 56.85

Table 4-4: Proportion of respondents on Affordability and Ability to pay

Variables		**Frequency %**
Occupation	Salary earner Self-employed/ Business Farmer	10.373 26.14 0.415

Variables		Frequency %
	Freelancer	53.112
	Others	9.96
The number of people in your household	2	6.64
	3	10.37
	4	14.52
	5	25.73
	6	19.92
	7	8.3
	8	7.88
	9	1.66
	10	0.83
	11	0.42
	Other	3.73
Number of jerry cans used per day per household	2	7.054
	3	19.5
	4	16.597
	5	38.59
	6	7.47
	7	1.66
	8	1.66
	9	0.415
	10	3.734
	Other	3.32
Water per day sufficient	Yes	73.44
	No	23.65
	Not applicable	2.91
If no, why	Inconsistent water supply	0.415
	Water tariff is expensive	19.09
	We have to travel far to gather	6.22

Variables		Frequency %
	water, and it is difficult	-
	Not applicable	74.275
Money paid per month for water bill if you are connected to water supply system	Between 1,000-3,000	12.863
	Between 3,000-5,000	19.09
	Between 5,000-7,000	31.12
	Between 7,000-9,000	20.33
	More than 9,000	9.543
	Other	7.054
Money paid a jerrycan if you are not connected to water supply system	50	85.643
	100	12.863
	Other	1.494
Are there a different prices for water depending on the source or location or availability e.g., transportation costs, storage costs)	Yes	19.09
	No	77.18
	Not sure	0.83
	Not applicable	2.9
If yes, please explain the factors that influence the price differences	Water is far away	4.15
	From the neighbors	2.08
	The price of water is high	3.73
	Additional cost for transport	0.83
	Irregularity of water supply	89.21
	Not applicable	-
Satisfaction with the affordability of water for your village/ community	Very satisfied	1.66
	Satisfied	73.86
	Neutral	-
	Dissatisfied	18.671
	Very dissatisfied	5.394
	Not applicable	0.415
Compare the current price of water with the past	Increased	89.63
	Decreased	0.83
	Remained the same	7.05

Variables		Frequency %
	Not sure	2.49
Improvements or changes you would like to see in the pricing of water in your village/ community	To decrease the price of water We should intervene in pricing decision making We should per at least 20 per jercan at public tap or To pay 2000Frw-2500Frw per month Public tap should work regularly Not applicable	70.95 0.415 5.81 0.415 22.41

Table 4-5: Proportion of respondents on Reliability of water service

Variables		Frequency %
Rate the current access to water services in area	Excellent Good Fair Poor Very poor	2.075 87.551 9.544 - 0.83
Cultural or religious practices in your village or community that affect water use or access	Yes No I don't know Other	1.66 95.02 0.415 2.905
Satisfaction with the quantity of water you are using currently	Very satisfied Satisfied Neutral Dissatisfied Very dissatisfied	2.075 80.498 - 17.012 0.415

Variables		Frequency %
Access to a reliable and safe water source throughout the year	Yes No	87.55 12.45
If no, time you experience water shortages	Daily Weekly Monthly Rarely Never Other	20.33 30.29 8.298 23.24 16.597 1.245
Coping with water shortages	Collect water from alternative sources Store water in containers or tanks Limit water usage Use water conservation practices	14.523 - 5.394 - 80.083
The alternative water sources safe for drinking and cooking	Yes No I don't know Not applicable	78.42 19.09 - 2.49
Leakage happens in community	Yes No	95.02 4.98
Notification to WASAC if a leakage happens in region	Yes No	93.78 6.22
If yes, ways of notification to WASAC	Call through the phone Tell any WASAC staff if you met him or her Other	80.497 5.81 13.693
Awareness on WASAC hotline	Yes No I don't know if it exist	84.65 15.35

Variables		Frequency %
Time taken to make leakage repair if it happens in region	One day	55.601
	Two days	35.685
	More than three days	3.734
	A week	1.66
	More than one week	0.83
	Other	2.49
Improvements or changes recommend to enhance access to water in your village or community	To increase the quantity of water	9.96
	To decrease the price of water	5.81
	Increase public tap	
	I don't know	6.22
		78.01

Table 4-1 shows the data provides insights into the demographics and decision-making roles of the respondents in the survey. The majority of respondents are involved in decision-making related to water supply in their households.

Figure4-1: Alternative water sources (springs) assessment

4.3. Overview of survey respondents

The respondents fall within the age group of 20 to 49 years, comprising 80.50% of the sample and the largest group has a primary level of education at 50.21%, followed by secondary school at 32.78% while only a small percentage (8.71%) have a university-level education and a significant majority (91.29%) of respondents are decision-makers in their households for water supply issues and 51.87% of respondents are female while 48.13% are male.

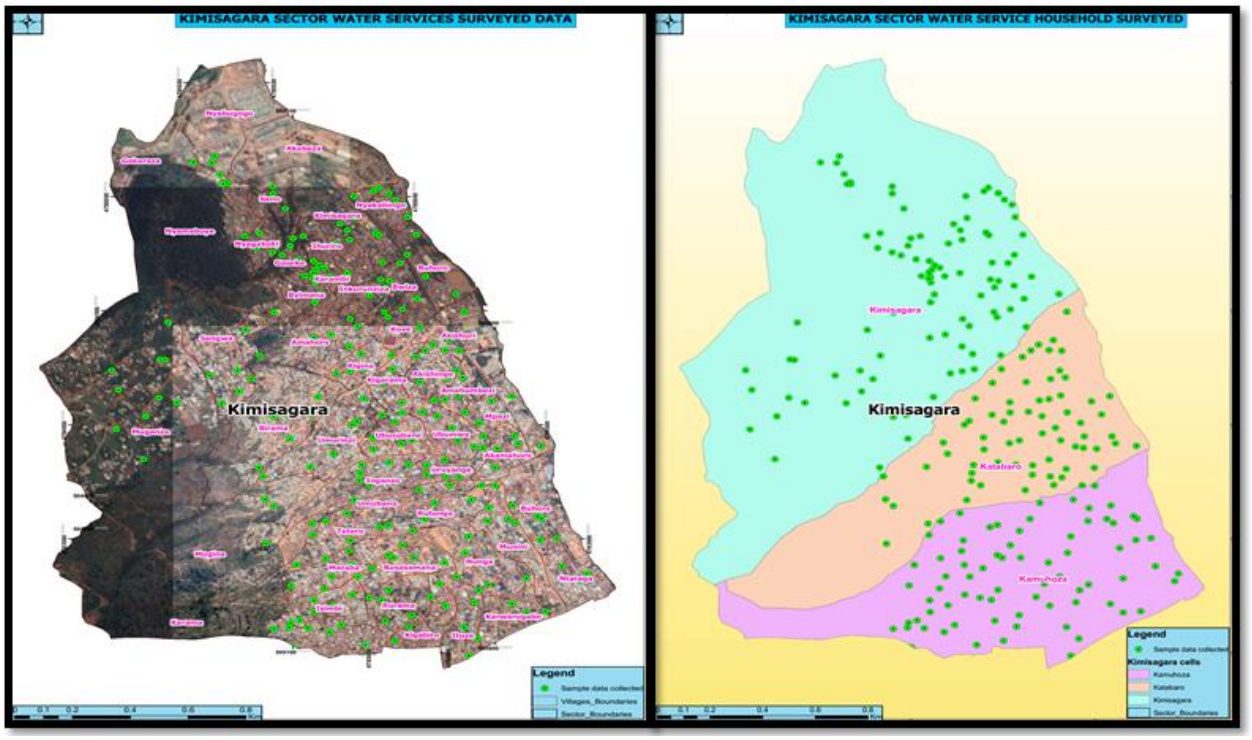

Figure4-2: Sampling of data collected map with orthophoto and without orthopho

4.3.1. Drinking water accessibility

Overall, the data provides valuable information about water sources, usage, accessibility, and the vulnerable groups affected by the lack of clean water in your community. It can be used to inform water resource management and development initiatives.

This data reveals the distribution of primary water sources in your village or community. The majority rely on spring (52.28%), followed by piped water supply at home (41.91%). The data also indicates the number of jerrycans required for daily household water use where the most common response is needing 5 jerrycans (36.93%) for daily use. The majority of respondents have their primary water source either within their house (44.4%) or within less than 100 meters (41.49%). Most respondents (73.44%) can collect water from the primary source in less than 15 minutes, indicating relatively convenient access and the data highlights that children and indigenous communities are considered the most affected by the lack of access to clean water in your village or community.

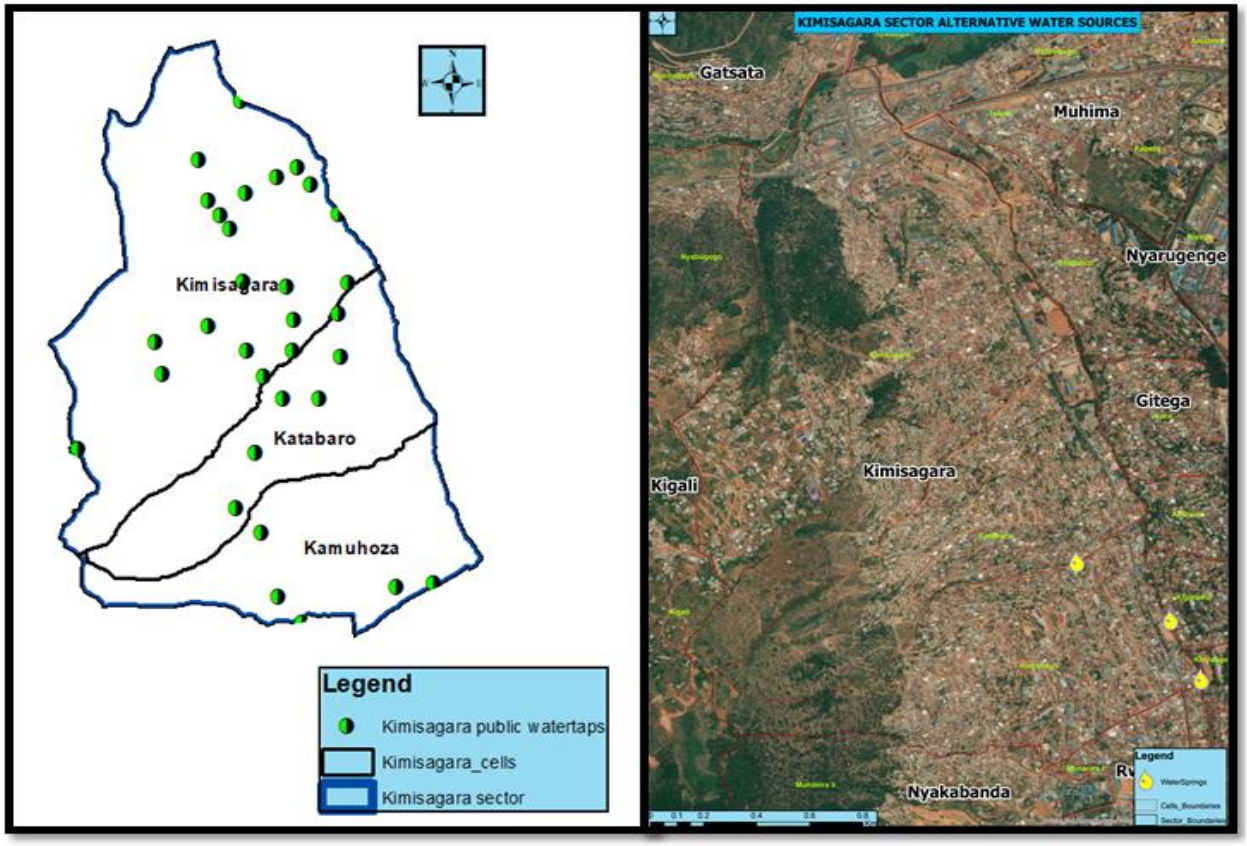

Figure 4-3: Existing Kimisagara sector public taps and alternative water springs

Table4-6: Public water taps distribution in villages

District	Sector	Cell	Village	Number of population	Number of water points
Nyarugenge	Kimisagara	Kimisagara	Akabeza	371	1
Nyarugenge	Kimisagara	Katabaro	Akamahoro	1,167	0
Nyarugenge	Kimisagara	Katabaro	Akishinge	969	1
Nyarugenge	Kimisagara	Katabaro	Akishuri	619	1
Nyarugenge	Kimisagara	Kimisagara	Amahoro	1,838	1
Nyarugenge	Kimisagara	Katabaro	Amahumbezi	507	0
Nyarugenge	Kimisagara	Kimisagara	Birama	2,799	2
Nyarugenge	Kimisagara	Kimisagara	Buhoro	1,400	2
Nyarugenge	Kimisagara	Kamuhoza	Busasamana	824	0

District	Sector	Cell	Village	Number of population	Number of water points
Nyarugenge	Kimisagara	Kimisagara	Bwiza	528	0
Nyarugenge	Kimisagara	Kimisagara	Byimana	949	1
Nyarugenge	Kimisagara	Kimisagara	Gakaraza	465	0
Nyarugenge	Kimisagara	Kimisagara	Gaseke	813	1
Nyarugenge	Kimisagara	Kimisagara	Ihuriro	761	0
Nyarugenge	Kimisagara	Katabaro	Inganzo	1,273	0
Nyarugenge	Kimisagara	Kimisagara	Inkurunziza	733	1
Nyarugenge	Kimisagara	Kamuhoza	Isimbi	1,338	0
Nyarugenge	Kimisagara	Kamuhoza	Ituze	654	0
Nyarugenge	Kimisagara	Kamuhoza	Karama	1,710	2
Nyarugenge	Kimisagara	Kimisagara	Karambi	553	0
Nyarugenge	Kimisagara	Kamuhoza	Karwarugabo	697	1
Nyarugenge	Kimisagara	Kamuhoza	Kigabiro	497	0
Nyarugenge	Kimisagara	Katabaro	Kigarama	649	0
Nyarugenge	Kimisagara	Kimisagara	Kigina	708	1
Nyarugenge	Kimisagara	Kimisagara	Kimisagara	591	2
Nyarugenge	Kimisagara	Kimisagara	Kove	334	0
Nyarugenge	Kimisagara	Kamuhoza	Mataba	1,299	0
Nyarugenge	Kimisagara	Katabaro	Mpazi	820	0
Nyarugenge	Kimisagara	Kimisagara	Muganza	1,971	3
Nyarugenge	Kimisagara	Katabaro	Mugina	1,403	1
Nyarugenge	Kimisagara	Kamuhoza	Munini	622	1
Nyarugenge	Kimisagara	Kamuhoza	Ntaraga	552	0
Nyarugenge	Kimisagara	Kamuhoza	Nunga	766	0
Nyarugenge	Kimisagara	Kimisagara	Nyabugogo	250	1
Nyarugenge	Kimisagara	Kimisagara	Nyagakoki	774	1
Nyarugenge	Kimisagara	Kimisagara	Nyakabingo	675	1

District	Sector	Cell	Village	Number of population	Number of water points
Nyarugenge	Kimisagara	Kimisagara	Nyamabuye	920	1
Nyarugenge	Kimisagara	Kamuhoza	Rurama	1,124	0
Nyarugenge	Kimisagara	Kamuhoza	Rutunga	1,387	0
Nyarugenge	Kimisagara	Kimisagara	Sangwa	1,770	1
Nyarugenge	Kimisagara	Kimisagara	Sano	372	0
Nyarugenge	Kimisagara	Kamuhoza	Tetero	1,448	1
Nyarugenge	Kimisagara	Katabaro	Ubusabane	1,065	1
Nyarugenge	Kimisagara	Katabaro	Umubano	564	1
Nyarugenge	Kimisagara	Katabaro	Umurinzi	2,507	1
Nyarugenge	Kimisagara	Katabaro	Uruyange	631	0
Total				**44,667**	**31**

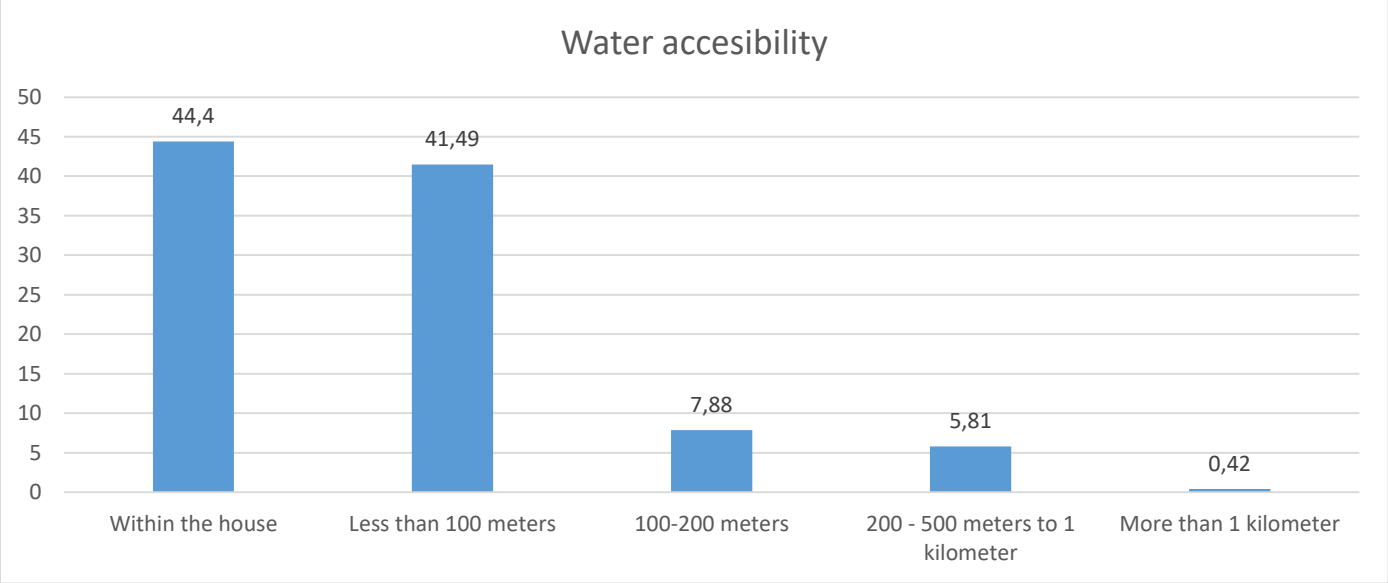

Figure4-4: Water accessibility response

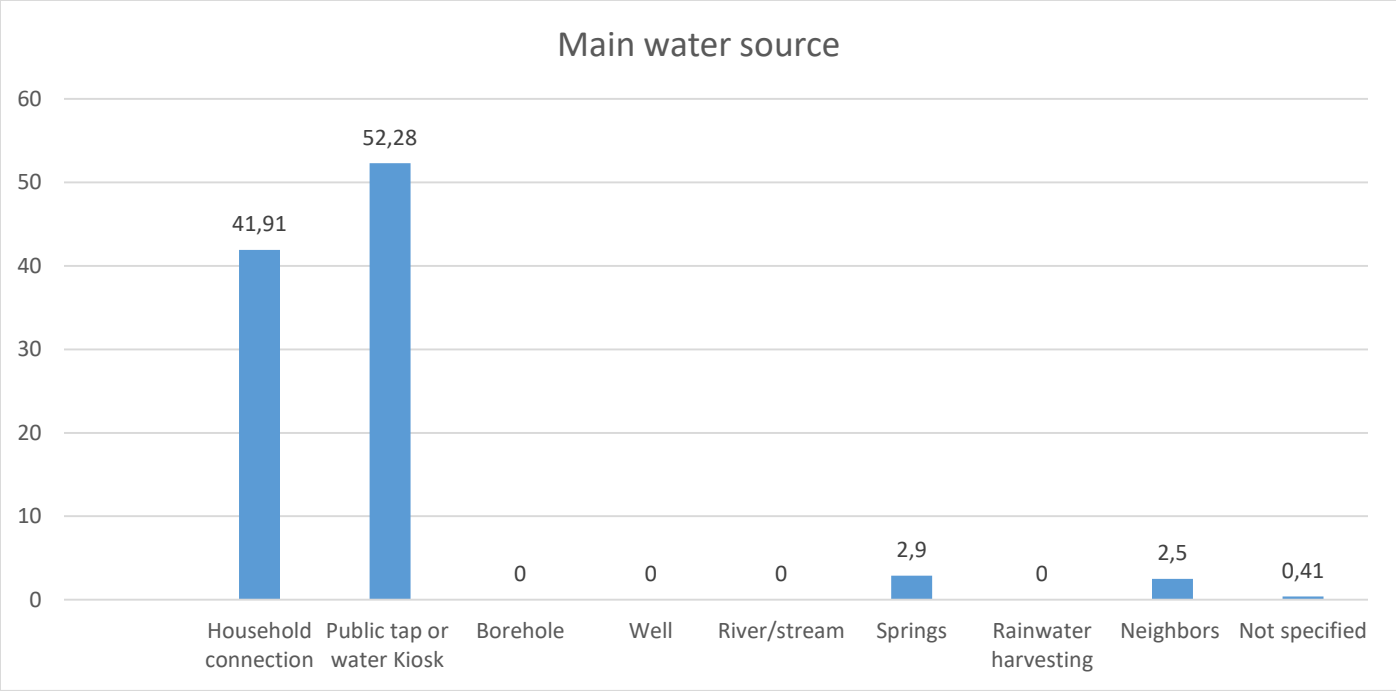

Figure4-5: Main water source usage

4.3.2. Water quality

The data highlights the awareness of water treatment methods, common treatment practices, accessibility and affordability of treatment methods, challenges from unclean water, and the incidence of waterborne diseases in your community.

Additionally, it underscores the impact on children's education due to water-related illnesses. This information can be used to assess the need for improved water treatment and access in your community. The data indicates that a significant majority of respondents are aware of water treatment or purification methods used in their community. Among those aware of water treatment methods, boiling is the most commonly used method (86.31%) and significant majority of respondents find water treatment methods accessible and affordable. The data reveals the incidence of various waterborne diseases in your village or community, with diarrhea and shigellosis being the most common and the data suggests that a significant portion of children in the community misses school due to illnesses caused by unclean water.

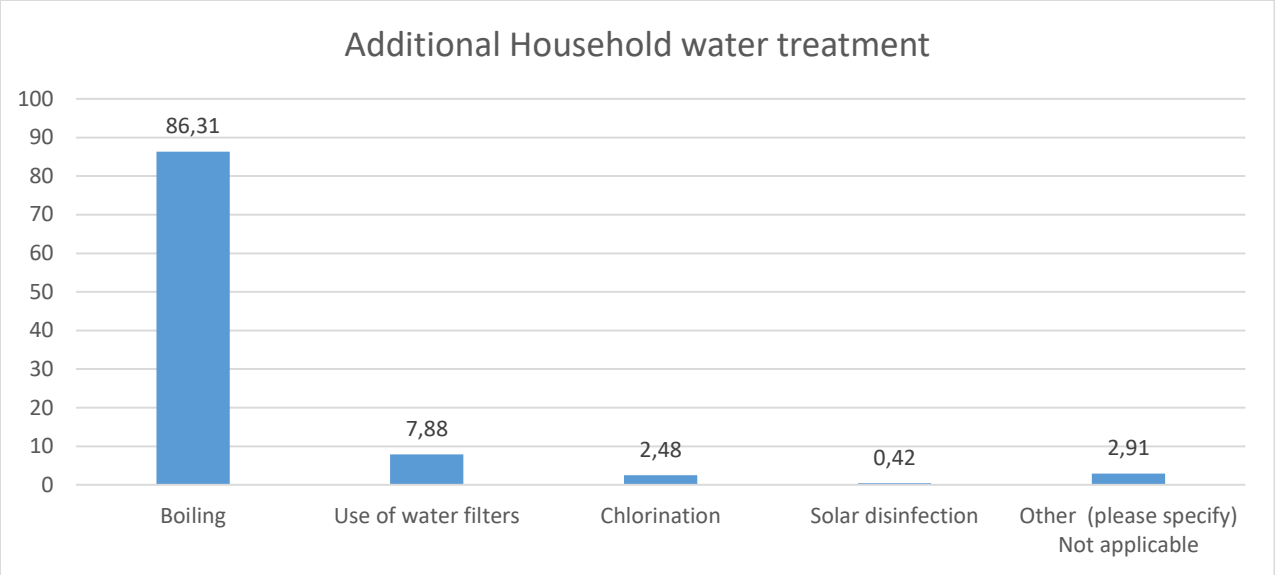

Figure4-6: Additional household water treatment

4.3.3. Water Affordability

This data provides insights into the occupation, household size, water usage, affordability, and pricing perception in your community, which can be useful for planning and policy decisions related to water resources and access.

The data indicates the various occupations of respondents. Freelancers and self-employed with small business owners are the most common. The data also represents the household sizes of the respondents, with households of 5 members being the most common.

Most respondents find their daily water supply sufficient, but a significant minority does not, with reasons provided. Respondents report also the range of monthly water bill expenses if they are connected to a water supply system.

The data represents that there are price differences for water for those who have water at their home compared to those who fetch water per jercan with additional cost for the transport and/or time to go and back to fetch water. The majority of respondents seem satisfied or neutral regarding the affordability of water in their community and most respondents report that the price of water has increased over time. Finally the respondents suggest various improvements in water pricing, with a desire to decrease prices being the most common as where as to increase the number of public water points to that they could have water nearby especially for those who have no water at their home.

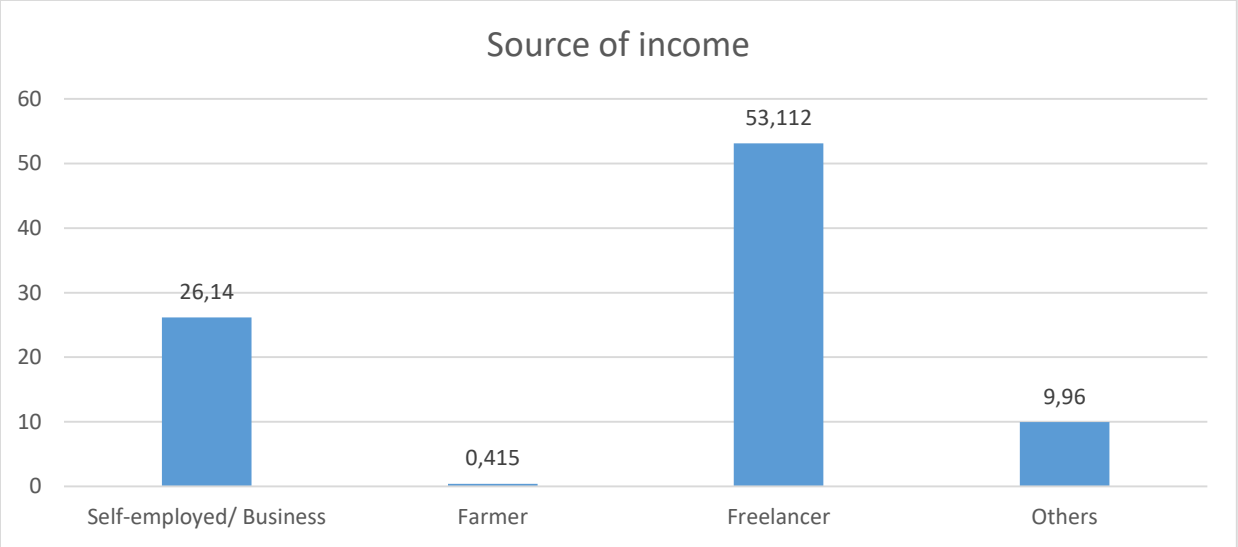

Figure4-7: Occupational

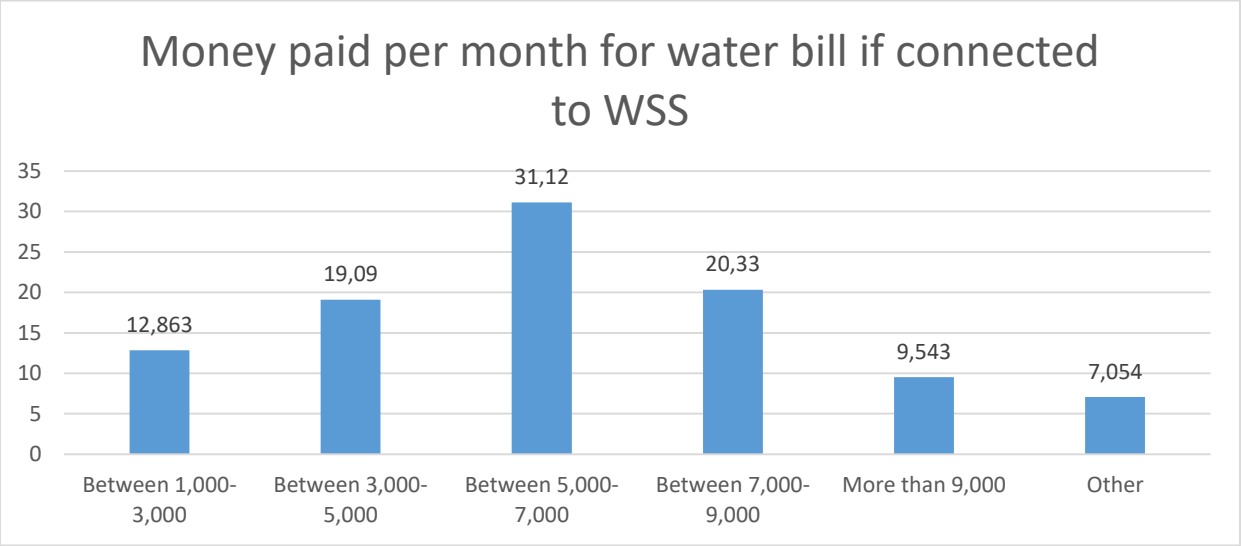

Figure4-8: Water billing if connected to WSS

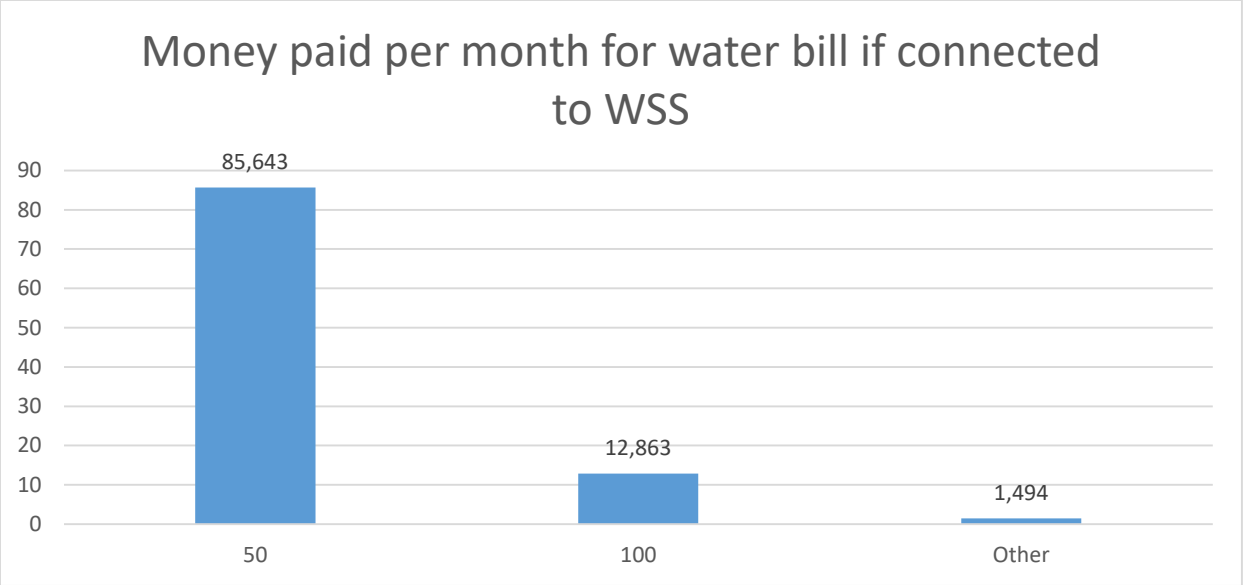

Figure4-9: Water billing if connected to WSS

4.3.4. Reliability of water service

The data provides valuable insights into the satisfaction with water access, coping strategies for water shortages, awareness of alternative water sources, and the handling of water leakage issues in your community. It can be used to inform improvements in water services and infrastructure.

The respondents rate the current access to water services in their area is 87.5% and satisfactory with the quantity of water is 80.5%. They are majority of respondents report having access to a reliable and safe water source throughout the year. Some respondents experience water shortages, with varying frequencies. Also most respondents cope with water shortages by collecting water from alternative sources and they are report that leakage happens in their community. A significant percentage of respondents are not aware of the WASAC hotline which cause most of them not notify WASAC about water leakage except when they meet with WASAC technician and this result on increase of water losses because leakage repairs take around within one, two days or more.

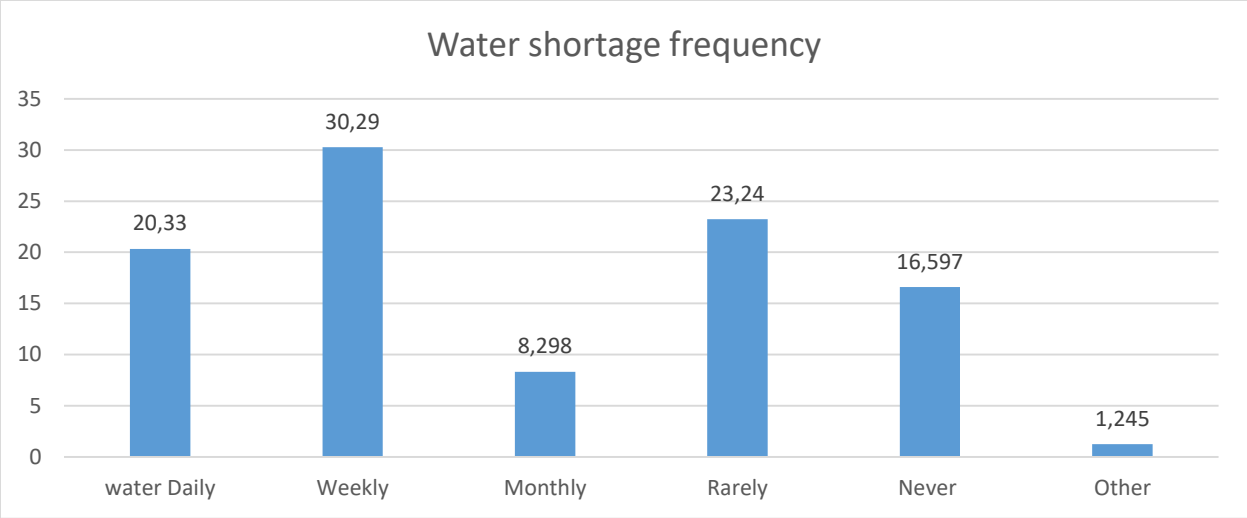

Figure4-10: Water shortage frequency

4.3.5. Alternative water quality test results

Alternative water source quality was assessed based on their chemical, physical and biological characteristics to know this suitability for drinking compared to the Rwanda National Standards and East African Community Standards for potable Drinking Water (RS EAS 12: 2018, Third Edition).

The findings are given in table below:

Table4-7: Water quality of alternative water sources (springs) results

Characteristic	**Unit**	**Results**			**Methods**	**Standards**
		Spring1	**Spring2**	**Spring3**		
Physical Requirements						
Turbidity	NTU	0.8	0.8	0.8	**EPA 180.1**	≤5
Electrical Conductivity (EC)	µS/cm	505	592	454	**ISO 7888**	1500
Chemical Requirements						
PH		6.38	6.05	6.16	**ISO 10523**	6.5-8.5
Total Dissolved Solid	mg/l	246	288	216.5	**HACH 98360**	1000
Total Hardness (as	mg/l	42	41	40	**HACH 8226**	300

Characteristic	Unit	Results			Methods	Standards
		Spring1	Spring2	Spring3		
Ammonium	mg/l	0.753	0.831	1.246	**HACH 8155**	0.5
Chloride (as Cl)	mg/l	23.36	22.264	17.296	**HACH 8113**	250
Fluoride (as Fl)	mg/l	Not detected	Not detected	Not detected	**HACH 8029**	1.5
Nitrates (as NO_3^-N)	mg/l	13.27	22.24	16.96	**HACH 8038**	10
Sulphates	mg/l	21	33	25	**HACH 8051**	400
Posphorates $Po4^{3-}$	mg/l	1.55	1.71	2.69	**HACH 8048**	2.2
Biological Requirements						
TVC 37^0 C	(CFU/100 ml)	**16.00**	**Absent**	**30.00**	**ISO 6222**	50
Total coliform	(CFU/100 ml)	**Absent**	**Absent**	**Absent**	**ISO 4832**	Absent
Fecal coliform	(CFU/100 ml)	**Absent**	**Absent**	**Absent**	**ISO 4832**	Absent
E.coli	(CFU/100 ml)	**Absent**	**Absent**	**Absent**	**ISO 9308-1**	Absent

According to the water quality results, those alternative water sources do not comply with the drinking water quality results. This poses a significant health risk to the local population, particularly vulnerable groups such as children and the elderly.

5. Conclusion and recommendations

The project aims to assess the sustainability of water service delivery in urban, low-income areas, using Kimisagara sector in Kigali City, Rwanda as a case study. It seeks to understand how effectively water services are being provided to the community, identify challenges, and propose solutions to improve long-term sustainability. Key considerations included water access, affordability, quality, infrastructure, and the impact of socioeconomic factors on service delivery.

The research surveyed 241 households, 31 public taps was identified and assessed alternative three water sources to analyze water services for households in the low-income urban area of Kimisagara sector in Kigali city, Rwanda. The findings revealed that only 41.91% of respondents had access to water at the household level and others relied on public taps, neighbors, and alternative water springs, which do not meet water drinking water quality standards.

Challenges include intermittent supply, a large population without water system connections, insufficient public taps, and irregular functioning of existing public taps. Those who fetch water from their neighbors pay approximately 2,500 Rwandan francs per cubic meter, about 7.35 times higher than the standard rate, while 53.112% of respondents are freelancers without regular income.

We argue that effective water access policies must consider what people perceive as good or bad water sources. For instance, if low-income, migrant-background individuals use poorer quality drinking water than others, it highlights inequality, potentially affecting health outcomes and civil stability in urban areas.

Our study indicates that many residents in low-income areas do not have access to improved drinking water by more acceptable definitions. Although middle-class households prefer piped water for domestic use like cooking, low-income residents often boil water for such purposes. Thus, the water access issue in low-income areas encompasses not only the quantity but also the quality of water available.

A limitation of this study is with limited time and found, this is study focused on low-income areas of Kimisagara sector in Kigali city, Rwanda within which is a small scale, which may yield different results compared to broader studies. Future research could expand the scale and analysis by including data from both urban and rural areas, as well as comparing low-income and high-income areas.

By focusing on Kimisagara sector, the study will offer insights into broader issues related to water service sustainability in similar low-income urban settings. This analysis could help in formulating strategies for better water management and service delivery, enhancing the well-being of the community.

Some recommendations according to the findings from the study:

- Priority should be given to the areas having low access to water supply
- Attention should also be given to affordability considerations to achieve equal right to access basic water services
- Regular maintenance of water infrastructures to minimize water losses
- Increase the number of public taps in villages based on updated Kigali masters plan
- promote delegated management through private operators, which is the key strategy to enhance the sustainability of rural water infrastructure
- Further study is recommended to implement treatment systems at springs as alternative water source to improve water quality as well as to make them accessible and useful.

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Appendixes

Research questionnaire

A. META DATA

Name respondent:…….
Gender:…….
Date of interview:…….
District: Nyarugenge
Sector: Kimisagara
Cell:……...
Village:……..

1. Gender

a) **Male**
b) **Female**
c) **Others**

2. Age group

a) **≤ 19 years**
b) **20 – 49 years**
c) **40-59 years**
d) **≥ 60 years**

3. Educational level

a) **Pre-primary**
b) **Primary**
c) **Junior secondary school**
d) **Secondary school**
e) **University**
f) **Others**

4. Are you a decision maker in issue of water supply in your household?

a) Yes
b) No

B. Drinking water access

5. What is the primary source of water for your village or community?

a) Piped water supply at home
b) Piped water supply at Public tap or water Kiosk
c) Borehole
d) Well
e) River/stream
f) Springs
g) Rainwater harvesting
h) Other (please specify) ……..

6. If not satisfied how many jerrycan could be sufficient for your household daily use? (please specify) ……

7. How far is the primary water source from your home?

a) Within the house
b) Less than 100 meters
c) 100-200 meters
d) 200 - 500 meters to 1 kilometer
e) 500 meters to 1 kilometer
f) More than 1 kilometer

8. How long does it take you to collect water from the primary source?

a) Less than 15 minutes
b) 15-30 minutes
c) 30 minutes to 1 hour
d) More than 1 hour

9. Which vulnerable groups do you think are most affected by the lack of access to clean water in your village/community? (Select all that apply)

a) Children
b) Pregnant women
c) Elderly
d) People with disabilities
e) Refugees or internally displaced persons
f) Indigenous communities
g) Low-income households
h) Other (please specify)

……..

C. Water quality

10. Are you aware of any water treatment or purification methods used in your community?

a) Yes
b) No

11. If yes, what water treatment or purification methods are commonly used? (Select all that apply)

a) Boiling
b) Use of water filters
c) Chlorination
d) Solar disinfection
e) Other (please specify) ……..
f) Not applicable

12. Are these treatment methods accessible and affordable for you?

a) Yes
b) No
c) Not applicable

13. Which are the challenges do you face from using unclean water (Explain)?

a. Poor sanitation
b. Occurrence of diseases
c. Others

14. Have you witness the incident of any of the following water borne diseases in your village/ community? (Select all that apply)

a) Cholera
b) Typhoid
c) Diarrhea
d) Shigellogis
e) Amoebiasis
f) Food poisoning
g) Other infectious diseases
h) Leptospirosis
i) Hepatitis
j) Helminthiasis
k) I don't know

15. How often the children miss the class in this or current semester due to illness caused by using unclean water?

a. Twice
b. Triple
c. A week
d. Other

D. Affordability and Ability to pay

16. Occupation

a) Salary earner
b) Self-employed/ Business
c) Farmer
d) Freelancer
e) Others

17. What is the number of people in your household

a. 2
b. 3
c. 4
d. 5
e. 6
f. 7
g. 8
h. Other

18. How many jerry cans do you use per day?

a. 2
b. 3
c. 4
d. 5
e. 6
f. 7
g. 8
h. 9
i. 10
j. Other

19. Do that water per day sufficient?

a. Yes
b. No

20. **If no, why**

a. Inconsistent water supply
b. Water tariff is expensive
c. We have to travel far to gather water, and it is difficult
d. other

21. How much money do you pay per month for water bill if you are connected to water supply system

a. Between 1,000-3,000
b. Between 3,000-5,000
c. Between 5,000-7,000
d. Between 7,000-9,000
e. More than 9,000
f. Other

22. How much money do you pay a jerrycan if you are not connected to water supply system

a. 50
b. 100
c. 300
d. None
e. Other

23. **Are there different prices for water depending on the source or location or availability** e.g., transportation costs, storage costs)**?**
    a) Yes
    b) No
    c) Not sure
24. If yes, please explain the factors that influence the price differences
    ……
    ……
    ……
    ……

25. How satisfied are you with the affordability of water for your village/ community?
    a) Very satisfied
    b) Satisfied
    c) Neutral
    d) Dissatisfied
    e) Very dissatisfied
26. How do you compare the current price of water with the past? Has it increased, decreased, or remained the same?
    a) Increased
    b) Decreased
    c) Remained the same
    d) Not sure
27. Are there any improvements or changes you would like to see in the pricing of water in your village/ community? Please provide your suggestions.
    ……
    ……

E. Reliability of water service

28. Overall, how would you rate the current access to water services in area?
    a) Excellent
    b) Good
    c) Fair
    d) Poor
    e) Very poor
29. Are there any cultural or religious practices in your village or community that affect water use or access?
    a) Yes
    b) No
    c) I don't know
30. How satisfied are you with the quantity of water you are using currently?

a) Very satisfied
b) Satisfied
c) Neutral
d) Dissatisfied
e) Very dissatisfied

31. Do you have access to a reliable and safe water source throughout the year?
    a) Yes
    b) No
32. If no, how often do you experience water shortages?
    a) Daily
    b) Weekly
    c) Monthly
    d) Rarely
    e) Never
33. How do you cope with water shortages? (Select all that apply)
    a) Collect water from alternative sources
    b) Store water in containers or tanks
    c) Limit water usage
    d) Use water conservation practices
    e) None
34. Are the alternative water sources safe for drinking and cooking?
    a) Yes
    b) No
    c) I don't know
    d) Not applicable

35. Is there any leakage happens in community?

a. Yes

b. No

36. Do you notify WASAC if a leakage happens in region?

a) Yes
b) No

37. If yes, how do you notify WASAC?

a. Call through the phone
b. Tell any WASAC staff if you met him or her
c. Other

38. Do you know WASAC hotline?

a. Yes
b. No
c. I don't know if it exist

39. How long it takes to make leakage repair if it happens in region?

a. One day
b. Two days
c. More than three days
d. A week
e. More than one week

40. What improvements or changes would you recommend to enhance access to water in your village or community?

……
……
……

GPS coordinates of the household
Latitude: _____
Longitude: _____

THANK YOU FOR TAKING TIME TO ANSWER THIS QUESTIONNAIRE!