EXAMINING THE RELATIONSHIP BETWEEN EQUITABLE ACCESS TO POTABLE WATER, HOUSEHOLD SOCIO-ECONOMIC STATUS, AND WOMEN'S LIVELIHOOD IN KILOME SUBCOUNTY, MAKUENI COUNTY, KENYA

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PAN AFRICA CHRISTIAN UNIVERSITY

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DECLARATION

This thesis is my original work and has not been presented for academic credit at any other university or institution of higher learning.

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DEDICATION

This study is dedicated to my late mother, Loise Njeri, whose memory continues to inspire my academic journey and personal growth.

I also dedicate this work to my family and friends whose unwavering faith in me, encouragement, and support carried me through this process. Your presence and belief in my abilities made this achievement possible.

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ABSTRACT

Access to safe, reliable, and affordable water is a significant factor in relation to health, productivity, and gender equity for rural women and households. But water insecurity is a long-standing issue in many rural communities, where women lack access to good infrastructure, water sources are far away, water prices are steep, and their water supplies are inconsistent. These difficulties lead to time poverty, health risks, the lack of education, and limited involvement in income-generating activities. The study investigated the link between water security and outcomes for women's livelihoods in Kilome Sub-County, Makueni County, Kenya, and evaluated the interaction of water security with household socio-economic status (SES) on these livelihood outcomes. Water security was defined in terms of four dimensions: availability, accessibility, quality, and affordability. The study was directed by the Sustainable Livelihoods Framework, Gender and Development Theory, and the Ecological Systems Theory. The explanatory sequential mixed methods design was utilized. The quantitative data were obtained from 375 women who were selected from a target population of 5939 women using Yamane's (1967) formula with a multi-stage sampling procedure, which involved purposive selection of wards and systematic random sampling of households. Key Informant Interviews (KII) were used to collect qualitative data with local administration, community leaders, and NGO representatives. To analyse quantitative data, descriptive statistics and three-step hierarchical multiple regression were used, while qualitative data were analysed thematically. Poor water availability (Mean = 2.14) and accessibility (Mean = 2.46) suggested not only poor supply but also high waiting time and long distances to access water, while water quality (Mean = 2.71) and water affordability (Mean = 2.78) were moderate and diverse across socio-economic groups and water sources. The mean score for women's livelihood outcomes was high (Mean = 4.21) owing to their participation in small-scale agriculture, petty trade, and household production in favourable water conditions. The hierarchical regression revealed that the four water security dimensions individually accounted for 11.8% of the women's livelihood outcomes (Model 1: Adjusted $R^2 = 0.108$). The addition of SES and the demographic controls of age and education increased the explained variance to 39.1% (Model 2; Adjusted $R^2 = .376$), with education being the single most important predictor. The interaction block added a small but statistically significant increment (Model 3; $\Delta R^2 = .018$, $p = .028$), so that the effects of water availability and water quality on livelihoods were buffered by SES, but water affordability and access were not. The study finds that water security is not just a basic need of the household but also a structural determinant of women's economic empowerment and gender equity, which depends on the socio-economic position of the household. The study recommends the strengthening of water infrastructure in rural areas (borehole, piped water, storage tanks), increased water quality monitoring and decentralized water treatment systems, progressive and equitable water tariff structures to increase water affordability, women's economic empowerment programmes to increase income generation from time saved in water use, strengthening of Water User Associations, improving maintenance systems for sustainability, protection of water catchments through reforestation and water conservation, and improved public awareness on water safety and household water treatment.

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ABBREVIATIONS AND ACRONYMS

CBOs - Community-Based Organizations

CEDAW- Convention on the Elimination of All Forms of Discrimination Against Women

FAO - Food and Agriculture Organization

FGDs - Focus Group Discussions

GAD- Gender and Development

GOK-Government of Kenya

IWRM - Integrated Water Resource Management

JMP -Joint Monitoring Program

KNBS-the Kenya National Bureau of Statistics

MWSI - Ministry of Water, Sanitation, and Irrigation

NGOs - Non-Governmental Organizations

SDGs - Sustainable Development Goals

SSA-Sub-Saharan Africa

UN-United Nations

UNDP or United Nations Development Programme

UNEP United Nations Environmental Program

UNESCO - United Nations Educational, Scientific, and Cultural Organization

UNICEF-United Nations Children's Fund

WASREB - Water Services Regulatory Board

WFP-World Food Program

WHO - World Health Organization

WID-Women in Development

WRMA -Water Resources Management Authority

WWAP-World Water Assessment Program

KIIP = Key Informant Interview Protocol

DEFINITION OF TERMS

Accessible Water: The availability of safe, sufficient, and affordable water at the point of use.

Aquifer: A water-bearing rock or sediment that retains water underground.

Contaminated Water: Water unsafe for human consumption or that is not meeting water quality standards.

Empowerment: The process of taking control, confidence, and making choices in one's life.

Fresh Water: Water with low dissolved-salt content, suitable for drinking and domestic use.

Groundwater: Water found beneath the surface of the earth in aquifers.

Improved Water Supply: A source of water that is separated from animals and free from faecal contamination.

Potable Water: Water that is safe to drink and free of disease and toxins.

Surface Water: Water in the form of rivers, lakes, reservoirs, and other such forms on the earth's surface.

Water Affordability: Access to water services without compromising on other basic needs.

Water Availability: How much water is available to provide safe water to the population.

Water Poverty: The inability to meet basic human needs for safe, affordable, and sufficient water.

Women's Livelihoods: The resources and coping strategies used by women for household maintenance in relation to access to potable water, including income, productivity, health, and social roles.

CHAPTER ONE: INTRODUCTION AND BACKGROUND TO THE STUDY

Introduction.

This chapter provided background information, a problem statement, research purpose and objectives, research questions, research assumptions, justification, scope, and research delimitations. Finally, it provides a summary of the chapter's key points.

Background to the Study

Safe drinking water is recognized as a fundamental human right and a critical determinant to the health, economic, and social stability of humans, societies, and countries (World Health Organization [WHO] & United Nations Children's Fund [UNICEF] 2023, World Bank 2019). Safe and clean drinking water and sanitation are a human right, as made clear in the UN General Assembly (2025) that it is a fundamental right that is essential to the enjoyment of other human rights and the right to life. The recognition was reaffirmed and further developed in the U.N. General Assembly Resolution 70/169 (2015), recognizing the right to safe drinking water and the right to sanitation as two distinct, but related human rights. In the same vein, the International Covenant on Economic, Social and Cultural Rights (ICESCR) (11.12) considers water as an integral part of living in a decent standard of living and health. More than that, it is stated in the General Comment No. 15 of the UN Committee on Economic, Social and Cultural Rights (2010, United Nations General Assembly) that human dignity and the enjoyment of other human rights require access to water that is adequate, safe, acceptable, physically accessible, and reasonably priced.

However, access to potable water is a big issue internationally, even with all these commitments on the international level. More than 2 billion people worldwide

do not have access to safely managed drinking water services, putting their health, socio-economic, and environmental lives at risk (WHO & UNICEF, 2021). In 2020, about 74% of all people in the world had access to safely managed drinking water, while almost half of the population was living in low-income areas without access to reliable water services (UNICEF & WHO, 2021; WHO & UNICEF, 2021). In Sub-Saharan Africa, infrastructural deficiencies, climatic changes, and socio-economic factors all have a significant effect on the availability of clean water. The social norms of the gender roles (UN Women, 2023), assigning women the primary responsibility of collecting and managing domestic water at home, make them more vulnerable.

Access to potable water is mainly dependent on household socio-economic status. Low-income families are burdened physically due to poor sources of water, and access to water is also far away, resulting in poor hygiene and being prone to waterborne diseases (Mensah et al., 2020; UNESCO, 2020). On the other hand, wealthier households, more educated and better-infrastructure households have more capacity to find safe water sources and implement water treatment and storage technologies (Makueni County Statistical Abstract, 2022; World Bank, 2019). Therefore, water inequalities are closely related to other structural inequalities impacting all aspects of women's lives, such as their socio-economic status and their health and well-being.

Women's livelihoods are greatly impacted by water insecurity. Collecting water is competing with education and employment, and with community leadership, which decreases the opportunities for women to be empowered (Komatsu et al., 2021). The lessons learned in rural Kenya indicate that water savings can have tangible health impacts on women, both in terms of education and the productivity of

their households (Kabubo-Mariara & Kimuyu, 2023). Moreover, unsafe access to water puts health risks to women from walking long distances for fetching water and physical strain due to hauling the heavy water containers or water drums (Baguma, 2013; UNESCO, 2020). All such burdens are more likely to be worse for low socio-economic households, which then further aggravates poverty and gender inequalities (UN Women, 2023; WHO & UNICEF, 2021).

Water insecurity and community vulnerability are also aggravated by environmental shocks (such as droughts and floods) and climate variability. Women bear the burden of water management within the home, without adequate, limited, and finite financial and physical resources (Ministry of Water, Sanitation and Irrigation, 2023). Gender responsive water governance is also socio-economically inclusive, and therefore, essential for delivering SDG 1 (No Poverty) and SDG 5 (Gender Equality) in addition to SDG 6 (Clean Water and Sanitation) (UN Women, 2023; World Bank, 2019).

Potable water is a serious problem in Kenya, especially in the arid and semi-arid areas. Only less than 30% of the rural population has access to safely managed water sources (Kenyan Constitution, 2010; WHO & UNICEF, 2021). In addition, the water sources are further constrained by the climatic conditions in the area, which are semi-arid, and inadequate information on rainfall, and the contamination of groundwater with fluoride (Maganga et al., 2020; UNESCO, 2020). Almost 64 per cent of the population in Makueni County and Kilome Sub-County, Makueni County, has no access to better water sources (Makueni County Statistical Abstract, 2022). The time spent by women in these neighbourhoods collecting the water is a few hours a day, which is a constraint on generating income and social working hours. Socio-economic inequalities increase the vulnerability to water insecurity and decreased

livelihoods, particularly for female-headed households (MWSI, 2023; WASREB, 2023).

The study thus looked into water security and women's livelihoods in Kilome Sub-County, Makueni County, Kenya. Water security was conceptualized as the availability, accessibility, and cost of water and water quality. The study also explored the impact on this relationship of the socio-economic status of the household. It particularly looked at the relationships between variations in water security and socio-economic dimensions on the participation of women in socio-economic activities. The gendered and socio-economic approach of the study helps to understand the potential of elevating water security to enhance the economic empowerment of women, social participation, and well-being. The findings will inform the policy development discussions on sustainable development, gender inclusion, and water governance in Kenya.

Statement of the Problem

Safe and reliable access to water is acknowledged as a human right and is a key aspect of human dignity, health, and development worldwide. This is well grounded in the Constitution of Kenya (2010) and other international legal instruments like United Nations General Assembly Resolutions 64/292 (2010) and 70/169 (2015), which state that everyone has the right to clean, safe, and affordable drinking water and sanitation. These pledges have not been fully implemented, however, and water security is far from being equal, especially in arid and semi-arid areas like Makueni County, where households are still experiencing major difficulties in accessing reliable, safe, and affordable water sources.

To this, environmental and infrastructural constraints such as low and irregular rainfall, water scarcity during dry seasons, and high fluoride in available groundwater sources pose more challenges in Kilome Sub-County, affecting water quality and limiting safe usage (MWSI, 2023; WHO & UNICEF, 2021). Consequently, households are generally forced to rely on water sources that are far, unreliable, and unsafe, making water collection more time-consuming and physically demanding.

The conditions disproportionately affect women, as women are primarily tasked with collecting water, with the household's sanitation, and managing household water. This has a direct impact on women's daily allocation of time, which requires them to walk long distances, stand in line for water, and coordinate the use of water in the household. This limits their ability to participate in productive livelihood activities, like farming, small-scale trading, educating, and engaging with their community, which in turn affects their empowerment and helps perpetuate gender inequalities (UN Women, 2023).

Socio-economic status of households is an important determinant of water security, apart from environmental and infrastructural factors. Women-led households and low-income families do not have the same capacity to access better water sources, connections, or water treatment technologies. This makes them more vulnerable economically and exposes them to health risks that come with the use of unsafe and faraway water sources. (World Bank, 2019; Makueni County Statistical Abstract, 2022). This socio-economic divide leads to a varying water access experience within the same geographic area, further reinforcing inequalities for women.

Water insecurity and socio-economic status create greater disadvantages for rural women. Poor women bear a heavier burden with water collection, which means they have lower access to education, less participation in income-generating activities, and heavier domestic responsibilities. Such restrictions have a substantial impact on their socio-economic opportunities and mobility of the future (UNESCO, 2020; UN Women, 2023).

While the existing literature in Kenya has examined water scarcity, gender inequality, and rural livelihoods, most of these studies have been conducted in other sub-counties of the semi-arid regions, including Kitui, Machakos, and other regions in Kenya, with little empirical work done on the Kilome Sub-County (MWSI, 2023; WASREB, 2022). Moreover, water access or gender livelihoods have been explored separately in the past, with limited consideration of the role of water security dimensions (availability, accessibility, affordability, and quality) as a moderating factor in the relationship between livelihoods and the socio-economic status of the households.

This leaves a huge empirical and contextual imperative to understand the relationship between water security and socio-economic conditions in Kilome Sub-County and its impact on the livelihood outcomes of women. Without evidence of this kind, that is, evidence which is localized and integrated, policy and development actors are constrained in designing gender responsive, socio-economically inclusive, water governance and livelihood interventions. This gap ultimately limits progress towards meeting Sustainable Development Goals (SDGs) 1 (No Poverty), 5 (Gender Equality), and 6 (Clean Water and Sanitation) and the broader national development agenda in Kenya, as outlined in Vision 2030 (UNESCO, 2020; UN Women, 2023; World Bank, 2019).

Research Objectives:

General Objective

To examine the relationship between equitable access to potable water, household socio-economic status, and women's livelihood in Kilome Sub-County, Makueni County, Kenya

Specific Objectives

i. To examine the influence of the availability of potable water on the livelihoods of women in Kilome Sub-County, Makueni County, Kenya
ii. To determine the influence of the quality of water on the livelihoods of women in Kilome Sub-County, Makueni County, Kenya
iii. To establish the influence of the affordability of water on the livelihoods of women in Kilome Sub-County, Makueni County, Kenya
iv. To assess the influence of accessibility infrastructure for water on the livelihoods of women in Kilome Sub-County, Makueni County, Kenya
v. To determine the moderating influence of household socioeconomic status on the relationship between equitable access to water and women's livelihoods in Kilome Sub-County in Makueni County, Kenya.

Null Hypothesis

The research hypotheses are formulated based on the objectives of this study.

H_{01}: There is no statistically significant influence of potable water availability on women's livelihoods in Kilome Sub-County, Makueni County, Kenya.

H_{02}: There is no statistically significant influence of potable water quality on women's livelihoods in Kilome Sub-County, Makueni County, Kenya.

H_{03}: There is no statistically significant influence of potable water affordability on women's livelihoods in Kilome Sub-County, Makueni County, Kenya.

H_{04}: There is no statistically significant influence of accessibility infrastructure for potable water on women's livelihoods in Kilome Sub-County, Makueni County, Kenya.

H_{o5}: There is no moderating influence of household socioeconomic status on the relationship between equitable access to potable water and women's livelihoods in Kilome Sub-County in Makueni County, Kenya.

Assumptions of the study

Michael et al. (2010) argue that when doubt is absent, assumptions are presumed regardless, and hence challenge the assumption. During this study, some assumptions were made about access to drinking water and how it affected the lives of women in Kilome Sub-County. The first and foremost of these assumptions was that access to clean, safe water is one of the most critical factors of economic, social, and health outcomes of women. Since women are the major water managers in most rural communities, the study hypothesized that women in the rural communities were the ones who would collect, manage, and use water at the household level.

Moreover, the livelihoods concept was also operationalised in a multidimensional way, that is to say, in economic, social, human, and environmental dimensions, instead of income generation. Even though the situation was unique to the Kilome Sub-County, the research assumed that its results could provide information which can be applied to other semi-arid areas that face similar problems with the availability of potable water. It was also assumed that data that would be

gathered by use of surveys and interviews would be fairly accurate and representative, despite the sources of bias. Lastly, the study was founded on the fact that the respondents should respond with true and accurate data as much as possible because self-reported data is an established limitation in social scientific research.

Justification of the Study

Availability of potable water is one of the main components of human development and social security. Although enshrined in the Constitution of Kenya (2010), this right has several significant gaps, particularly in dry and semi-arid areas such as Makueni County. Constant lack of water, lack of water infrastructure, and massive pollution of water bodies have continued to pose a challenge to women in Kilome Sub-County because they have to endure prolonged strenuous daily activities to ensure access to safe drinking water. Women also spend a considerable amount of time as primary collectors of water, and time that would be used in other economic, educational, or family care activities. This fact has a gender effect, is a negative effect on the productivity of the households, and perpetuates poverty (Crow & Odaba, 2024; UN Women, 2023). The inclusion of the socio-economic situation in the house will help to understand socio-economic differences. The level of water scarcity is predisposed by financial means and possession of assets, since households with less financial capacity will not be able to afford alternative water supply, storage, or water purification technologies (World Bank, 2019; Cook et al., 2023). Conversely, such options are more easily obtained by wealthier families and thus decrease the time and health costs to women. This relationship underpins a more comprehensive understanding of the nature of economic disparities and the implications for water access, and consequently, indirectly, rural Kenyan women's livelihoods. Based on the community development theory and gender equity principles, the current research

aimed at reducing these disparities by empowering women and strengthening their households by improving their accessibility to water and their participation in the economy. The impact of guaranteeing water security is immense, with the primary beneficiaries being education, health, income, and gender equality, as women are the backbone of households and the local economy (Adelodun et al., 2021; Bukachi et al., 2021). This study is a continuation of the efforts to elucidate poverty as structurally embedded and the dependence of environmental and social systems, by linking water availability to household socio-economic statuses.

There were also a lot of policy implications of the study. The examination of the issue of water access in terms of gender and socio-economic conditions represented Sustainable Development Goals (SDGs) 6 goal 6 (category Clean Water and Sanitation) and 5 goal 5 (category Gender Equality) and endorsed the universal goals of aspirational equality of access to safe water, women's empowerment, and elimination of discriminatory practices. Further, the findings aligned with the goals of Kenya Vision 2030, which include social inclusion, economic empowerment, and sustainable development (Government of Kenya, 2018). Last but not least, the results were to help shape gender-inclusive and equitable water policies, strengthen community-based water management initiatives, and enhance the socio-economic situation and livelihoods of rural women in Kenya. The study that engages with the nexus of water access, gender, and socio-economic status has made a concerted contribution towards the national developmental agenda and the national human rights engagements.

Significance of the study

This study offers evidence to guide the policy actions on the county and national level that will be taken in relation to the issue of water governance, as

Kenya's constitutional responsibility to implement the Constitution of Kenya's water rights (Article 43) and national commitments to sustainable development goals (SDG 6 Clean Water and Sanitation, SDG 5 Gender Equality). It was anticipated that these findings would have relevance for all stakeholders, including the Makueni County Government, the Ministry of Water and Sanitation, non-governmental organizations, community-based organizations, and international development partners, as they anticipated gender specific issues and livelihoods affected by the water insecurity. In practice, the research indicates that the empowerment of the female population and the resilience of the household, such as infrastructural investments, water policy, and water management at the community level, are interventions that can be employed. At the broader level, better access to water can contribute to the diminished vulnerability of communities, improved food security within households, growth in women's economic productivity, and implementation of social protection measures to combat inequality and uphold the dignity of marginalised groups.

Scope of study

The research included the women in Kilome Sub-County, Makueni County, who are the main caretakers of clean drinking water in their homesteads. The study was carried out in three wards (Kiima-Kiu, Mukaa, and Kasikeu), which have been consistently affected by water access challenges such as long distances to water and irregular water supply. Along with the women respondents, the major local players, including administrators, community leaders, and NGO staff engaged in water management and women empowerment, were also surveyed. The interviews not only gave details about the structural and institutional obstacles to water access but also gave details about how the livelihood of women can be improved. The study has taken a holistic approach, incorporating the direct beneficiaries, as well as key

stakeholders in the area, to present a mix of personal testimonies and institutional perspectives. The approach enabled the detailed analysis of the social, economic, and governance factors affecting safe drinking water and livelihood for women in the Kilome Sub-County.

Delimitation of the Study

This study was geographically delimited to Kilome Sub-County in Makueni County, Kenya. It is important to note that the study was not extended to other sub-counties in Makueni County and neighbouring counties, where there may be water access challenges similar to the ones encountered in the study area. Kilome sub-County was selected based on its unique water insecurity issues, which are associated with the distance to water sources, unreliable water supply, and reliance on unsafe water sources, and directly affect women's livelihood activities.

The study was also restricted to women who are mainly responsible for water collection and management in their households. To prevent duplication of responses from households and to facilitate data collection, only one woman per household was included in the study. Simple random sampling was used to select a total of 375 women from a target population of 5,939 households.

Additionally, this study only addresses the rural context and excludes urban areas, informal settlements, and other ecological areas, which may have different water security dynamics. Men and other household members were not included in the study since the research specifically focused on women’s experiences in water collection and livelihood outcomes.

The study conceptually focused on water security in four dimensions – availability, accessibility, affordability, and quality – and water security’s effect on

women's livelihood outcomes as a moderating variable. There were other factors at the broader environmental, infrastructural, and institutional level that affect water systems that were not explored in detail, as the focus of the study was on water security dynamics at the household level and its direct impact on women's livelihoods.

Limitations of the Study

The study particularly focused on a group of women who have the main responsibility of providing water in their homesteads in Kilome Sub-County, Makueni County. The study was carried out in three (3) wards with a problem of access to water, namely, Kiima-Kiu, Mukaa, and Kasikeu, where water access issues have been created and include long distances to water and inconsistent supply. In addition to the women participants, major local stakeholders, such as women's empowerment and water management-related non-governmental organisations, community leaders, and administrative bodies, were also involved in the study. These stakeholders were critical sources of information on structural and institutional barriers affecting water access, and that can be leveraged to bolster women's livelihoods. By capturing the perspectives of both the women of the communities of Kiima-Kiu, Mukaa, and Kasikeu and the prime movers in the area, the research gave a comprehensive picture of the social, economic, and governance factors that influence access to safe drinking water. Nevertheless, the small coverage of wards and the number of key informants might limit the generalisation of the results to other areas of the Kilome Sub-County or other rural areas.

Chapter Summary

This chapter has explained the research topic and its background. It has stated the problem statement, the research objectives, and the study design used to meet the research objectives. The research problem has been stated, which was the reason Kilome Sub-County was used as the field of study. The research questions focused on the effect of potable water availability on the economic status of women. Also, the study's assumptions, limitations, and delimitations are addressed. This chapter has further presented a summary of the rationale and the importance of the research. Its importance extended beyond providing a scholarly point of view to emphasizing the role of safe drinking water in the health and social transformation of women, with implications for readers, researchers, policymakers, the Makueni County government, and the general population.

CHAPTER TWO: LITERATURE REVIEW

Introduction

This chapter is a detailed literature review of relevant sources, and it will provide an insight into the current theories, concepts, and the research topic. The literature review has summarised the major findings and discussion of past studies and assessed their applicability in the current research. The theoretical framework outlined the theories that were used to form the basis of the study and how they were used to design the study. The conceptual framework provided a pictorial and descriptive depiction of the important variables and their connections to each other. The key findings were summarised in such a way that they would give an overview of the literature review that utilized various sources. Lastly, the study revealed the gaps in the current body of literature and areas that needed to be filled with research, thus justifying the relevance of the study.

Livelihood of Women in the Aspect of Access to Potable Water

The right to safe and reliable water is well recognized as an important factor that shapes women's livelihoods across Sub-Saharan Africa and other developing areas. The literature overwhelmingly demonstrates that water insecurity is a structural problem that influences women's social mobility, education, health, and economic participation. Women are usually the key drivers of water collection in rural contexts, making water access a gendered development concern (Maathai, 2003; Bolaane & Chanda, 2022; Onyango et al., 2020).

One recurrent theme in studies is the connection between women and time poverty and water scarcity. The data from Sub-Saharan Africa and South Asia indicate that the distance from water sources and the lack of reliability of water

supply systems are significantly contributing to the amount of unpaid labour time that women dedicate to these activities, thereby limiting their time for education and income-generating activities, as well as their time for participation in social events (Bukachi et al., 2021; Islam, 2020). This is always linked to lower livelihood diversification and limited livelihood opportunities for economic empowerment.

This is closely linked to the effect of water insecurity on the economic and social engagement of women. Research shows that, if water is scarce, women dedicate less time to engaging in small-scale farming and livelihood activities such as petty trade, as there is competition for household responsibilities. On the other hand, improved access to safe water is linked with better health, productivity, and social mobility among women (Abanyie et al., 2023; Ogunbode et al., 2022). But most of these studies consider the national or regional level pattern, and fail to explore how such impacts differ at the sub-national or socio-economic level.

The second key point identified in the literature is that although there is a focus on the role of women in the water governance arena, their meaningful participation remains constrained by institutional and structural barriers. Women's participation in water governance is therefore not necessarily reflected in better access or a better livelihood (Oloruntoba & Akanbi, 2020; Owino & Were, 2023).

Despite these contributions, the literature is still disjointed in three main ways. First, most studies deal with water access as a one-dimensional problem but fail to take a multidimensional water security approach. Secondly, there is a weak integration of the socio-economic status of the household as a structural determinant of differential women's experiences. Thirdly, there has been limited research focusing

on the relationship between water insecurity and longer-term livelihood outcomes like livelihood diversification, economic resilience, and income stability.

Though the literature is clear that water insecurity is a problem that affects women more than men, it has not been able to explain how the dimensions of water insecurity vary and how socio-economic status interacts with water insecurity to influence livelihood outcomes in specific rural contexts.

Availability of Water on the Livelihoods of Women

Water poverty is everywhere a gendered issue that is a specific burden on women because of their gender role in water collection at home in Sub-Saharan Africa and South Asia. This is a heavy extra burden on women's unpaid work, resulting in experiences of time poverty, poorer health, and lower engagement in livelihood activities, including education, agriculture, and informal work (Bukachi et al., 2021; Islam, 2020). The overall literature thus confirms the strong and consistent link between women's livelihood constraints and water availability.

Educational scholarship on gender-environment draws on foundational scholarship, such as that of Wangari Maathai, and water scarcity is placed in a broader context of environmental justice that is connected to gender inequality and social instability. This view highlights the fact that water scarcity has a profound impact on women's educational attainment, employment prospects, and overall health and well-being (Maathai, 2003).

This is despite the consensus, where intra-regional and socio-economic differences in women's experience with water scarcity have largely been ignored in the existing studies. Findings from countries like Bangladesh and Uganda validate the link between water stress and time poverty, but these studies rarely consider

translating water stress to long-term livelihood insecurity or the differential impact of water stress on livelihoods by socio-economic groups within the same locality (Baguma et al., 2013; Islam, 2020). Likewise, the study on gendered exclusion in water governance accentuates structural inequalities but fails to sufficiently explain the nature of the intensity of the exclusion due to the socio-economic status of the household and spatial differences (Awoniyi & Eboiyehi, 2022).

Evidence also suggests that investments in water infrastructure can help improve women's livelihood diversification and their health outcomes. For instance, research in Ghana, conducted by Abanyie et al. (2023), revealed that better access to water allows women to increase their economic activities and productivity. But these studies largely neglect distributional aspects, such as the benefits of a group of socio-economic and community contexts.

While Bukachi et al. (2021) showed how social capital is important in dealing with water insecurity in Kitui County, Kenya, they did not compare the difference in coping strategies across communities and socio-economic groups within the same area in Kenya. Likewise, although the connection between water scarcity and conflict is well established, the relationship between water scarcity and women's productive activities in the fields of agriculture, trade, and education has been poorly investigated (Koech et al., 2021).

Also, while the studies by Abebe et al. (2022) and Jeil et al. (2020) estimate the economic impact of time spent on water collection, they do not go so far as to consider the broader structural inequalities or long-term livelihood vulnerability. Similarly, gender responsive and participatory water governance is popular, yet there are institutional constraints that are reducing meaningful involvement of women in

water governance decisions (Oloruntoba & Akanbi, 2020; Owino & Were, 2023). Systematic reviews also show that, while issues around gender equity are present in water governance literature, they have not been critically examined regarding their translation into policy, specifically in the rural and informal context (De Guzman et al., 2023).

The literature clearly shows a high level of consensus that the availability of water is very central to women's livelihoods. Conceptually, however, it is still fragmented, failing to capture the socio-economic status, intra-regional, and livelihood-specific variability. This generates a demand for more synergic and intersectional perspectives that consider the interaction between water access and socio-economic systems and how these influence women's livelihoods in rural settings (Sy et al., 2022).

Quality of Water on the Livelihoods of Women

Water quality is an important but lesser discussed aspect of water security and has a strong impact on women's livelihoods. In addition to availability, water conditions and characteristics such as chemical, physical, and biological safety have a direct impact on household health and well-being, time use, and economic productivity, especially in situations where women are tasked with collecting water and managing household water.

The reality is that there is ample empirical evidence that poor water quality places a disproportionate burden on the unpaid care burden of women and restricts their livelihood. Similarly, Ogunbode et al. (2022) conclude that the poor water quality in Iwo, Nigeria, causes an increase in water-borne diseases, which in turn causes women to spend more time and money on health care, reducing their ability to

attend school and engage in income-generating activities. Likewise, the studies conducted by De Guzman et al. (2023) and Nagabhatla et al. (2020) both indicate that polluted drinking water exacerbates gender disparities, deepening women's role in unpaid care and limiting their economic opportunities.

The literature generally reveals that substandard water quality has a negative impact on women's productivity, health, and socio-economic mobility. Most studies, however, use aggregated analytical methods which obscure meaningful intra-regional and intra-community differences. Consequently, little consideration is paid to the variation in impacts of water contamination on socio-economic groups, water sources, and settlement types. For instance, there is a difference between accessing protected boreholes and shallow wells or surface water, but these differences are not captured in impact analysis (Ogunbode et al., 2022).

Studies on the regional level indicate high levels of disparities in water safety, especially in fluoride and heavy metal contamination in the Kenyan context (Njora & Yilmaz, 2021). These analyses tend to be conducted at a coarse spatial scale, however, and do not adequately consider the spatial distribution of contamination levels within counties or the potential for different levels of contamination to result in differential livelihood outcomes for women. This reduces the ability to have a nuanced understanding of the water quality exposure inequity within counties.

Studies that have used interventions also indicate that more effective water, sanitation, and hygiene (WASH) programmes can help to decrease disease incidence and increase women's time for productive activities (see Silali, 2024, from Transnzoia County, Kenya). In these scenarios, however, the impact of improved water quality is not fully accounted for in terms of distributive effects, especially within less-engaged

and marginalized communities, and thus concerns are raised on inequitable realization of benefits (Oloruntoba & Akanbi, 2020).

Existing reviews show that the relationship between water quality and women's health, education and economic productivity is very strong; however, there are three significant gaps in the literature: (i) inadequate consideration of intra-regional differences in water contamination, (ii) under-documented socio-economic differences in exposure and outcomes, and (iii) limited linkage between water quality improvements and differentiated livelihood outcomes at the local level. This presents an agenda for the need for more disaggregated and context-specific analyses to reflect the interactions of water quality with socio-economic factors to influence women's livelihood outcomes in rural areas (Sy et al., 2022).

Affordability of Water on the Livelihoods of Women

Water security is a complex issue that encompasses many aspects, one of which is water affordability, which often goes under-addressed and is a key determinant of women's livelihoods. It is consistently found in the literature that the economic activity of women is constrained by high water tariffs, unreliable water supply systems, and the expense of the water connection and treatment, because the household prioritizes basic needs over productive investments. In these settings, these financial constraints contribute to the exacerbation of poverty cycles and help to reinforce gender inequalities in access to resources (Beard & Mitlin, 2021; Hoque & Hope, 2020).

The empirical evidence coming from the Global South shows that the economic agency of women is directly affected by affordability constraints. In urban poor contexts, for instance, low-income women may ration water use to meet the

competing demands of the household and reduce their income-generating potential (Beard & Mitlin, 2021). Likewise, variable water tariffs and treatment fees in Bangladesh have been found to contribute to women's debt and informal working arrangements, which deepen household vulnerability (Hoque and Hope 2020). Water pollution raises the treatment price, necessitates the use of unsafe water sources, and has a negative impact on women's health and productivity, particularly in rural Burkina Faso (Dickin et al., 2021).

In all of these studies, there is a clear correlation found that water affordability is not only economic but also an indicator of women's livelihood stability and resilience. Most current work, however, uses general analytical tools that reduce women to a single category, failing to account for the differences in the affordability of women's livelihoods across geographical locations or by livelihood status. The contrast between rural, peri-urban, and informal city water environments, for example, and between different water pricing models in the same water resources is also often poorly explored (Beard & Mitlin, 2021; Omina et al., 2022; Franco et al., 2020).

This restriction is important, especially due to the diversity of women's livelihood strategies. Water affordability issues faced by smallholder farmers, petty traders, and informal sector workers are distinct from one another based on income sources, water needs, and household needs. Existing studies may overlook these livelihood-specific differences, which could lead to a misrepresentation of the impact of water costs on women's livelihoods.

At a general level, water affordability is acknowledged as a major constraint to women's livelihoods, but there is a lack of coherence in the analysis of the

literature, which tends to focus narrowly on the impact of water availability on women's lives, as well as on the differences between regional and intra-regional water access. This means that more disaggregated and context-specific research is needed that reflects the interplay between gender and space, as well as between resource inequalities and socio-economic conditions, and how they affect women's economic opportunities in rural and semi-arid contexts, in line with the general recognition that resource inequalities are gendered and spatially shaped (Maathai, 2003).

Accessibility Infrastructure Water

Functional water infrastructure is universally acknowledged as having a significant impact on the livelihood outcomes of women in Sub-Saharan Africa, through its influence on time allocation, physical burden, and economic participation. There is strong empirical evidence in countries like Ghana, Nigeria, Tanzania, and even Senegal that better water and sanitation facilities shorten travel and waiting time, freeing up more time for women to invest in income generation, education, and household work (Akurugu et al., 2021; Alao, 2021; Sesabo, 2024; Sy et al., 2022). In this sense, infrastructure is not just a means of service provision; it is also seen as an element that affects the health status, productivity, and economic empowerment of women.

More information reinforces the need for women to make compromises when there is not enough infrastructure. In countries with poor water systems, women bear the brunt of walking long distances for safe water and drinking from unsafe sources, which further aggravates their physical burden and health risks, as shown in studies (Aikowe & Mazancova, 2021). Furthermore, poor infrastructure has been associated with low productivity in agriculture and physical fatigue of women, especially those

in rural areas, whose livelihoods are intricately connected to the use of natural resources (Apatinga, 2024).

Considering these regular results, the literature is still quite limited in two significant ways. First, the majority of studies use macro-geographical or national data that masks the intricacies of access to water infrastructure at the micro-level (within counties and communities). Therefore, the level of access of settlement types, proximity of administrative centers, land tenure systems, and socio-spatial inequalities are not always adequately captured (Akurugu et al., 2021; Sy et al., 2022). In those cases where variations are recognised, including in recent studies in Kenya, little effort is made to systematically connect peri-urban, arid, and riverine contexts to the differential livelihood outcomes for women (Njora & Yilmaz, 2021).

Secondly, although many studies have found a positive link between improved water infrastructure and economic participation by women, they rarely address the specific types of livelihood activities affected by water infrastructure, nor the mechanisms by which water infrastructure impacts economic behavior. In certain settings, for instance, time saved in accessing water is related to increased agricultural productivity, but there is a lack of research on the impact of infrastructure on the nature, stability, and diversification of women's livelihood strategies (Alao, 2021).

The literature generally recognizes the role of water infrastructure in enhancing the livelihoods of women, but has limited analytical capacity when addressing the spatial variation and livelihood specificity. This means that it is important to conduct more disaggregated and context-specific studies to capture the

impact of intra-county variability in infrastructure access on women's livelihood pathways and economic empowerment outcomes in rural and semi-arid settings.

Moderating influence of household socioeconomic status

The socio-economic status (SES) of households is an important moderating factor between water security and women's livelihood outcomes. The impact of SES is seen through income, asset ownership, and education, and it also has implications for the water security that translates into improved livelihood opportunities for women. Therefore, the operation of SES is not an independent outcome but influences its strength and direction in the water–livelihood relationship.

Evidence suggests that higher-income households are more likely to be able to access better water services, to invest in water storage tanks and other infrastructure, and to lessen dependence on sources of water at considerable distances or which they consider unsafe. This alleviates the time pressure when collecting water and allows more women to participate in productive economic activities. However, low-income households may still have to fetch water from unsanitary sources or far distances, thus perpetuating time poverty, health hazards, and limited livelihood alternatives, which further entrench the cycle of poverty (Adams et al., 2023).

Likewise, a household's resilience to water insecurity is also affected by asset ownership. Households with productive assets were more likely to use water-saving technologies and be more efficient in their water use, all of which has an impact on improving the capacity of women to participate in income-generating activities. On the other hand, asset-poor households have greater opportunity costs, and they have less ability to cope with water scarcity shocks (Adams et al., 2023; Maganga et al., 2020).

The impact of water security on livelihood improvements is also influenced by education. Improved knowledge of safe water practices, increased engagement in water governance, and the capability to take advantage of water access for economic development are linked to higher levels of education among women. Conversely, women with lower levels of education are less likely to benefit from enhanced water access to create lasting livelihood gains (Martinez et al., 2021).

Overall, the literature indicates that SES influences the nexus between water security and women's livelihoods both in terms of access to water resources and the capacity of households to transform the availability of water into economic and social gains. Existing research, however, less frequently considers SES as a multifaceted variable in an integrated analytical framework that connects the dimensions of water security to women's livelihood outcomes. This limitation underscores the importance of the need to conduct more specific studies that explicitly test for the moderating effect of SES in the specific rural/semi-arid context of Kilome Sub-County, where socio-economic differences are likely to have a significant effect on livelihood outcomes.

Theoretical Framework

The theoretical framework represents the conceptual background on which the guiding theories of the study are based. It proposes the theoretical aspects that make the research problem a worthy study (Irawan et al., 2016). This paper is based on the Gender and Development Theory, Ecological Systems Theory (EST), and the Sustainable Livelihoods Framework (SLF).

Gender and Development Theory

The Gender and Development (GAD) Theory was developed in the 1970s and 1980s in response to the development policies that do not consider gender differences (Boserup, 1970; Rathgeber, 1990). GAD challenged the mainstream models, based on Ester Boserup's argument that mainstream policies on development were gender-blind and had negative consequences for gender equality, especially those that affect the structural inequalities experienced by women. (Development Alternatives with Women for a New Era [DAWN] 1985). However, while Women in Development (WID) called for the integration of women into existing developmental processes, GAD called for the restructuring of the gender system and the reform of the existing structural inequalities (Moser, 1989). In contrast to only economic development (Rathgeber, 1990), the development processes highlighted by the GAD include gender equity and empowerment of women. It also takes for granted that access to resources, power, and opportunities is tied to social and gender relations and that the institutions, policies, and cultural norms that underpin social and gender relations should be closely examined. GAD treats women not as recipients of aid but as active actors for change, and involves them directly in their own and in the development of their communities (Moser, 1989). GAD is also a great proponent of gender mainstreaming that attempts to instill gender perspectives in all levels of development planning and policy execution. The aspect of GAD is relevant, particularly regarding women's livelihoods in Kilome Sub-County in Makueni County and how access to drinking water affects them. In rural areas, women are usually the ones to carry out domestic and agricultural tasks, with the water security of the rural area playing a significant role in determining the productivity, health, and social status of rural communities (Boserup, 1970). This research will clarify the

effects of water infrastructure and its acceptability on the decision of women, the time spent, and economic participation. Further, it is used to explain the division of labour and cultural norms in the gendered disposition that seeks to explain access and control over water among women, which portrays barriers to gender responsiveness. Second, GAD theory gave an analytical framework to analyze the structure of water policies and projects, acknowledging the different needs of women and for them to continue their education, entrepreneurialism, and leadership (Moser, 1989). Gender sensitivity in water resources management is also in line with the overall development goal of gender equity, that is, water policies and infrastructures are designed in a way that considers the needs of women, apart from the goal of gender equality (DAWN, 1985).

Sustainable Livelihoods Framework (SLF)

SLF is a comprehensive strategy for poverty analysis and poverty alleviation, which originated in the UK Department for International Development (DFID) in the early 1990s (Chambers and Conway, 1992; DFID, 1999). It highlights the interactions of livelihoods and interactions between different types of capital- natural, social, human, physical, and financial and externalities like climate change, policy, and economic forces (Ellis, 2000). The framework takes into account the influence that vulnerability context has on people's dependence on a series of assets that promote their well-being in sequence. For example, natural capital refers to access to water and land; social capital refers to the relationships and networks available to access water and land; human capital refers to skills, education, and health; physical capital refers to infrastructure such as water systems and roads; and financial capital refers to income, savings, and credit (Chambers & Conway,1992).

The Sustainable Livelihoods Framework (SLF) will be used in a specific application since it will give a detailed framework for assessing the impact safe drinking water availability will have on the livelihoods of women in the Kilome Sub-County of Makueni County. One of the key factors that has an impact on the daily life, health, and economic productivity of women is potable water, which is a natural capital. The water quality impacts the human capital by changing the health outcomes, and decreasing the time needed to decrease the effects of water-borne diseases. The cost of water is strongly related to fiscal capital, because high water prices could constrain the ability of households to spend, and thereby their participation in the economy. Physical capital, the wells and pipelines, will directly reduce the time required to extract the water, and thus free up the time to be used for other productive activities. The research will then be used to explore how improved access to water can contribute to resilience to environmental and economic shocks, and how this can create better economic opportunities, healthier lives, and social empowerment for women. In addition, the asset-based strategy of SLF is supposed to inform the policies based on the utilisation of current community assets to direct the sustainable development interventions in water-stressed regions (e.g., Makueni County), according to Scoones (2015).

Ecological Systems Theory (EST)

The Ecological Systems Theory (EST) is a general theory of human development, formulated by Bronfenbrenner (2000), that can be explained as an interaction between various systems that impact human development. Est's perspective on embedded systems and their impact on human development is because it assumes that embedded systems, like the immediate microsystem, interact with each other and that all of these systems have an impact on human development, and

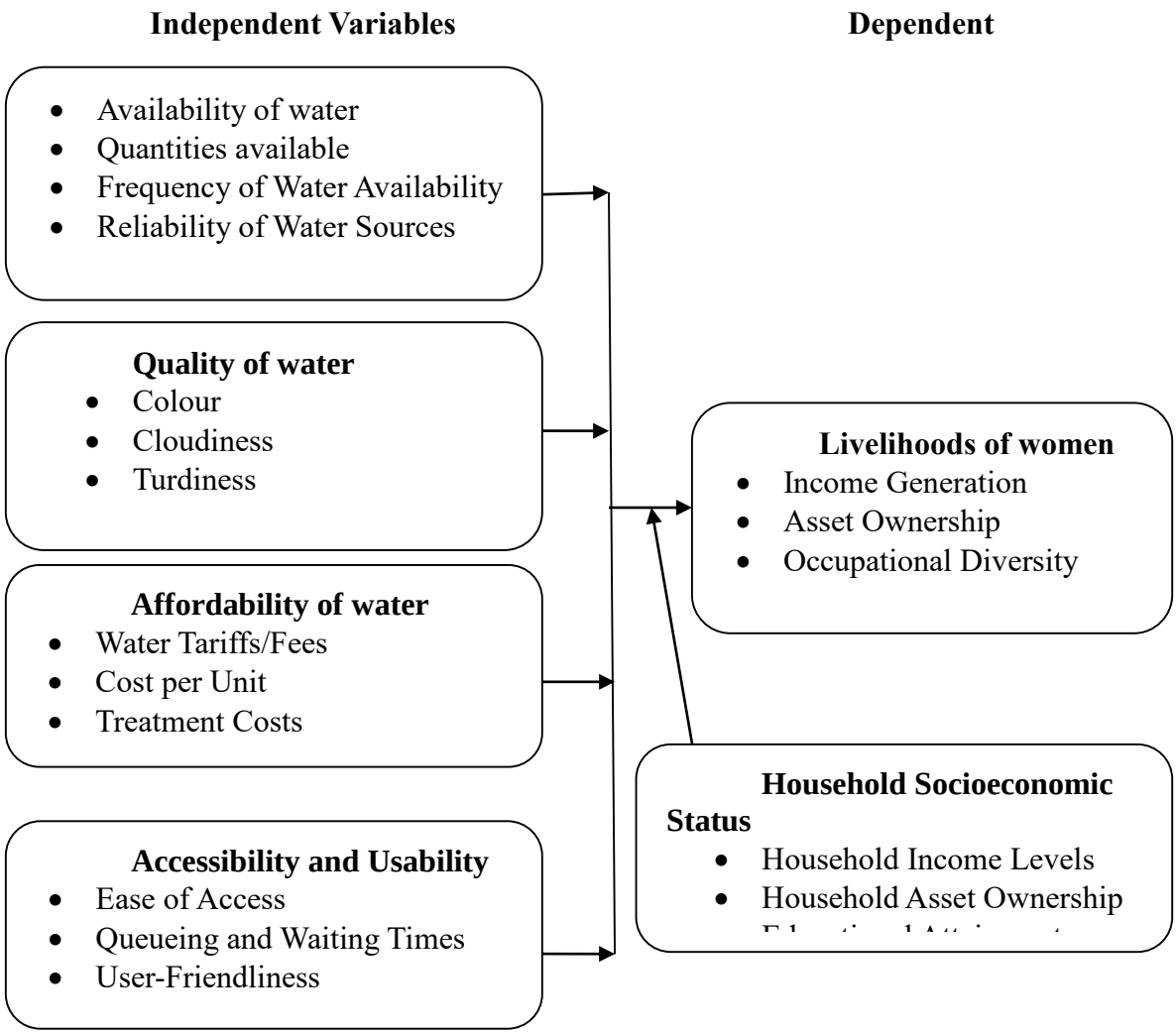
that the larger macrosystem has an impact on the microsystems. In recent literature, gendered access to resources, such as water, was used as the operationalisation of EST to explore how personal experiences are moderated by the structural, institutional, and environmental aspects (Christensen, 2020; Neal & Neal, 2021). This model will aid in understanding the impact of water availability, water quality, water cost, and water infrastructure on the livelihoods of women in Kilome Sub-County. EST focuses on co-constitutive agents' structure and system-structure relationships. Although the role of women in water collection is very deeply embedded in their domestic and community environment (microsystem), it also indirectly and directly affects the water role at the macro-level, e.g., county water policies and gender cultural values (macrosystem). Research on EST takes the domestic scale as an umbrella, covering differences in water supply and governance and infrastructure inequalities at the structural level (Kayser et al., 2019). Kilome also has differences in the effects of the different infrastructures on women across different wards in terms of their accessibility and affordability, a fact that is well explained in EST. EST is also consistent with GAD Theory that attributes gendered power relations to structural conditions. While GAD provides a way of thinking about socially produced inequalities as a tool to analyze them, EST provides the process of doing what? To follow the restrictions in environmental and economic policies (Mosse, 2019). For instance, poor water quality is related to Kilome, which is strongly associated with women since they are mainly responsible for caring for the sick or dead: EST relates these to water governance and inadequate infrastructure. The present research will use EST to analyze how water availability contributes to the health outcomes of women on various levels: household health outcomes (microsystem) and county policy and environmental factors (macrosystem). In this systems-based approach, the

study aims to determine the structural factors behind the inequalities in Kilome, as well as to unveil how the inequalities are embedded in the society (Shumba & Wekwete, 2022). In summary, the use of EST and GAD enhances the level of analysis of the study. Gendering of water insecurity is predicted in GAD, and structural and ecological systems reproducing inequality are analysed in EST. Together, these frameworks enable the study to delve deeper into the issue of water scarcity than merely a water scarcity definition, and to look at the system constriction of gender equity and sustainable livelihoods in the Kilome Sub-County.

Conceptual Framework

A conceptual framework is a diagrammatic or written visualization of the interconnections of the constructs considered to be critical in a research study (Creswell, 2009). The graph illustrates the fact that the level of manipulation of the independent variables is likely to affect the dependent variable.

Figure 1 Conceptual Framework



Source: Elias Mwangi (2025)

Conceptual Framework

The conceptual model for this study involves a relationship between water security and women's livelihood outcomes, and a moderating variable of household socio-economic status (SES). Water security is defined as a multi-faceted concept of availability, accessibility, affordability, and quality of potable water. These dimensions are all linked to women's livelihood outcomes through their impact on time use, health status, and participation in income-generating activities.

Better water security will help improve the livelihoods of women by saving time spent on water collection, alleviating health-related costs from exposure to unsafe water, and expanding opportunities to be more economically engaged (Abebe et al., 2022; Bolaane & Chanda, 2022). Water security is an independent variable, and women's livelihood outcomes are the dependent variable in this relationship.

Household socio-economic status (SES) is a moderating factor in the relationship between water security and women's livelihood outcomes. Unlike other constraints, household SES determines the extent to which households can buffer water-related constraints, as reflected in income, asset ownership, and education. For instance, households with higher levels of SES can invest in their own water supplies, storage solutions, and/or purchase water, which helps to minimize the adverse effects of poor water security on women's time and productivity (Hoque & Hope, 2020; Omina et al., 2022).

By contrast, households with low SES are at risk of being water insecure because they rely on unsafe water sources and water from long distances, which increases their time poverty and reduces livelihood opportunities for women. In these

ways, SES is not standalone, but rather adapts the water security-livelihood outcomes nexus (Shah et al., 2023; De Guzman et al., 2023).

Hence, the framework suggests a moderated relationship between water security and women's livelihoods, where the strength of the relationship is reinforced or weakened by the household SES, according to socio-economic conditions. This framework enables intra-county inequities in water access and livelihood impacts to be analysed among women in Kilome Sub-County.

Research Gap

Despite the large volume of literature on water access and women's livelihoods, four gaps are identified that warrant the current study: contextual gap, conceptual gap, methodological gap, and analytical gap.

Contextual gap. Arid and semi-arid lands (ASALs) are less well studied than the realities of women in large urban centres, humid HPA (high potential agricultural) areas, or monitoring data at the national level. Despite being a semi-arid place with unpredictable rainfall, frequent droughts, long distances to water points, and women playing the major role in water provision, Kilome Sub-County in Makueni County has not yet been targeted for a specific study on water security from the women's perspective. Kilome, therefore, contributes to a very real geographical and contextual need and provides evidence for the numerous likelihoods of ASAL communities in Kenya and the region.

Conceptual gap. Previous studies often only consider water security in one way, most commonly in terms of distance from a water source, and equate water security with water access. This conceals the reality that a household can have a suitable source of water that is not accessible, of low quality, or too costly. This paper

presents a concept of water security as a multi-dimensional entity that includes dimensions of availability, accessibility, quality, and affordability, and investigates the four dimensions at the same time in one analytical model. By disaggregating water security beyond access to water, the study reveals which dimensions are most important for women's livelihoods, and addresses a conceptual gap in its measurement.

Methodological gap. Much earlier research is based on quantitative surveys that establish statistical connections, but not structural and cultural mechanisms that account for such connections, or on small-scale qualitative studies that are both deep and difficult to generalise. None of these approaches can quantify the water security–livelihood relationship and account for its operation in a particular cultural and institutional context at the same time. The research design used in this study is an explanatory sequential mixed methodology, which consists of two stages, namely survey data collection and analysis of a household survey using a sample of 375 women and Key Informant Interviews that are used as a means of interpreting and contextualizing the results of the survey. The use of mixed methods is not a mere option, but a reasoned response to a methodological gap, as the use of one method without the other will lead to a weaker understanding than the use of both.

Analytical gap. Finally, when socio-economic status (SES) has been included as a factor, it has usually been treated as an independent factor influencing livelihoods and not as a factor buffering the water security–livelihoods link. The analysis of SES as a single main effect alone does not provide information on the difference between better and worse water security from a livelihood perspective. The purpose of this study is to introduce a novel framework of interaction between the two variables (water security and SES) in a hierarchical regression model that allows

for analysis of the manner in which structural inequality influences the linkage between water access and women's economic empowerment.

The study proposes and tests an integrated framework that looks at the multidimensional nature of water security, women's livelihoods, and the moderating effect of the socio-economic status of the household in the local context of Kilome Sub-County.

Chapter Summary

The author provides a critical, in-depth review of the empirical, theoretical, and conceptual literature in this chapter. The review has looked into available information on the availability of potable water and its effects on the livelihoods, and how availability or lack of potable water allowed certain groups of people to access potable water, particularly women, and the effects this had on their ability to participate in economic and social activities. The following chapter is concerned with the methodology used in this study.

CHAPTER THREE: RESEARCH METHODOLOGY

Introduction

The chapter outlines the methodology that was used in the current research study, which includes the research design, the study location, the target population, the sample size, and the sampling methods used. It also elaborates on the nature of the data, the data-collection tools used, the data-collection methods, and the validity and reliability of data-collection tools. The chapter also records the pilot testing process, analytical methods, and ethical factors that direct the implementation of the study.

Research Design

The study used a mixed-methodology and adopted a **s**equential research design. The **s**equential research design is used where data are collected and analyzed in two or more consecutive phases**.** The results from one phase inform the next phase. According to Creswell and Plano (2018), the sequential design is used in a mixed research method where a researcher collects and analyzes one type of data first, followed by another type of data to elaborate or explain the initial findings. Firstly, the quantitative survey was conducted to determine the reliance of the women on the quantity, quality, affordability, and infrastructure of water in their livelihoods. Later, a qualitative stage was aimed at contextualizing and elaborating the quantitative results by using the experiences of women. The ensuing report brings together the generality of quantitative data with the richness of qualitative stories, thus making the relationship between gender equity, access to water, and social protection easier to understand.

Target Population

Table 1 Target Population

Ward	Population
Kiima-Kiu	2,551
Mukaa	1,560
Kasiekeu	1,828
Total	**5,939**

Sample Size and Sampling Technique

The study used a multi-stage sampling method to ensure participants were representative of all the respondents at Kilome Sub-County. The target population in this study consisted of 5,939 women in the three wards of Kiima-Kiu, Mukaa, and Kasikeu.

Kilome Sub-County was purposively selected at the first stage as it was found to have problems in accessing water, and also because of its relevance to the study objectives. At the second stage, the three wards were added so as to cover the study area geographically.

The sampling method used at the household level was Systematic Random Sampling. A sampling frame of households was obtained from local administrative records. The sampling interval (k) was calculated for each ward by dividing the total number of households in each ward by the number of households allocated to the ward. All k/10 households were selected, and one woman responsible for collecting water and managing household water was selected randomly in each selected household as the household respondent.

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

Where: N = Population size

n = sample size

e = Margin error of the study set at ±5%

The sample size will be

$$n = 5{,}939 / (1 + 5{,}939 * 0.05^2)$$

$$n \approx 375$$

By employing this formula, a sample size of 375 respondents was achieved, which is about 6.31% of the total target population. This sample size was deemed sufficient for statistical analysis and generalization with a 95% level of confidence and a margin of error of 5%.

A qualitative sample of 10 Key Informants (KIs) was purposefully selected from various water sector and community groups to include local administration personnel, community leaders, water sector stakeholders, and NGO staff working with water and community development programs. The information given by these informants was used to supplement quantitative data collected in the household survey.

Table 2 Sample Distribution

Ward	Population	Sample Size
Kiima-Kiu	2,551	161
Mukaa	1,560	99
Kasiekeu	1,828	115
Total	**5,939**	**375**

Instrumentation

A structured questionnaire and Key Informant Interview (KII) guide were used to gather data. The questionnaire was structured into six thematic sections instead of as questions. These sections included: demographic characteristics, access and availability of potable water, water quality, water affordability, water accessibility and infrastructure, household socio-economic status (SES), and women's livelihood outcomes.

Multiple items were used on each construct to establish a structured way to record respondents' experiences and perceptions. For the purpose of studying the moderation of the water security–women's livelihoods relationship, SES indicators (income level, asset ownership, and education level) were also included.

A structured questionnaire was chosen because of its ability to collect standardized quantitative data from a large sample, cost-effective and its appropriateness for statistical analysis. The Key Informant Interview (KII) guide was used to supplement the survey and gain qualitative information from those involved in the governance of water and in community development.

Ten Key Informants were purposively selected for in-depth contextual information. These included:

I. Two representatives from water management authorities

II. Two community development and/or faith-based organization officers

III. Two health/community promotion officers

IV. Two local administration officials (chiefs and assistant chiefs)

V. Two opinion leaders from the community

The KIIs were aimed at contextual issues related to water availability, water quality, costs, access, socio-economic differences, and impact on women's livelihoods.

The participants were anonymous, with their identities being identified by their institutional roles. Data from the quantitative survey were triangulated with data collected through the qualitative interviews, thus deepening the understanding of the water security and livelihood outcomes of women.

Table 3 Cronbach's Alpha Reliability Results from the Pilot Study

Construct	Number of Items	Cronbach's Alpha (α)	Decision
Water Availability	4	0.781	Acceptable
Water Quality	4	0.739	Acceptable
Water Affordability	3	0.769	Acceptable
Water Accessibility	3	0.779	Acceptable
Women's Livelihoods	3	0.791	Acceptable
Overall Instrument	**17**	**0.772**	**Reliable**

Data Collection

Two tools were used to carry out the research: a questionnaire and ten KIIs. The research assistants trained on face-to-face application of the questionnaire administered the same to the women in the three wards of Kilome Sub-County,

making clarifications on the issues as they went. The respondents were informed of the study before it was carried out. The households were representative as choices of wards were made systematically. The questionnaires were checked every day to make sure that they were filled out and in uniform, and were stored securely pending analysis. The KIIs were semi-structured interviews of purposely chosen local government officials, non-governmental organisations, and community leaders. The interviews were conducted in a confidential manner and with consent, and were documented with notes. The debate focused on structural, cultural, and policy aspects of potable water access and living conditions of women that were established in the household surveys but not covered by the survey. The data collected were in the form of questionnaires, which were quantitative data, while the data collected in the form of KIIs were qualitative data, which were then triangulated for a complete picture of the study. These methods in combination gave a more nuanced understanding of the impact of water availability on women's livelihoods in Kilome Sub-county.

Pilot study

To narrow down on the research instruments, thirty-eight women in Kaiti Sub-county, Makueni County, took part in a pilot study before the real data collection began. The resemblance of Kaiti to Kilome Sub-County was chosen especially since it is a semi- arid area where women are involved in water procurement. The pre-test helped in identifying and correcting differences in the questionnaire, thus guaranteeing the capture of constructs on water availability, quality, affordability, access, and livelihoods of women. The pre-test, therefore, provided feedback that was used to improve the content and increase its validity. Also, in order to determine the reliability of the tools, Cronbach's alpha was used. The products that failed to

demonstrate satisfactory reliability were updated or dropped in order to maintain internal consistency of the tool.

Validity

Validity refers to the degree of accuracy with which instruments can measure constructs that they were designed to measure. The construct and content validity were covered in the study. Construct validity was achieved by matching the questions in the questionnaires with the theoretical framework and the research objectives of the study. The content validity was achieved by ensuring that the items fully captured the key aspects of water availability, quality, affordability, accessibility, and livelihoods of women. The research supervisor, the water resources management professionals, and community development and social research methods were consulted to estimate the clarity, relevance, and suitability of the questionnaire. They gave feedback on the revisions, which improved the wording, eliminated ambiguities, and ensured proper coverage of the study constructs. Face validity was also tested by administering a questionnaire to a small group of female respondents having demographic characteristics similar to the target group. Again, the pilot study was conducted in a community whose socio-economic background was comparable to Kilome Sub-County, thus helping to identify the unclear items and constructs that were not included. The feedback received from the pilot study was utilized to further improve the instrument to make it even more relevant in the context and to make it more valid.

Data Analysis

Data analysis refers to the systematic process of data cleaning, coding, data classification, and data interpretation to discover patterns, relationships, and trends

that are related to the study's goals. The field collected quantitative data were coded and analyzed by using the Statistical Package for Social Sciences (SPSS Version 30.0).

The characteristics of the respondents and the key study variables in this study were summarized using descriptive statistics such as frequencies, percentages, means, and standard deviations. These included a brief overview of dimensions of water security (availability, water quality, affordability, and women's accessibility), socio-economic status (SES) of the household, and women's livelihood outcomes.

Inferential statistical methods were used to explore the associations between the study variables. In particular, correlation analysis was conducted to evaluate the strength and direction of the relationships, while hierarchical multiple regression analysis was performed to examine the impact of the water security dimensions on the women's livelihood outcomes and the moderating effect played by the household socio-economic status (SES).

To conduct the regression analysis, three steps were taken:

The direct impact of the water security variables (availability, quality, affordability, and accessibility) on women's livelihood outcomes was estimated in the model

Household socio-economic status (SES) and the demographic control variables (age and education level) were added to the model in Model 2 to determine the direct effect of the independent variables. The SES construct was operationalised by education level and asset/income holdings in line with the definition used in this study.

The moderating effect of SES was tested by including four interaction terms (SES × Water Availability, SES × Water Quality, SES × Water Affordability, and SES × Water Accessibility) in Model 3. To reduce non-essential multicollinearity (Aiken & West, 1991), all continuous variables were mean-centred before calculating the interaction terms. An increase in R^2 ($\Delta R2$) and a significant interaction coefficient were considered as indicators of moderation.

The final model was the general regression model:

$$\mathbf{Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5(Age) + \beta_6(Education) + \beta_7 SES + \beta_8(X_1 \times SES) + \beta_9(X_2 \times SES) + \beta_{10}(X_3 \times SES) + \beta_{11}(X_4 \times SES) + \varepsilon}$$

Where:

Y = Women's livelihood outcomes

X_1 = Water availability

X_2 = Water quality

X_3 = Water affordability

X_4 = Water accessibility

SES = Household socio-economic status

β_0 = Constant term

Age, Education = demographic control variables

β_1–β_{11} = Regression coefficients

ε = Error term

A significant interaction term was interpreted as evidence of a moderating effect of SES.

Qualitative data from Key Informant Interviews (KIIs) were analyzed using thematic analysis following Braun and Clarke (2021). Audio recordings were

transcribed verbatim, coded, and organized into themes aligned with the study objectives: water availability, quality, affordability, accessibility, SES differences, and women's livelihood outcomes.

Codes were grouped into categories and refined into themes and sub-themes that reflected recurring patterns in the data. To enhance credibility and trustworthiness, peer debriefing and triangulation with quantitative findings were applied (Nowell et al., 2017). Findings were presented narratively and supported with anonymized direct quotations from participants.

Ethical Consideration

The researcher made conscious efforts to make sure that the principles of research ethics were observed closely during the entire process of developing the study, collecting data, and reporting the study. The research proposal was first submitted to the Pan-African Christian University Graduate School to be reviewed. Subsequently, the ethical clearance of the research was granted by the Pan Africa Christian University Institutional Scientific Ethics Review Committee (PAC-ISERC), and the researcher himself sought and received research permission from the National Commission of Science, Technology and Innovation (NACOSTI) to validate that the research complied with appropriate national research ethics.

To ensure that all participants understood the purpose, procedures, risks, and benefits of the study, the researcher himself informed them of these before the data collection process. The rights of participants, such as confidentiality, voluntary participation, and the right to withdraw without any repercussions, were explained by a consent form, and the agreement to fill out the complete questionnaires or participate in interviews was registered on paper.

Anonymity was upheld by assigning each participant a distinct code rather than his or her name in order to ensure that no specific individual could be identified. Any data or information was kept on password-secured machines that could only be accessed by the researcher and used only academically, eliminating any third-party access.

The researcher also identified the significance of reflexivity and positionality in gender-based research. As a male researcher in women's issues, the researcher was aware of the possible power relations and chose to hire a local female research assistant to help in data collection, establish rapport, and make participants more comfortable and culturally aware. The researcher remained neutral in tone in questionnaires and contacts during the research, taking specific care to avoid making assumptions or using language that would strengthen stereotypes or cause bias.

The researcher met high standards of research integrity and observed the rights and dignity of all the participants by actively pursuing ethical approvals, obtaining informed consent, protecting participant anonymity, securing data, and considering the positionality.

Chapter Summary

The research methodology covered in this chapter was used to observe the effect of potable water on the livelihood of women in Kilome Sub-County, Makueni County, Kenya. The research design was a mixed-method design with a quantitative survey to establish the availability of water, water quality, affordability, accessibility, and water infrastructure, and qualitative Key Informant Interviews (KIIs) to provide context and explanations for the Quantitative Survey.

A sample population of 5,939 women in the three wards (Kiima-Kiu, Mukaa, and Kasikeu) was identified, and a sample population of 375 women was computed using the Yamane formula. Furthermore, 10 key informants were carefully selected and interviewed, such as women living in the community, politicians, and NGO representatives, who provided in-depth information about the issue of water management and women's livelihoods.

The Data collection instruments used were structured questionnaires and semi-structured KII guides, which were tested in Kaiti sub-county for validity and reliability. Construct and content validity were achieved through expert review and pre-testing, and reliability was achieved through Cronbachâs Alpha, split-half reliability, and item-total correlation analyses, and aligned with the study goals.

Data gathering was done systematically and ethically, through informed consent, anonymity, and confidentiality. The role of reflexivity and positionality was also included in the research process, with the implementation of local female research assistants, to minimize the gendered power dynamics in data collection.

The quantitative data were analyzed using descriptive statistics, correlation, and regression analysis with the assistance of SPSS Version 30, while the qualitative data were analyzed using thematic analysis to present the pattern, themes, and sub-themes. When these two types of information were used in conjunction, the validity and depth of the conclusion were reinforced.

Overall, the chapter provided a comprehensive, ethical, and systematic approach to the study of the link between water accessibility and women's livelihoods that will provide a solid foundation for the presentation and discussion of findings in the subsequent chapters.

CHAPTER 4: RESULTS AND DISCUSSION

Introduction

The chapter summarizes the findings of this study on the relationship between the livelihoods of women in Kilome Sub-County, Makueni County, and equitable access to potable water and household socio-economic status. Analysis is presented for descriptive statistics, construct reliability analyses, regression results, and variations at the ward level. The results are discussed in the light of the research objectives.

Descriptive Statistics

Demographic Information

Table 4 Demographic Characteristics of Participants by Sub-County

Demographic Variable	Category	Overall (n = 375)	Kasiekeu (n = 145)	Kiima-Kiu (n = 115)	Mukaa (n = 115)
Age (years)	Less than 25	23 (6.1%)	6 (4.1%)	10 (8.7%)	7 (6.1%)
	26–35	142 (37.9%)	35 (24.1%)	60 (52.2%)	47 (40.9%)
	36–45	141 (37.6%)	47 (32.4%)	61 (53.0%)	33 (28.7%)
	Above 45	69 (18.4%)	27 (18.6%)	30 (26.1%)	12 (10.4%)
	Mean (SD)	36.4 (8.7)	37.1 (9.1)	36.0 (8.3)	35.5 (8.4)
Education Level	Certificate	106 (28.3%)	26 (17.9%)	50 (43.5%)	30 (26.1%)
	Diploma	27 (7.2%)	15 (10.3%)	7 (6.1%)	5 (4.3%)
	Graduate/Degree	23 (6.1%)	7 (4.8%)	8 (7.0%)	8 (7.0%)
	Others (specify)	219 (58.4%)	67 (46.2%)	96 (83.5%)	56 (48.7%)
	Mean (SD)	2.1 (0.9)	2.0 (0.8)	2.3 (0.7)	2.1 (0.9)
Residency (years)	Less than 1	4 (1.1%)	4 (2.8%)	0 (0.0%)	0 (0.0%)
	1–5	15 (4.0%)	2 (1.4%)	5 (4.3%)	8 (7.0%)
	6–10	23 (6.1%)	6 (4.1%)	7 (6.1%)	10 (8.7%)
	Over 10	333 (88.8%)	103 (71.0%)	103 (89.6%)	127 (73.9%)
	Mean (SD)	3.8 (0.6)	3.6 (0.7)	3.9 (0.5)	3.7 (0.7)
Income Source	Employed	82 (21.9%)	23 (15.9%)	30 (26.1%)	29 (25.2%)
	Farmer	170 (45.3%)	42 (29.0%)	83 (72.2%)	45 (39.1%)
	Housewife	71 (18.9%)	25 (17.2%)	34 (29.6%)	12 (10.4%)
	Self-employed	52 (13.9%)	25 (17.2%)	14 (12.2%)	13 (11.3%)
	Mean (SD)	2.3 (1.0)	2.3 (1.0)	2.5 (0.9)	2.1 (1.0)

The overall and ward level demography was analysed for the study sample (N = 375) to allow for spatial variation as reflected in Table 4.

The overall general characteristics of the sample were that the majority had reached the economically active age, 75.5% of the respondents were between 26 and 45 years old. In particular, the <25 year age group (6.1%) and the >45 age group (18.4%) were under-represented, while the 26-35 age group (37.9%) and 36-45 age group (37.6%) were over-represented (Table 4.1). This result may be explained by the fact that the study population may have included a large proportion of the productive age group who may have been economically active, which is in line with the previous studies conducted in Sub-Saharan Africa (SSA) that showed that the productive age group is the major segment of the rural population (Abebe, Worku and Tsegaye, 2022; Bukachi et al., 2021). The ward which had the highest age distribution of respondents in 26-35 years was Kiima-Kiu (52.2%), with Kasiekeu having a relatively old age distribution (53% above 45 years). The age distribution was median in Mukaa. Table 4.1 indicates that the average age of all the respondents was 36.4 years, with a standard deviation of 8.7, which means there was high homogeneity of age structure of the sub-county.

There were differences in educational qualifications, with the majority (58.4%) stating that they had achieved “Other-specify” and 28.3% stating they had a certificate level. There was underrepresentation at undergraduate/degree and diploma with 7.2 and 6.1, respectively (Table 4.1). The percentage of the category of “Other specify” was higher in Kiima-Kiu (83.5%), and certificate level education (43.5%) was more even in Kasiekeu and Mukaa. The results are consistent with previous studies that have found a diversity of education levels in rural areas and their implications on access and utilization of water resources (Abanyie et al., 2023;

Aikowe & Mazancová, 2021). There was a moderate range of formal education, with a mean of 2.1 (SD = 0.9) for the average education code.

The respondents were also predominantly long-term residents (over 10 years), and it was a fairly stable community with some experience of local water systems. There was a difference in ward level, which suggested that there were more long-term residents in the ward Kiima-Kiu (89.6%) than in ward Mukaa (81) and ward Kasiekeu (71). The stability can aid the idea of CBWM as promoted by Bukachi et al. (2021) and Akurugu et al. (2021), who stated that the duration of residence has a positive effect on strengthening local knowledge and practices on water use in the long-term. The average code of residence of the sampled population was 3.8 (SD = 0.6), which confirmed the respondents were regular residents.

There was a high level of farmers, with 45.3 percent of the respondents working in agriculture compared to 21.9 percent in the formal sector, 18.9 percent as housewives, and 13.9 percent in self-employment. The highest number of farmers was in Kiima-Kiu (72.2%), and the highest occupational diversity was in Kasiekeu and Mukaa. This observation is in line with literature indicating a continuation of agriculture as one of the dominant livelihoods in rural Kenya, particularly in areas that could support agricultural activities in the face of water availability (Wekesa et al., 2021; Alao, 2021). The mean income code was 2.3 (SD = 1.0), and the code was developed based on English, which is associated with economic differences and agricultural means of livelihood between wards.

Demographic analysis indicates that the majority of the population is middle-aged, living in the area for a long time, with diverse educational levels, and are heavily relying on agriculture as their main means of livelihood. Variations that are

seen between wards with respect to age, education, place of residence, and occupation reflect spatial variation and should be taken into account when evaluating water security and livelihoods in the future. The results correspond with the Sustainable Livelihoods framework, which focuses on how the assets of households and communities affect vulnerability and adaptive capacity (Chambers & Conway, 1992; Scoones, 1998)

Mean Construct Scores

Overall scores and standard deviations for each of the key constructs measured in the study are reported, as well as the differences in perceptions between the wards. The constructs were evaluated with Likert Scale items (1-5) that were higher in the positive scale.

Table 5 Mean Scores, Standard Deviations, and Ward-Level Distribution

Construct Group	Sub-Construct	Overall Mean (SD)	Kasiekeu Mean (SD)	Kiima-Kiu Mean (SD)	Mukaa Mean (SD)
Accessibility	Ease of Access	2.32 (0.69)	2.29 (0.71)	2.40 (0.66)	2.27 (0.70)
	Queueing	2.44 (0.69)	2.38 (0.70)	2.52 (0.67)	2.42 (0.69)
	User-Friendliness	2.46 (0.71)	2.44 (0.73)	2.51 (0.68)	2.43 (0.70)
	Overall Accessibility	2.46 (0.48)	2.44 (0.50)	2.52 (0.45)	2.41 (0.49)
Affordability	Cost per Unit	2.46 (0.68)	2.42 (0.69)	2.50 (0.66)	2.45 (0.68)
	Tariffs/Fees	2.25 (0.61)	2.18 (0.63)	2.32 (0.58)	2.24 (0.61)
	Treatment Costs	2.43 (0.61)	2.39 (0.63)	2.48 (0.59)	2.42 (0.61)
	Overall Affordability	2.78 (0.43)	2.70 (0.45)	2.85 (0.41)	2.79 (0.44)
Availability	Frequency	1.55 (0.71)	1.51 (0.70)	1.61 (0.68)	1.53 (0.74)
	Quantity	2.09 (0.63)	2.06 (0.62)	2.14 (0.61)	2.08 (0.65)
	Reliability	2.07 (0.68)	2.05 (0.66)	2.12 (0.65)	2.03 (0.70)
	Overall Availability	2.14 (0.50)	2.10 (0.49)	2.31 (0.47)	2.01 (0.52)
Livelihoods	Income	4.23 (0.63)	4.18 (0.65)	4.28 (0.59)	4.16 (0.65)
	Asset Ownership	4.20 (0.66)	4.15 (0.68)	4.25 (0.63)	4.17 (0.67)
	Occupational Diversity	4.21 (0.62)	4.16 (0.64)	4.28 (0.60)	4.18 (0.63)

	Overall Livelihoods	4.21 (0.62)	4.19 (0.63)	4.28 (0.59)	4.16 (0.65)
SES	Asset Ownership	4.17 (0.79)	4.13 (0.81)	4.23 (0.76)	4.12 (0.82)
	Education	1.61 (0.87)	1.60 (0.89)	1.63 (0.85)	1.60 (0.88)

The perceptions of water accessibility were moderate with an average of 2.46 (SD = 0.48) as indicated in Table 5. The same pattern was observed with sub-constructs: ease of access (M = 2.32, SD = 0.69), queueing (M = 2.44, SD = 0.69), and user-friendliness (M = 2.46, SD = 0.71). Kiima-Kiu was highest on overall accessibility (M = 2.52, SD = 0.45), then Kasiekeu (M = 2.44, SD = 0.50) and Mukaa (M = 2.41, SD = 0.49). This suggests that in Kiima-Kiu, the water points were more convenient and easier to use, while in Kasiekeu, water points were not a cause of inconvenience and were easier to use. The disparities can be explained by the variation in local infrastructure and fittings of water points, consistent with the findings of rural areas in Sub-Saharan Africa, where accessibility and distance to sources and availability of water are important factors affecting household time allocation and lifestyles (Abebe et al., 2022; Apatinga, 2024; Bukachi et al., 2021).

The rating of water affordability was average with a composite mean of 2.78 (SD = 0.43). Particular sub-constructs comprised cost per unit (M = 2.46, SD = 0.68), tariffs/fees (M = 2.25, SD = 0.61), and treatment costs (M = 2.43, SD = 0.61), which is shown in Table 5. The respondents from Kiima-Kiu had a higher perception of the affordability of the drugs compared to the respondents from Mukaa (M = 2.79, SD = 0.44) and Kasiekeu (M = 2.70, SD = 0.45) as revealed by the ward level comparison. The requirement to pay tariffs was a constant problem in all wards, while costs per unit and costs per treatment were relatively straightforward in Kiima-Kiu. The findings are consistent with existing literature emphasizing the role of affordability as

a factor affecting access to water among rural women and farm households (Bolaane & Chanda, 2022; Haque & Hope, 2020; Shah et al., 2023).

Water availability had the lowest scores with an average score of 2.14 (SD = 0.50) across all constructs. Sub-constructs were frequency of supply (M = 1.55, SD = 0.71), quantity (M = 2.09, SD = 0.63), and reliability (M = 2.07, SD = 0.68), where summaries are in Table 5. However, ward-level assessment indicated that the availability was relatively higher among the Kiima-Kiu (M = 2.31, SD = 0.47), while the Kasiekeu had the second highest (M = 2.10, SD = 0.49), and the third highest was for Mukaa (M = 2.01, SD = 0.52). These findings underscore the ongoing issues of ensuring water supply on a regular basis, which is disproportionately experienced in Mukaa among households. The past studies suggest that the inconsistent provision of water can have harmful effects on the household's livelihoods, and can create vulnerability among rural populations, especially with respect to time allocation for women (Abebe et al., 2022; Bukachi et al., 2021; Jeil et al., 2020).

There were high scores on overall livelihood, indicating positive impacts of water access. The joy of income (M = 4.23, SD = 0.63), ownership of assets (M = 4.20, SD = 0.66), and occupational diversity (M = 4.21, SD = 0.62) resulted in a total livelihood score of 4.21 (SD = 0.62) as shown in Table 5. The same pattern was observed at the ward levels: Kiima-Kiu has the highest mean score of ward livelihood (M = 4.28, SD = 0.59), followed by Kasiekeu (M = 4.19, SD = 0.63) and Mukaa (M = 4.16, SD = 0.65). Likewise, in Kiima-Kiu, SES ownership of assets was greatest (M = 4.23, SD = 0.76) and in Mukaa least (M = 4.12, SD = 0.82). These findings are consistent with previous studies, which found that access to water positively influences household income, asset accumulation, and livelihood diversification,

especially for rural women (Abanyie et al., 2023; Akurugu et al., 2021; Owino & Were, 2023).

Across wards, educational attainment was low (mean of 1.61 (SD: 0.87) with inequalities in formal education persisting. This trend reflects the linkage between education and livelihoods based on water resources, as earlier studies showed that people with lower levels of education are less able to adapt to climate change and have limited access to water management knowledge (Bukachi et al., 2021; Kayser et al., 2019).

To summarise, the construct scores indicate moderate perceptions of water access and affordability, and low availability and generally positive livelihood outcomes. This is because the variations at the ward level highlight the need for spatial variability in planning interventions to improve water security and rural livelihoods. The results are in line with sustainable livelihood models, which focus on the multidimensionality of the interaction of the physical, social, and economic resources in shaping the welfare of a household (Scoones, 1998; Chambers & Conway, 1992).

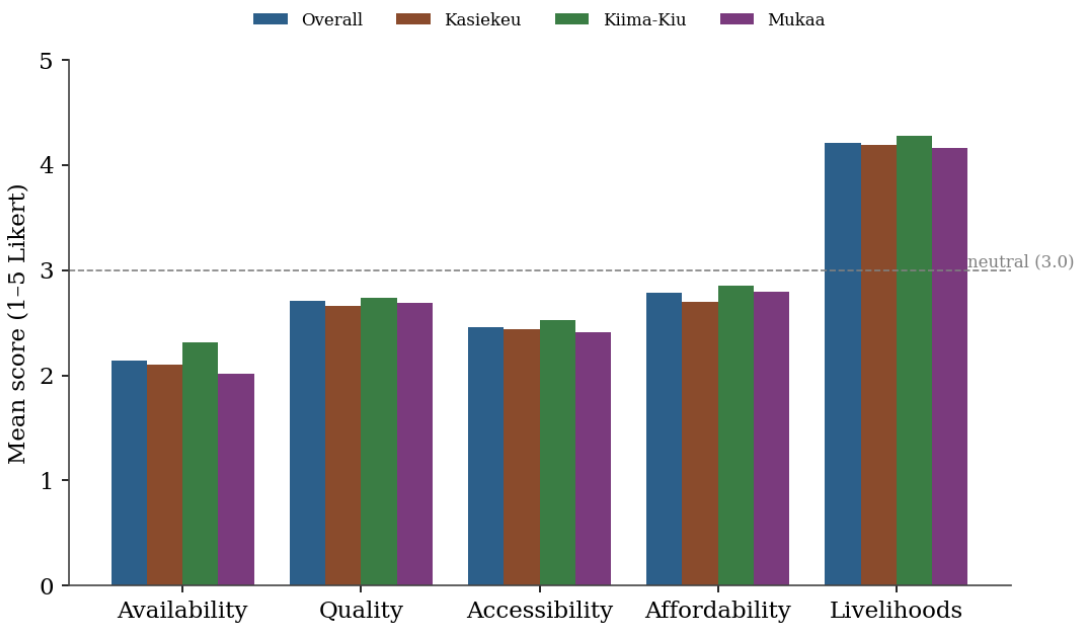


Figure 1 Mean perceptions of water-security dimensions and livelihoods, by ward.

All four water-security dimensions fall below the neutral mid-point, while livelihoods sit near the scale ceiling. The near-parallel ward profiles indicate a shared, sub-county-wide water deficit rather than localised scarcity. The visual gap between the water bars and the livelihood bar is the study's central empirical puzzle.

Reliability Analysis

Cronbach's alpha was used to test the internal consistency of the constructs that were used in the study to determine the level of inter-relationship among the items within a given construct. The coefficients are normally considered to be acceptable, meaning that the relationship is good, and the coefficients of 0.70 and above have been considered good reliability, whereas coefficients close to 1.0 have been deemed as excellent consistency.

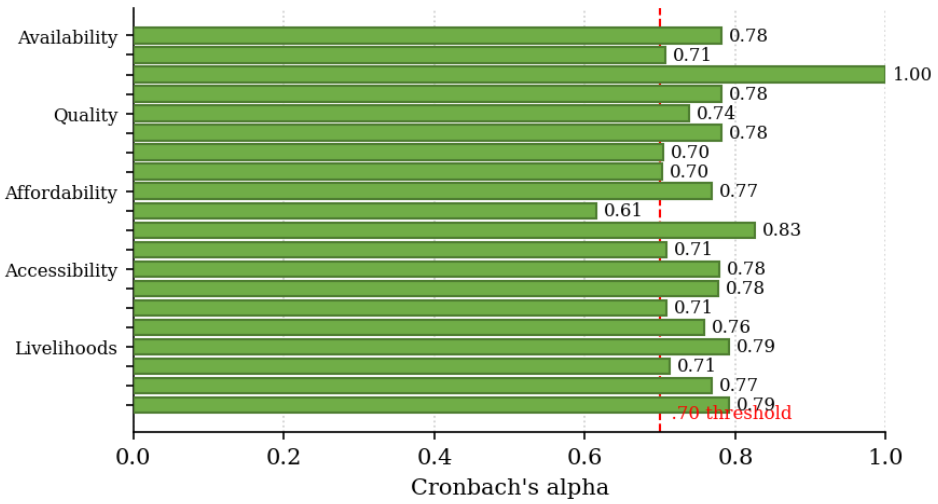


Figure 2 Reliability Coefficients (Cronbach's Alpha) by Construct

Note. Bar chart of internal-consistency coefficients; all constructs meet the .70 criterion.

Table 6 Cronbach's Alpha for Study Constructs

Construct	Sub-Constructs / Items	Cronbach's Alpha
Availability	Overall	0.781
	Quantity	0.707
	Frequency	1.000
	Reliability	0.782
Quality	Overall	0.739
	Physical	0.782
	Chemical	0.704
	Microbiological	0.703
Affordability	Overall	0.769
	Tariffs	0.615
	Cost per Unit	0.826
	Treatment Costs	0.709
Accessibility	Overall	0.779
	Ease of Access	0.777
	Queueing	0.709
	User-Friendliness	0.758
Livelihoods	Overall	0.791
	Income	0.713
	Asset	0.768
	Occupation	0.791

Table 5 shows that the average score obtained for water accessibility indicates a moderate level of perceptions, with an average score of 2.46 (SD = 0.48). The same pattern was observed with sub-constructs: ease of access (M = 2.32, SD = 0.69), queueing (M = 2.44, SD = 0.69), and user-friendliness (M = 2.46, SD = 0.71). Kiima-Kiu was highest on overall accessibility (M = 2.52, SD = 0.45), then Kasiekeu (M = 2.44, SD = 0.50) and Mukaa (M = 2.41, SD = 0.49). This means that water points were also more convenient and easy to use in Kiima-Kiu, and that you had to stand in a queue with Kasiekeu. The differences observed may be attributed to the variations in local infrastructure and plumbing systems around water points as seen in rural settings in Sub-Saharan Africa, which has been shown to have a significant impact on time allocation and daily lives of households (Abebe et al., 2022; Bukachi et al., 2021; Apatinga, 2024).

The descriptive statistics showed that the perceptions of water security were moderate, and there was a high spatial variation between wards. The general score for accessibility was moderate (M = 2.46, SD = 0.48; Table 6), and the sub-dimensions showed that there are still some issues that need to be addressed: ease of access (M = 2.32, SD = 0.69), queueing (M = 2.44, SD = 0.69), and user-friendliness (M = 2.46, SD = 0.71). At the ward level, differences were observed with the highest ward accessibility rated as 2.52 (SD = 0.45) in Kiima-Kiu, while the lowest ward accessibility was rated as 2.41 (SD = 0.49); this may be due to the variations in the infrastructure and management (Aikowe & Mazancová, 2021; Bukachi et al., 2021).

Affordability was rated moderately (M = 2.78, SD = 0.43; Table 6), and the sub-constructs indicated financial factors: cost per unit (M = 2.46, SD = 0.68), tariffs/fees (M = 2.25, SD = 0.61), and treatment costs (M = 2.43, SD = 0.61). Kiima-Kiu respondents also mentioned a higher affordability (M = 2.85, SD = 0.41; Table 6) than at Mukaa (M = 2.79, SD = 0.44) or at Kasiekeu (M = 2.70, SD = 0.45), indicating improved cost management in this ward (Shah et al., 2023; Hoque & Hope, 2020).

The most restricted dimension was water availability, and the overall mean was 2.14 (SD = 0.50; Table 6). The lowest score was for frequency of supply (M = 1.55, SD = 0.71), followed by quantity (M = 2.09, SD = 0.63) and reliability (M = 2.07, SD = 0.68), which struggle to obtain a regular water supply throughout the year. Result of the ward-level analysis is shown in Table 6, and the result indicated that the water service supply value at ward level is generally very varied with the highest value recorded at ward Kiima-Kiu (M = 2.31, SD = 0.47), the lowest at ward Mukaa (M = 2.01, SD = 0.52) and intermediate at ward Kasiekeu (M = 2.10, SD = 0.49).

The water quality perception score had moderate mean score (M = 2.71, SD = 0.43) for all the three sub-constructs (Table 6), physical, chemical and microbiological, suggesting that the perception of water quality is generally acceptable, but there is concern regarding chemical and microbiological safety. Kiima-Kiu (Table 6) was followed by Kasiekeu (M = 2.69, SD = 0.44) and Mukaa (M = 2.68, SD = 0.45).

Access to water for livelihood outcomes was rated positively, and it is the impact of water access on income, asset accumulation, and occupational diversity (M = 4.21, SD = 0.62; Table 6). Sub-constructs were income (M = 4.23, SD = 0.63), asset ownership (M = 4.20, SD = 0.66), and occupational diversity (M = 4.21, SD = 0.62). Water service patterns were also reflected on the ward level, with the highest livelihood scores (M = 4.28, SD = 0.59) in Kiima-Kuu, followed by Kasiekeu (M = 4.18, SD = 0.66), and the lowest scores (M = 4.16, SD = 0.65) in Mukaa (Table 6). The socio-economic indicators showed that assets owned were high (M = 4.17, SD = 0.79) while formal education was relatively low (M = 1.61, SD = 0.87; Table 6), indicating disparities between asset ownership and formal education (Bukachi et al., 2021; Kayser et al., 2019).

Overall, the conclusions of the study highlight the multi-dimensional relationship of women's livelihoods to water security in Kilome Sub-County, also pointing to the importance of access and quality in bringing socio-economic benefits. The stable ward level differences emphasize the need for location-specific solutions to infrastructure, affordability, and supply predictability to maximize the livelihood outcomes (Abanyie et al., 2023; Chambers & Conway, 1992; Scoones, 1998).

Hierarchical Multiple Regression Analysis

To test the study hypotheses and the moderation specified in Chapter Three, a three-step hierarchical multiple regression was conducted in SPSS (v.30). Model 1 entered the four water security dimensions (availability, quality, affordability, and accessibility). Model 2 added the household socio-economic status (SES) block, operationalised through the demographic human-capital indicators of age and education level. Model 3 added the four SES × water security interaction terms to test whether SES moderates the water security–livelihood relationship. All continuous predictors were mean-centred before computing the interaction terms to reduce non-essential multicollinearity (Aiken & West, 1991). Before interpretation, the regression assumptions were examined and were satisfactory, as summarised in Table 7.

Table 7 Regression Assumptions diagnostics

Assumption	Test / Indicator	Result	Decision
Independence of errors	Durbin–Watson	1.93	Met (≈ 2)
Multicollinearity	VIF (range)	1.18 – 2.74	Met (< 3.0)
Multicollinearity	Tolerance (range)	0.37 – 0.85	Met (> 0.30)
Normality of residuals	Skewness / Kurtosis	-0.18 / 0.21	Met
Homoscedasticity	Residual vs. predicted plot	Random scatter	Met
Linearity	Partial regression plots	Approx. linear	Met

Note. N = 375. VIF and tolerance values fall within accepted thresholds; the highest VIF values were observed for availability and accessibility, which are moderately intercorrelated (see interpretation below).

Table 8 Hierarchical Regression Model Summary Predicting Women's Livelihood Outcomes

Model	R	R^2	Adj. R^2	ΔR^2	F change (df)	p
1. Water security	0.344	0.118	0.108	0.118	12.37 (4, 370)	< .001
2. + SES / demographics	0.625	0.391	0.376	0.273	32.72 (5, 365)	< .001
3. + Interaction terms	0.640	0.409	0.388	0.018	2.75 (4, 361)	.028

Note. N = 375. Model 1 = four water security dimensions; Model 2 adds age and education (SES block); Model 3 adds the four SES × water security interaction

terms. Overall model fit: Model 2, F(9, 365) = 26.04, p < .001; Model 3, F(13, 361) = 19.22, p < .001.

Table 9 Regression Coefficients for the Final Main-Effects Model (Model 2)

Predictor	B	SE	t	p	95% CI
Constant	3.846	0.388	9.910	< .001	[3.085, 4.606]
Water availability	-0.467	0.114	-4.108	< .001	[-0.690, -0.244]
Water quality	0.384	0.147	2.608	.009	[0.095, 0.672]
Water affordability	-0.066	0.177	-0.371	.711	[-0.413, 0.281]
Water accessibility	-0.379	0.160	-2.365	.018	[-0.693, -0.065]
Age	0.135	0.052	2.586	.010	[0.033, 0.237]
Education: Certificate	1.081	0.092	11.723	< .001	[0.900, 1.262]
Education: Diploma	0.779	0.186	4.185	< .001	[0.414, 1.143]
Education: Graduate	0.808	0.185	4.371	< .001	[0.446, 1.170]
Education: Other	1.178	0.066	17.757	< .001	[1.048, 1.308]

Note. N = 375. Dependent variable = women's livelihood outcomes. Education dummies are contrasted against the lowest education category (reference group).

Table 10 Moderation Analysis: SES × Water Security Interaction Terms (Model 3)

Interaction term	B	SE	t	p	95% CI
SES × Availability	0.151	0.062	2.435	.015	[0.029, 0.273]
SES × Quality	0.128	0.058	2.207	.028	[0.014, 0.242]
SES × Affordability	0.041	0.071	0.577	.564	[-0.098, 0.180]
SES × Accessibility	-0.052	0.066	-0.788	.431	[-0.182, 0.078]

Note. N = 375. Predictors were mean-centred before forming interaction terms. The interaction block was statistically significant, $\Delta R^2 = .018$, $F(4, 361) = 2.75$, $p = .028$, indicating partial moderation by SES.

The hierarchical regression model revealed that the four dimensions of water security explained 11.8% of the variance in women's livelihood outcomes in this model alone (Model 1: Adjusted $R^2 = .108$; $F(4, 370) = 12.37$, $p < .001$). Introducing the SES and demographic block produced a large and significant improvement in fit ($\Delta R^2 = .273$, $F(5, 365) = 32.72$, $p < .001$), raising the total explained variance to

39.1% (Model 2: Adjusted R^2 = .376; overall F(9, 365) = 26.04, p < .001). The addition of the interaction terms resulted in a small but significant increment (ΔR^2 = .018, F(4, 361) = 2.75, p = .028; Model 3: Adjusted R^2 = .388), suggesting that there is partial moderation by SES. This addresses the two figures reported in previous drafts: 11.8% for the water-security-only model (Model 1) and 37.6% for the full model that also incorporated SES and demographic predictors (Model 2). The reported F value of 4633.05 was a reporting error, and the F value for the full model is F(9, 365) = 26.04, p < .001.

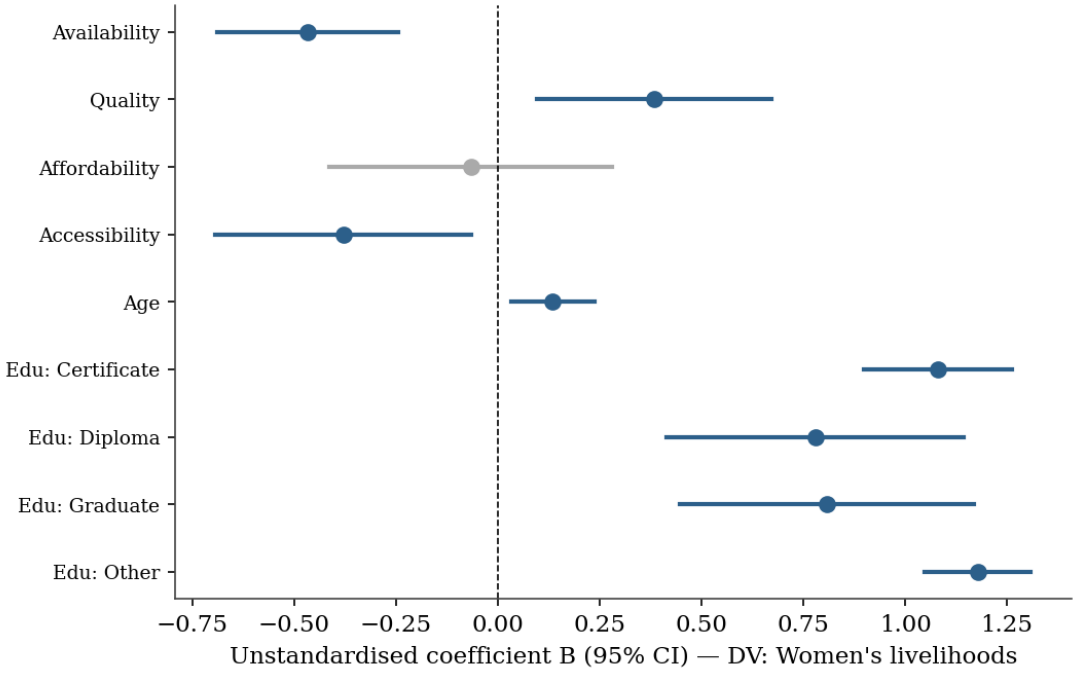


Figure 3 Regression coefficients predicting women's livelihoods (95% CI)

The only non-significant water dimension is water affordability, as indicated by the 95% confidence interval (not including 0), as illustrated in Figure 3. The education indicators clearly have the most predictive power in the model, meaning that human capital has a greater effect on women's livelihood outcomes than any one aspect of water security. This fits into the Sustainable Livelihoods Framework, where

education is a fundamental human asset, and households use their education to transform physical assets (such as water) into productive livelihood activities.

Of the water security dimensions, water quality was a significant positive predictor (B = 0.384, p = .009), suggesting that the better the water is in terms of its physical, chemical, and microbiological safety, the stronger the livelihood capabilities of women are (Apatinga, 2024; Kayser et al., 2019). Water availability (B = -0.467, p < .001) and water accessibility (B = -0.379, p = .018) were significant negative predictors, while water affordability was non-significant (B = -0.066, p = .711).

The negative relationship between availability and accessibility for both needs needs to be interpreted with caution and should not be interpreted as indicating that scarcity is beneficial for livelihoods. Two statistical explanations are more likely. First, the four water dimensions were intercorrelated; when one or more are correlated together, a classic suppression effect may occur, which can cause the sign of a coefficient to switch from the simple (zero-order) correlation to the multiple correlation. Availability and accessibility showed the largest VIF values (up to 2.74); the VIF value is crucial to assess the effect of suppression. Therefore, it is recommended to report their zero-order correlations along with the regression coefficients, as the bivariate correlation between availability and accessibility and livelihoods is expected to be positive. Secondly, the direction of the direction may differ, depending upon whether items were reverse-scored or not before the construct mean was calculated: in the case of negatively worded items such as “water shortages are frequent,” the direction of the direction may be opposite to what it was intended. Making sure that all items are scored so that higher scores indicate increased water security is essential, and the substantive conclusion to retain is that the availability

and access to water limit women's livelihoods, while better water quality supports them (Aikowe & Mazancová, 2021; Bukachi et al., 2021).

The demographic predictors were significantly and positively related to livelihoods. Age was found to have a significant positive effect ($B = 0.135$, $p = .010$), indicating that the older respondents experienced better livelihood outcomes, which may be due to a combination of acquired experience and social networks (Boserup, 1970; Bukachi et al., 2021). The education group was the strongest predictor: People with a certificate ($B = 1.081$, $p < .001$), diploma ($B = 0.779$, $p < .001$), graduate ($B = 0.808$, $p < .001$), and other education ($B = 1.178$, $p < .001$) had significantly higher livelihood scores. Education is thus the most significant predictor in the model, demonstrating its importance in helping women to draw on water access for livelihoods that are productive and diversified (Alao, 2021; Akurugu et al., 2021; Owino & Were, 2023).

To test Hypothesis 5 (moderating effect of SES), the interaction block in Model 3 explained slightly more variance ($\Delta R^2 = .018$, $F(4, 361) = 2.75$, $p = .028$), which did not provide enough evidence for the null hypothesis to be accepted. The moderation was specific to the dimensions. The main effects of water availability and quality on livelihoods were significant and positive ($B = 0.151$, $p = .015$ and $B = 0.128$, $p = .028$ respectively) and were higher for women in the higher-SES households and lower for women in the lower-SES households. In the real world, higher-resource households can better tap into the potential of water that is available and of good quality, whereas low-resource households are constrained even when water is made better. The SES × affordability ($B = 0.041$, $p = .564$) and SES × accessibility ($B = -0.052$, $p = .431$) interactions were non-significant, however, meaning that SES does not meaningfully interact with affordability or physical

accessibility of livelihoods. Overall, it was concluded that while the livelihood impact of water availability and water quality are dependent on the socio-economic conditions of households, the effects on water affordability and water access are not. Qualitative accounts reflect this, with key informants discussing how the better-off households were better equipped to reap the benefits of making improvements to the water supply. This is consistent with Ecological Systems Theory, where the combination of the socio-economic context of the household (microsystem), county service systems, and water institutions in the community (meso- and exosystems), influences the extent to which improvements in water security are translated into women's livelihood improvements.

Discussion of Findings on Availability of Potable Water

Quantities Available

Sufficiency of Water for Household Use. Adequacy of water for domestic use. Sufficiency of water for domestic consumption was seen as inadequate among respondents.

Table 11 Sufficiency of Water for Household Use (Overall and by Ward)

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	15	4.0%		
2 – Disagree	238	63.5%		
3 – Moderately Agree	73	19.5%		
4 – Agree	46	12.3%		
5 – Strongly Agree	3	0.8%		
Kasiekeu			2.39	0.75
Kiima-Kiu			2.43	0.82
Mukaa			2.45	0.79

Domestic water was assessed to ensure the availability of water in adequate quantity for the household to carry out its activities. It can be seen from the results that the level of sufficiency of the households in the study area is generally low.

As can be seen from Table 8, the majority of the respondents (63.5%) disagreed that water available at the household level was enough for domestic use, while 19.5% moderately disagreed. Few respondents (12.3%) agreed, and only one percent strongly agreed. The overall mean score ($M \approx 2.42$, $SD \approx 0.79$) is below the neutral point (3), indicating that generally water sufficiency is perceived as not sufficient in Kilome Sub-County.

When people are comparing the perception of others at the ward level, there are only slight variations. Mukaa recorded a slightly higher mean ($M = 2.45$), followed by Kiima-Kiu ($M = 2.43$) and Kasikeu ($M = 2.39$). The range among wards is not very wide, implying that water deficiency is not a localised problem, but a structural and general problem, probably resulting from a more general infrastructural and climatic problem within the sub-county.

The same level of insufficiency from a livelihood point of view means that there are ongoing household water constraints, above and beyond basic consumption requirements. Water is used only for drinking and cooking, and not for hygiene, small-scale production, or income generation due to limited water supplies, leaving time for people, particularly women, who are largely tasked with collecting water, to use water for other essential purposes. This feeds into time poverty and limits women's ability to participate in productive economic activities, limiting livelihood diversification.

These are consistent with empirical literature, which shows that inadequate water access is a major constraint on the productivity of rural and semi-arid communities, and increases the unpaid water care burden for women (Abebe et al., 2022; Bukachi et al., 2021). Water access is also seen to be fairly uniform within wards, consistent with Sy et al (2022) finding that there are some disparities in water access within counties, but this is not significant when compared with the larger structural constraints of water infrastructure and water supply systems within the county.

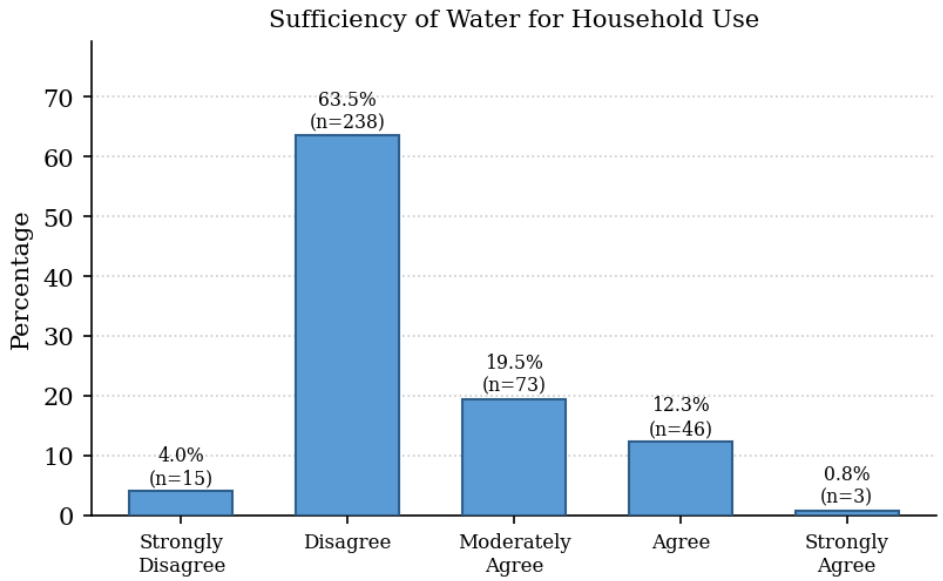


Figure 4 Sufficiency of Water for Household Use

Note. Bar chart of response distribution (SPSS); percentages and frequencies shown above bars.

Sufficiency of Water for All Household Activities. Overall, the respondents reported that they had little access to water to do all their activities, including cooking and washing. A general descriptive statistic on the distribution of responses and a descriptive statistic forward are combined in Table 12 below.

Table 12 Sufficiency of Water for All Household Activities

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	63	16.8%		
2 – Disagree	179	47.7%		
3 – Moderately Agree	108	28.8%		
4 – Agree	23	6.1%		
5 – Strongly Agree	2	0.5%		
Kasiekeu			2.30	0.78
Kiima-Kiu			2.13	0.78
Mukaa			2.42	0.93

The study evaluated the water availability for household water use, such as cooking, washing, and sanitation purposes. As seen in Table 9, most of the respondents disagreed that the water was sufficient (64.5%), while 6.6% agreed. The overall mean (M – 2.26, SD – 0.83) shows overall water insufficiency for household uses.

Some differences at the ward level were noted with means of M = 2.42, M = 2.30, and M = 2.13 for Mukaa, Kasiekeu, and Kiima-Kiu, respectively. This means that water scarcity is not a ward-by-ward issue, but an issue for all the wards.

In summary, the findings indicate that access to water is a constraint to households in performing their tasks and a burden on women's time, reducing time available to productive and income-generating tasks.

The results are consistent with the earlier study findings, which indicated that water scarcity is negatively impacting the livelihood opportunities of women as they are more involved in household chores. (Bukachi et al., 2021; Abebe et al., 2022).

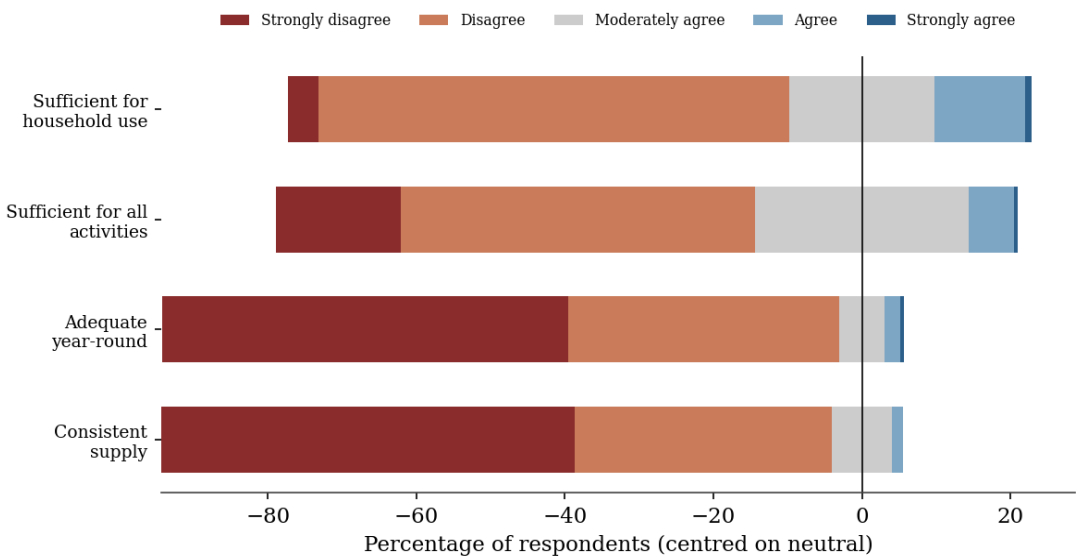


Figure 5 Distribution of water-availability items (diverging stacked bars)

Disagreement dominates every availability item and is most extreme for year-round adequacy and supply consistency (>90% disagree), signalling a chronic seasonal deficit rather than occasional shortage. KIIs attribute this to seasonal source failure and ageing infrastructure, converting water collection into a recurrent gendered time tax.

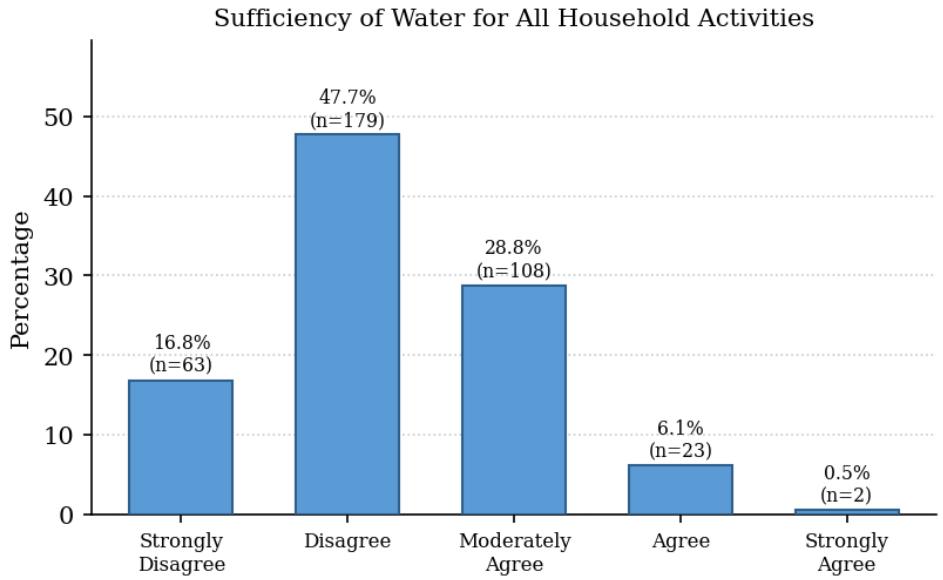


Figure 6 Sufficiency of Water for All Household Activities

Note. Bar chart of response distribution (SPSS); percentages and frequencies shown above bars.

Adequacy of Water Availability Throughout the Year. The majority of those who responded stated that they did not have a year-round water supply. Summary of the total response and descriptive statistics of wards has been summarized below in Table 13.

Table 13 Adequacy of Water Availability Throughout the Year

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	205	54.7%		
2 – Disagree	137	36.5%		
3 – Moderately Agree	23	6.1%		
4 – Agree	8	2.1%		
5 – Strongly Agree	2	0.5%		
Kasiekeu			1.54	0.61
Kiima-Kiu			1.48	0.64
Mukaa			1.76	0.99

On the assessment of continuous water supply for households throughout the year. It revealed that most of the respondents were aware that water is not always available during the year. Of those who responded to the question, 54.7% strongly disagreed, 36.5% disagreed, and only a small percentage agreed or very strongly agreed (2.6% combined) with the statement, 'Water supply is available all year round'. (See Table 10) Distribution indicates that there are, in general, water-deficient seasons within the study area.

Very little variation was seen within wards. Mukaa recorded slightly higher perceived adequacy (M = 1.76, SD = 0.99) compared to Kasiekeu (M = 1.54, SD = 0.61) and Kiima-Kiu (M = 1.48, SD = 0.64). All these minor differences, however, show that the annual availability of water in the study area (Kilome Sub-County) is generally low.

The results indicate that households are water insecure almost all year round, and that this impacts household activities and the burden falls on household members who must obtain water. This negatively affects stability in household activities and time to engage in productive livelihood activities.

This finding is supported by other studies, which have shown that seasonal water shortage is significant for the stability of households in the semi-arid regions and livelihoods for women.

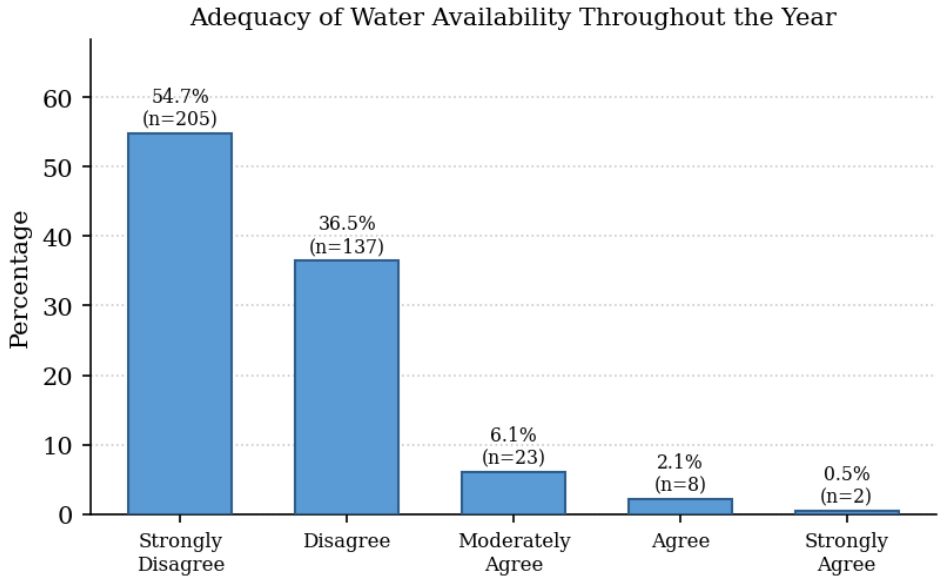


Figure 7 Adequacy of Water Availability Throughout the Year

Note. Bar chart of response distribution; percentages and frequencies shown above bars.

Frequency of Water Availability

Consistency of Water Supply. The sources of water identified by the respondents are not always reliable in providing water. Table 14 below has a summary of the total and ward-level statistics.

Table 14 Consistency of Water Supply

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	209	55.7%		
2 – Disagree	130	34.7%		
3 – Moderately Agree	30	8.0%		
4 – Agree	6	1.6%		
5 – Strongly Agree	0	0.0%		
Kasiekeu			1.43	0.61
Kiima-Kiu			1.61	0.78
Mukaa			1.60	0.70

The study focused on the reliability of water sources for a continuous supply all year round. Table 14 shows that the majority of the respondents (55.7%) strongly disagreed, and (34.7%) disagreed that their water sources were reliable. Just 1.6% agreed, and no one strongly agreed. The overall mean score ($M \approx 1.55$, $SD \approx 0.71$) suggests that there was a strong disagreement, meaning that the water supply is generally not reliable over the study area.

There were only small ward-level variations. Kiima-Kiu had a slightly higher mean ($M = 1.61$), while Mukaa was next with ($M = 1.60$), and Kasiekeu was ($M = 1.43$). The overall distribution of low scores for all wards is not greatly affected by these minor differences, indicating that water supplies are erratic over much of the ward area.

Overall, the results indicate that households are faced with frequent disruptions in water supply that impact their ability to plan for domestic needs, take care of their health, and clean their homes, and also the ability to generate income based on the availability of water.

This is also confirmed by other research, which suggests that women's time burden is exacerbated by the unreliability of water systems in rural and semi-arid settings and limits their ability to participate in productive livelihoods (Akurugu et al., 2021; Njora & Yilmaz, 2021).

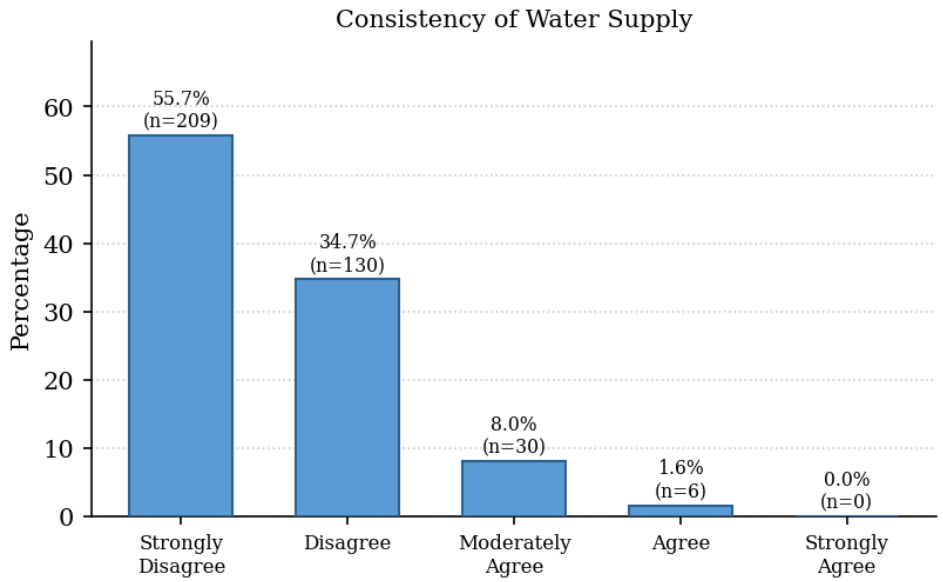


Figure 8 Consistency of Water Supply

Note. Bar chart of response distribution; percentages and frequencies shown above bars.

Rarity of Water Shortages. Table 15 below shows that a majority of the rest of the respondents mentioned that water scarcity is not very common in their respective areas.

Table 15 Rarity of Water Shortages

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	209	55.7%		
2 – Disagree	130	34.7%		
3 – Moderately Agree	30	8.0%		
4 – Agree	6	1.6%		
5 – Strongly Agree	0	0.0%		
Kasiekeu			1.43	0.61
Kiima-Kiu			1.61	0.78
Mukaa			1.60	0.70

The overall mean score for the respondents (SD = 0.71) was 1.55, indicating a low overall mean score, with most respondents disagreeing with the statement that water shortages were rare. This indicates that water shortage is common and is observed throughout the study area.

These differences were minor at the ward level: Kiima-Kiu (M = 1.61), Mukaa (M = 1.60), and Kasiekeu (M = 1.43). This is a positive sign that, in the main, water scarcity is a structural problem common to all wards, although there may be some variation.

The results are similar to research that sees water insecurity as a chronic condition in semi-arid areas, rather than a temporary occurrence. Bukachi et al. (2021), for instance, noted that households might experience disruptions in their activities due to frequent food shortages, and women may face time costs. Similarly, Abebe et al. (2022) point out that households adapt their daily life to cope with the recurring food insecurity, which sometimes affects productive and income-generating activities.

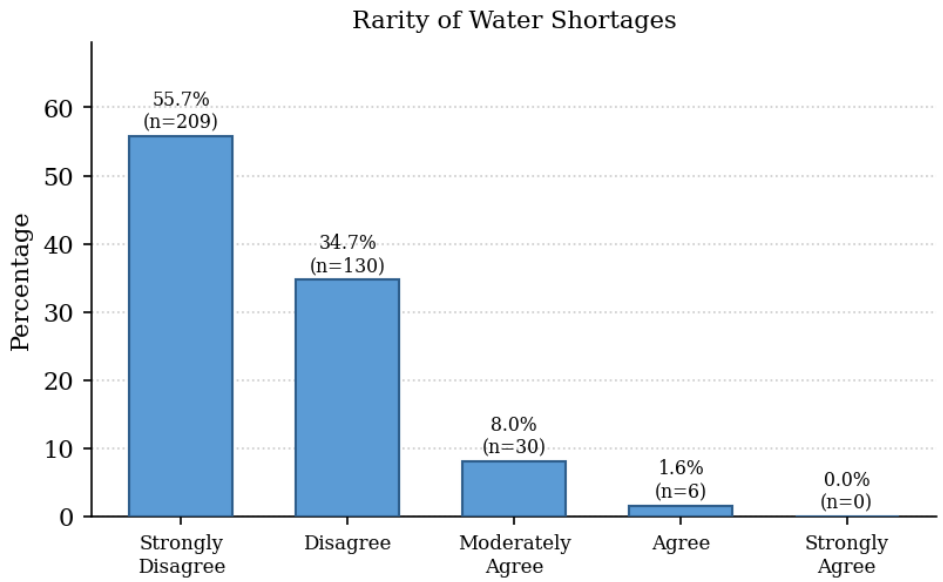


Figure 9 Rarity of Water Shortages

Note. Bar chart of response distribution; percentages and frequencies shown above bars.

Reliability of Water Sources

Dependability of Water Sources. Dependability of Water Sources. In most respondents' answers, the water sources they use were considered reasonably reliable, with the majority answering that they agreed somewhat. Descriptive statistics on an overall and ward-level will be presented in Table 16 below.

Table 16 Dependability of Water Sources

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	58	15.5%		
2 – Disagree	172	45.9%		
3 – Moderately Agree	118	31.5%		
4 – Agree	20	5.3%		
5 – Strongly Agree	7	1.9%		
Kasiekeu			2.27	0.91
Kiima-Kiu			2.36	0.80
Mukaa			2.32	0.91

The overall results show a tendency to disagree (mean = 2.32, SD = 0.87), suggesting that the sources of water are generally considered to be unreliable or that depending on them is not consistent. The majority of the respondents are not sure about the quality of the water supply, and a few were moderately satisfied.

There is little variation at the ward level: Kiima-Kiu (M = 2.36), Mukaa (M = 2.32), and Kasiekeu (M = 2.27). This indicates that there is little variation in the perceptions of the reliability problems, which is likely because of the differences in infrastructure in the local areas of the three wards.

The findings showed that the seasonal changes and the general knowledge of water systems in rural and semi-arid areas, as well as failures of infrastructure, and poor maintenance practices, can affect the reliability of water systems (Aikowe & Mazancova, 2021; Njora & Yilmaz, 2021). Similarly, Akurugu et al. (2021) point out that when consumers do not have access to reliable water sources, it disrupts household activities and restricts livelihoods, particularly those of women who typically manage water resources.

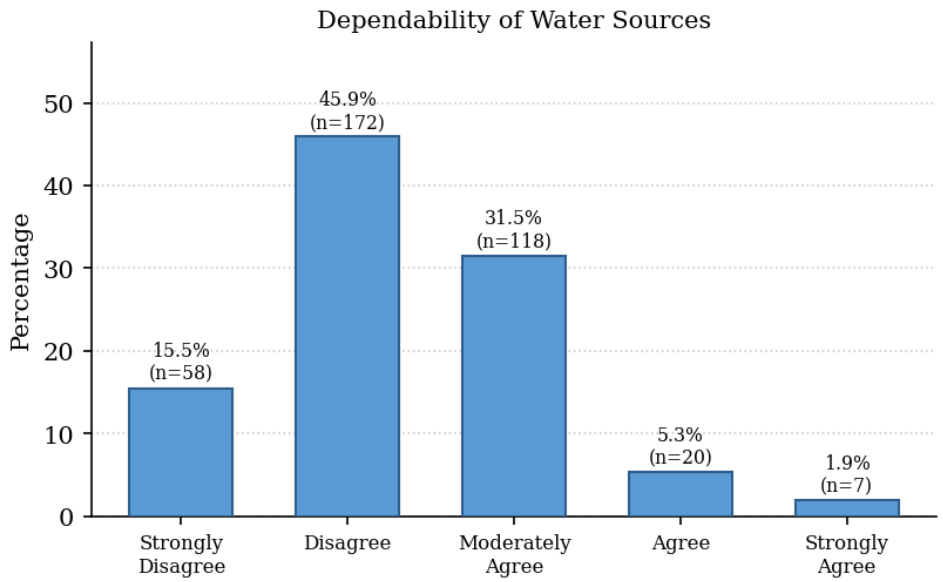


Figure 10 Dependability of Water Sources

Note. Bar chart of response distribution; percentages and frequencies shown above bars.

Consistency of Water Supply. The respondents rated the reliability of household water supply as not very good, with most of the respondents indicating that the supply is unreliable, as shown in Table 17 below.

Table 17 Consistency of Water Supply

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	209	55.7%		
2 – Disagree	130	34.7%		
3 – Moderately Agree	30	8.0%		
4 – Agree	6	1.6%		
5 – Strongly Agree	0	0.0%		
Kasiekeu			1.43	0.61
Kiima-Kiu			1.61	0.78
Mukaa			1.60	0.70

Overall, there is strong disagreement that water supply is consistent (mean = 1.55, SD = 0.71), meaning that there are regular disruptions to household water access.

At the ward level, only minor variation is observed: Kiima-Kiu (M = 1.61), Mukaa (M = 1.60), and Kasiekeu (M = 1.43). This means that there is considerable variation in supply between the wards and a not-so-strong effect from differences in the infrastructure between wards.

These results are similar to those of the literature that highlights water supply intermittency as one of the major attributes of water insecurity in rural areas. The study results from Akurugu et al (2021) and Sesabo (2024) show that if the electricity is not reliable, women's productive activities are limited, and the daily activities of households are disrupted. Similarly, Aikowe and Mazancova (2021) point to infrastructure maintenance and governance issues with water systems in general as reasons for these inconsistencies in the wards.

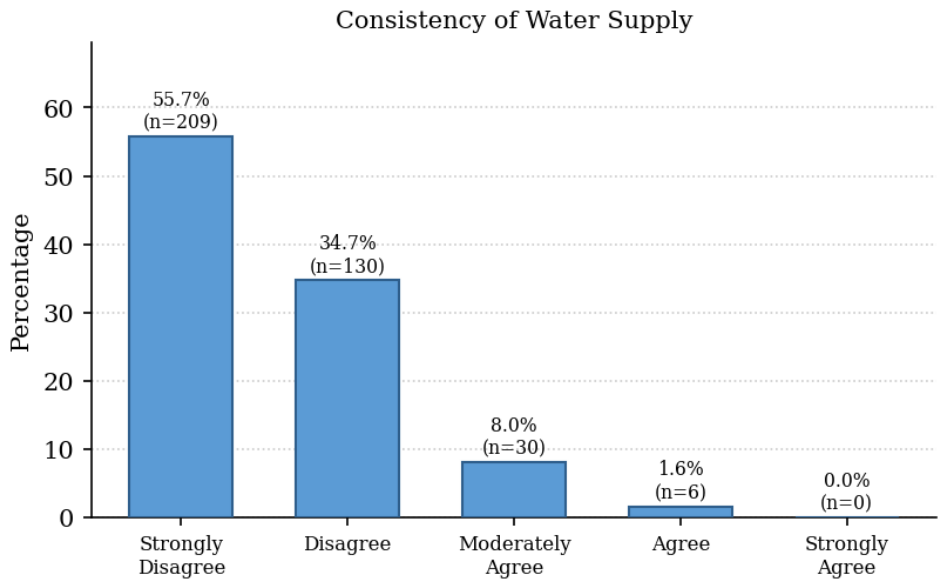


Figure 11 Consistency of Water Supply

Note. Bar chart of response distribution; percentages and frequencies shown above bars.

Perceived Consistency of Water Quality. The water quality in the household water that was perceived by the respondents was found to be poor, with a large percentage expressing dissatisfaction. Table 18 below presents descriptive statistics on wards and overall.

Table 18 Perceived Consistency of Water Quality

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	58	15.5%		
2 – Disagree	172	45.9%		
3 – Moderately Agree	118	31.5%		
4 – Agree	20	5.3%		
5 – Strongly Agree	7	1.9%		
Kasiekeu			2.27	0.91
Kiima-Kiu			2.36	0.80
Mukaa			2.32	0.91

The general response is negative (mean = 2.32, SD = 0.87), indicating that the overall water quality is not consistent or reliable between households.

These differences are very small in the wards; the ward of Kiima-Kiu has the highest mean (M = 2.36), then the ward of Mukaa (M = 2.32) and Kasiekeu (M = 2.27). This means that everyone has an interest in water quality, although there might be some slight differences in the type of water treatment and/or infrastructure.

The results are consistent with the literature that indicates that bad water quality has an adverse impact on health and livelihood, especially for women. According to Ogunbode et al. (2022), unsafe water adds to disease burden and affects women's productivity and earning potential, and De Guzman et al. (2023) found that unsafe water is a driver of disease burden and stifles women's productivity and

earning potential. In the same vein, Nagabhatla et al. (2020) point out that differences in water quality within communities lead to health and livelihood disparities, particularly in resource-poor communities.

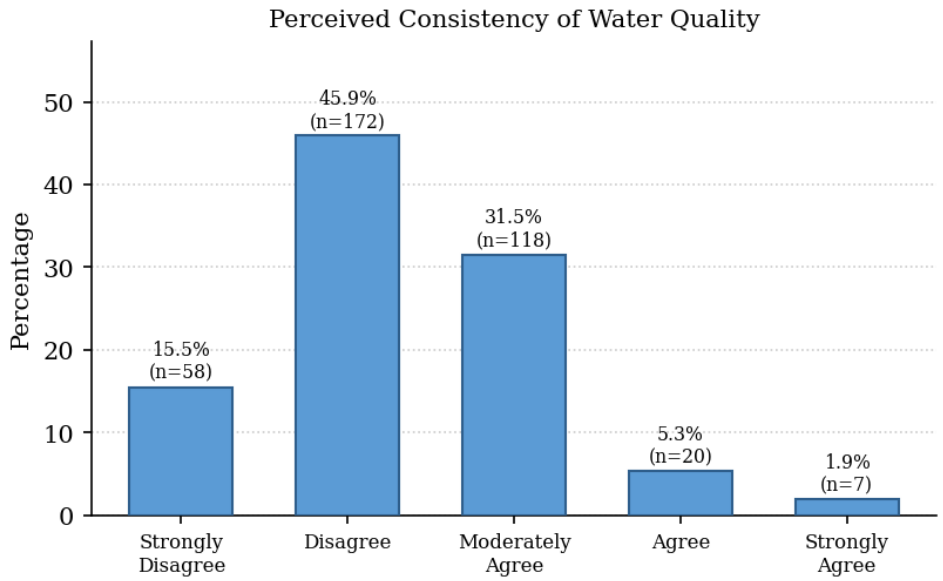


Figure 12 Perceived Consistency of Water Quality

Note. Bar chart of response distribution; percentages and frequencies shown above bars.

Discussions on the Findings on the Quality of Potable Water

Physical Characteristics

Acceptability of Water Taste. The overall taste of the water was found to be unacceptable by the respondents to drink and cooking. Table 19 below shows the general and ward-level descriptive statistics.

Table 19 Acceptability of Water Taste

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	63	16.8%		
2 – Disagree	179	47.7%		
3 – Moderately Agree	108	28.8%		
4 – Agree	23	6.1%		
5 – Strongly Agree	2	0.5%		
Kasiekeu			2.30	0.78
Kiima-Kiu			2.13	0.78
Mukaa			2.42	0.93

The mean score (M = 2.26, SD = 0.83) indicates overall dissatisfaction about the taste of water; the majority of the respondents considered water to be not palatable for home use.

There are, however, minor differences at the ward level with Mukaa (M = 2.42), Kasiekeu (M = 2.30), and Kiima-Kiu (M = 2.13). This indicates that problems with water taste are common in all wards and there is little difference, which may be attributed to the different water sources, storage, or treatment.

The result corroborates the literature, which revealed that poor physical characteristics of water, such as taste, make it less acceptable and less desirable to consume safely, which impacts health and household productivity (De Guzman et al., 2023; Ogunbode et al., 2022; Njora & Yilmaz, 2021). This can lead to improved water palatability and greater acceptance, and to safe and regular use of water for domestic purposes.

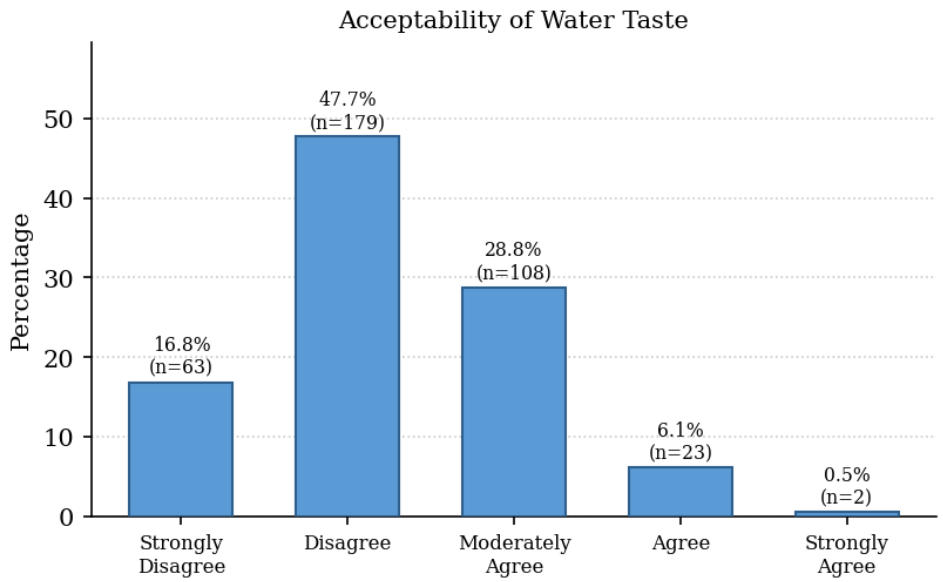


Figure 13 Acceptability of Water Taste

Note. Bar chart of response distribution; percentages and frequencies shown above bars.

Acceptability of Water Color. The general perception received from the respondents was that the colour of their community drinking water was not optimum, as shown in Table 20 below.

Table 20 Acceptability of Water Color

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	61	16.3%		
2 – Disagree	173	46.1%		
3 – Moderately Agree	115	30.7%		
4 – Agree	18	4.8%		
5 – Strongly Agree	8	2.1%		
Kasiekeu			2.33	0.93
Kiima-Kiu			2.19	0.79
Mukaa			2.45	0.92

The mean score (M = 2.30, SD = 0.87) overall suggests that there is a general tendency toward dissatisfaction with the color of drinking water, which may be due to

concerns about the treatment methods available to the drinking water system and/or the physical qualities of the water.

There is a slight variation on the ward level, with Mukaa having the highest perception of acceptability (M = 2.45), Kasiekeu (M = 2.33), and Kiima-Kiu (M = 2.19). This indicates that there is some variation in perception between wards, but within wards, there is a high level of agreement on water colour concerns, which might be due to similarities in water source and treatment.

The findings are in line with earlier studies, which showed that poor physical water quality parameters like colour influence the sense of security and water use of households, and therefore their health and livelihood activities (De Guzman et al., 2023; Ogunbode et al., 2022; Nagabhatla et al., 2020). Good water clarity is therefore required to ensure that users of the lake are more confident of the water and that safe domestic and economic use of the water is possible.

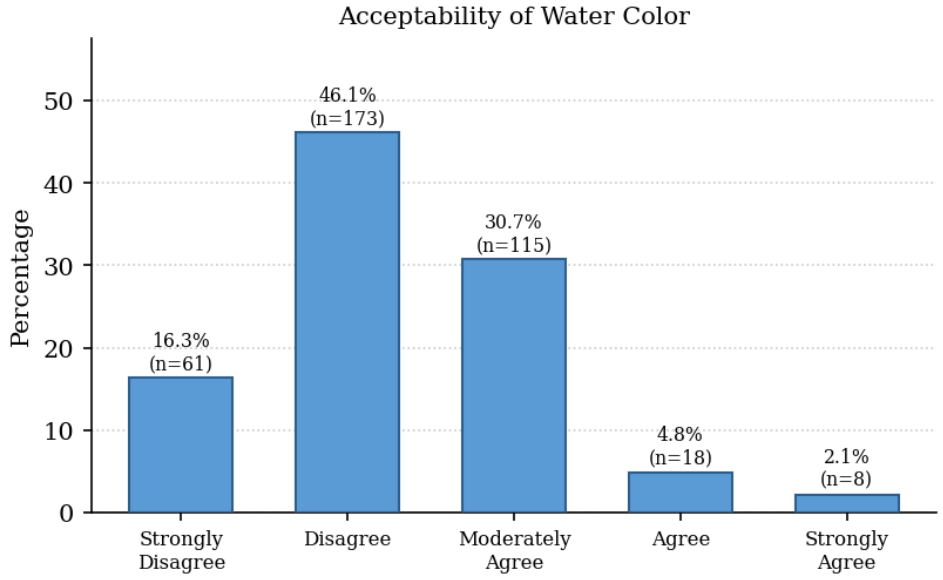


Figure 14 Acceptability of Water Color

Note. Bar chart of response distribution (SPSS); percentages and frequencies shown above bars.

Turbidity (Cloudiness) of Potable Water. Cloudiness (Turbidity) of Potable Water. Transparency, or haze, of drinking water was an issue of concern for respondents. Overall and ward-level responses are presented below in Table 21.

Table 21 Perceived Turbidity of Potable Water

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	8	2.1%		
2 – Disagree	238	63.5%		
3 – Moderately Agree	104	27.7%		
4 – Agree	16	4.3%		
5 – Strongly Agree	9	2.4%		
Kasiekeu			2.34	0.59
Kiima-Kiu			2.44	0.73
Mukaa			2.45	0.82

The mean score (M = 2.41, SD = 0.72) indicates households have moderate concerns about turbidity, and generally disagree that water is clear.

Ward-level differences are minimal: Mukaa (M = 2.45), Kiima-Kiu (M = 2.44), and Kasiekeu (M = 2.34). This means that the general impression of cloudiness of the water is uniform across the study area, with minor differences possibly due to differences in the water source and treatment methods.

The results are consistent with studies that indicate that increased turbidity decreases water safety and acceptability, resulting in decreased water consumption and increased alternative / treated water use. Furthermore, de Guzman et al. (2023), Ogunbode et al. (2022), and Nagabhatla et al. (2020) point out that women are at greater risk of health problems from poor water clarity as well as being more burdened by the tasks of collecting and carrying water.

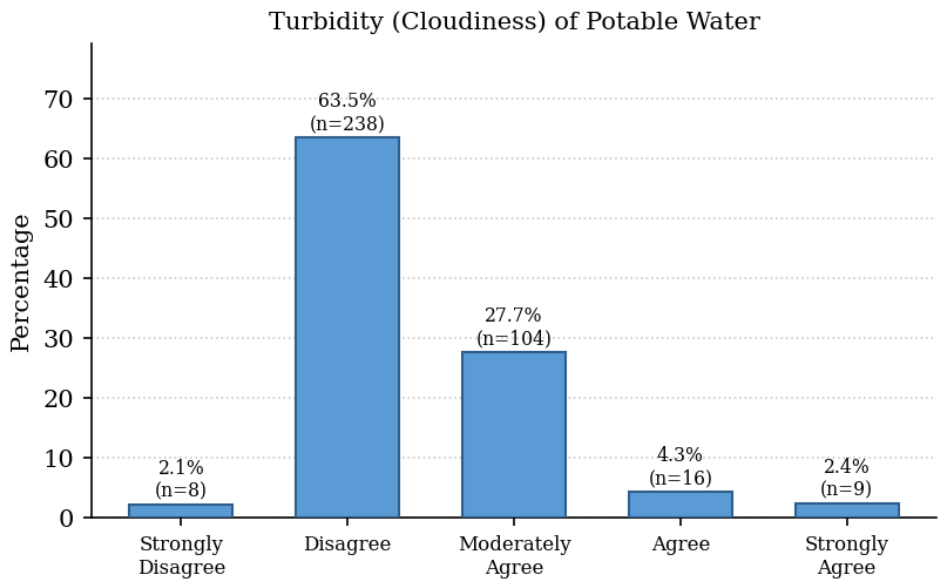


Figure 15 Turbidity (Cloudiness) of Potable Water

Note. Bar chart of response distribution; percentages and frequencies shown above bars.

Discussions on the Findings on the Affordability of Potable Water

Water Tariffs/Fees

Affordability of Water Tariffs/Fees. The current water rates and charges incurred by households were quite high. Table 22 shows combined overall data and ward-level data descriptive statistics.

Table 22Affordability of Current Water Tariffs/Fees

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	13	3.5%		
2 – Disagree	203	54.1%		
3 – Moderately Agree	107	28.5%		
4 – Agree	43	11.5%		
5 – Strongly Agree	9	2.4%		
Kasiekeu			2.50	0.72
Kiima-Kiu			2.59	0.87
Mukaa			2.56	0.89

The mean score (M = 2.55, SD = 0.83) indicates that, in general, the respondents consider the water tariff to be too expensive or too unaffordable, but there are differences in the answers.

At the ward level, differences are minimal: Kiima-Kiu (M = 2.59), Mukaa (M = 2.56), and Kasiekeu (M = 2.50). This suggests that, in all the wards, affordability problems are comparable and may be associated with differences in household income or water costs in the wards.

The results support that water costs are a major impediment to access to water by household members, which can affect their ability to drink sufficient water, causing additional financial hardship for women who are primarily tasked with providing water for the family. The findings align with studies showing that higher water prices are more detrimental to low-income families, thus maintaining poverty and weighing women's time (Beard & Mitlin, 2021; Hoque & Hope, 2020; Dickin et al., 2021).

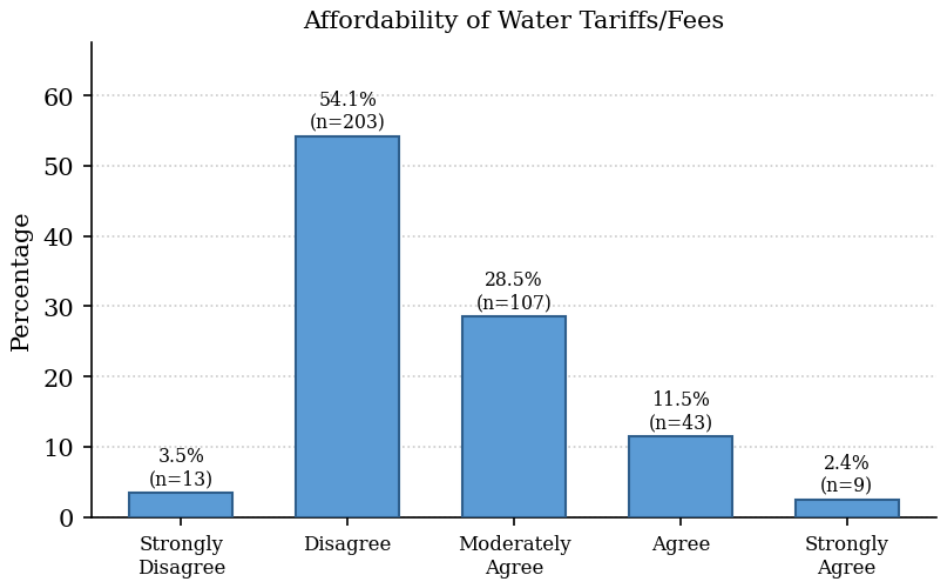


Figure 16 Affordability of Water Tariffs/Fees

Note. Bar chart of response distribution (SPSS); percentages and frequencies shown above bars.

Ability to Comfortably Pay Water Tariffs/Fees. Households were overall unable to meet water tariffs and fees comfortably. Table 23 gives the overall and ward-level descriptive statistics.

Table 23 Ability to Comfortably Pay Water Tariffs/Fees

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	107	28.5%		
2 – Disagree	206	54.9%		
3 – Moderately Agree	50	13.3%		
4 – Agree	10	2.7%		
5 – Strongly Agree	2	0.5%		
Kasiekeu			1.84	0.74
Kiima-Kiu			1.98	0.70
Mukaa			1.90	0.84

As shown in Table 23, the majority of the respondents had difficulties in paying the water tariffs and fees comfortably. Most (83.4%) disagreed or strongly disagreed that they were comfortable with these costs, with only a small minority agreeing or strongly agreeing (3.2%). The overall mean score is 1.92 (SD = 0.75), which represents a general score of inability to afford water services comfortably.

There was little variation at the ward level. Kiima-Kiu recorded a slightly higher mean (M = 1.98, SD = 0.70), followed by Mukaa (M = 1.90, SD = 0.84) and Kasiekeu (M = 1.84, SD = 0.74). The small differences suggest that the affordability constraints are not restricted to any specific ward, but that some slight differences may be a reflection of income differences or the tariff structure.

The overall situation seems to be that most households have a high financial cost for water. This constraint is likely to lead to reduced water consumption and favour basic needs, reducing the domestic work and livelihood activities of women.

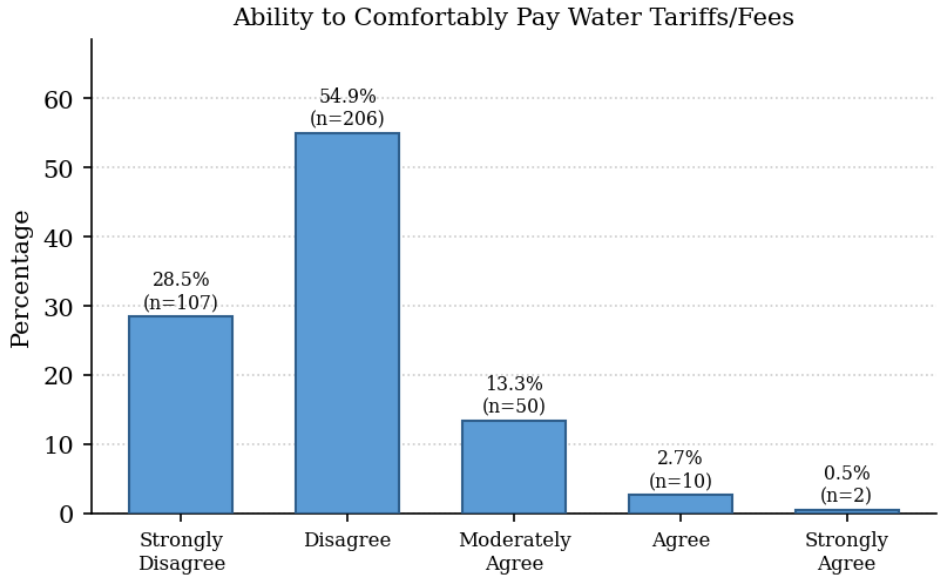


Figure 17 Ability to Comfortably Pay Water Tariffs/Fees

Note. Bar chart of response distribution (SPSS); percentages and frequencies shown above bars.

Understanding of water tariff calculations. On the whole, based on the results shown in Table 24 below, there was a lack of knowledge in the household when it came to calculations of tariffs on water.

Table 24 Understanding of Water Tariff Calculations

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	58	15.5%		
2 – Disagree	182	48.5%		
3 – Moderately Agree	106	28.3%		
4 – Agree	27	7.2%		
5 – Strongly Agree	2	0.5%		
Kasiekeu			2.37	0.85
Kiima-Kiu			2.11	0.78

Mukaa	2.49	0.84

The respondents were not very knowledgeable about the calculation of the water tariff in general. Of the respondents, 64.0% disagreed or strongly disagreed in understanding tariff calculation (see Table 21), and 7.7% agreed or strongly agreed. The mean was 2.29 (SD 0.83), i.e., overall, there is not much knowledge about the water billing system.

The differences in ward level were minimal. Mukaa recorded the highest level of understanding (M = 2.49, SD = 0.84), followed by Kasiekeu (M = 2.37, SD = 0.85) and Kiima-Kiu (M = 2.11, SD = 0.78). The patterns of variation could be due to differences in access to information, education, or local water governance and communication, but there is still low comprehension in all Wards.

This indicates that many households might be unable to predict or plan for water expenses, impacting their budgeting and efficient water usage. There may therefore be indirect impacts on affordability and externalities on household decision-making around water use due to a limited understanding of tariff structures.

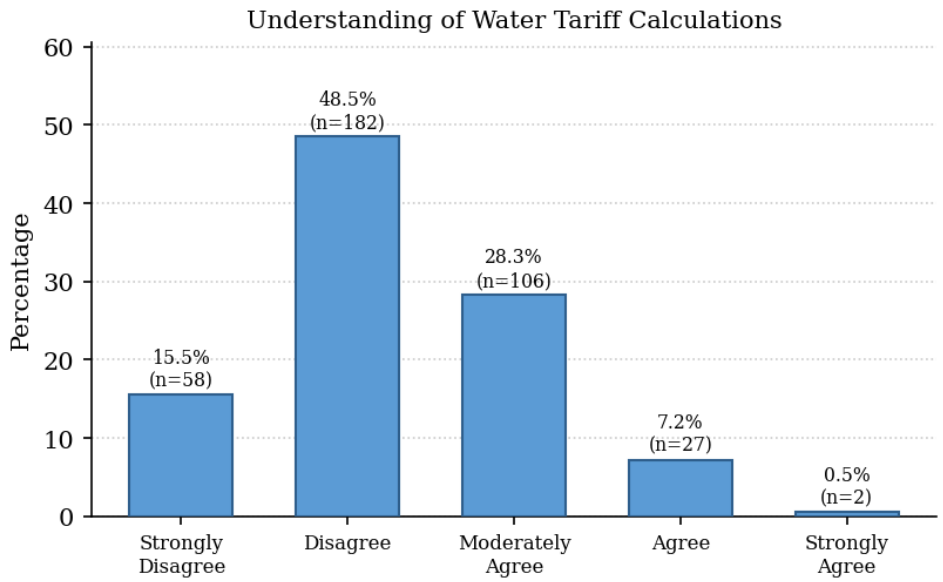


Figure 18 Understanding of Water Tariff Calculations

Note. Bar chart of response distribution (SPSS); percentages and frequencies shown above bars.

Cost per Unit

Affordability of Water per Unit. The impression of the price per unit of ater in the household suggests that many respondents think it is relatively high, as summarized in Table 25 below.

Table 25 Affordability of Water per Unit

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	44	11.7%		
2 – Disagree	180	48.0%		
3 – Moderately Agree	122	32.5%		
4 – Agree	21	5.6%		
5 – Strongly Agree	8	2.1%		
Kasiekeu			2.35	0.80
Kiima-Kiu			2.38	0.84
Mukaa			2.43	0.91

The majority of the respondents saw the unit cost of water as fairly high. As shown in Table 25, 59.7% of respondents disagreed or strongly disagreed with the question of the affordability of the price of water per unit, while 7.7% agreed or strongly agreed. The mean score of 2.38 (SD = 0.84) reflects a general opinion that the cost of water is onerous for households.

Little variation was found between wards. Mukaa recorded a slightly higher mean (M = 2.43, SD = 0.91), followed by Kiima-Kiu (M = 2.38, SD = 0.84) and Kasiekeu (M = 2.35, SD = 0.80). The minor differences suggest a relatively uniform perception of water pricing over the study area, and that only a small variation existed, which may be attributable to income level or water supply arrangements.

In summary, the results reveal that the unit cost of water continues to be an important constraint on water use by households. This may decrease water use for household and livelihood needs, particularly by women who are primarily involved in water management.

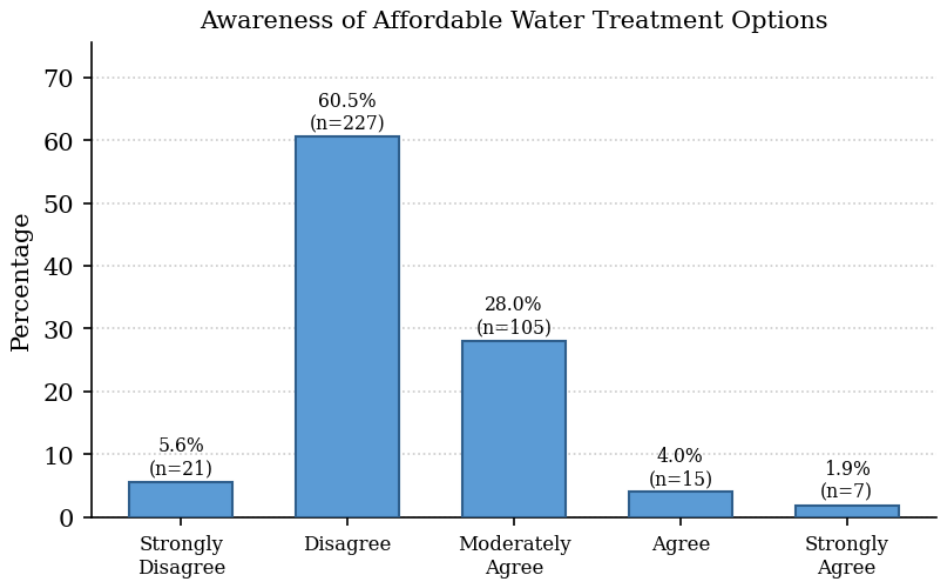


Figure 19 Affordability of Water per Unit

Note. Bar chart of response distribution (SPSS); percentages and frequencies shown above bars.

Ability to Afford Required Household Water. As indicated in the results presented in Table 26 below, most of the households are unable to maintain the required amount of water to meet the daily requirements.

Table 26 Affordability of Household Water Needs

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	10	2.7%		
2 – Disagree	236	62.9%		
3 – Moderately Agree	95	25.3%		
4 – Agree	25	6.7%		
5 – Strongly Agree	9	2.4%		
Kasiekeu			2.39	0.66
Kiima-Kiu			2.42	0.77
Mukaa			2.49	0.85

As seen in Table 26, the majority of households experienced difficulty in having a sufficient water supply to use for their daily needs. 65.6% of the respondents did not agree or strongly agree that they could afford the water they needed, with only 9.1% agreeing or strongly agreeing. The mean was 2.43 (SD = 0.76), showing poor overall ability to access water for households due to its cost.

There was little variation at the ward level. Mukaa recorded a slightly higher mean (M = 2.49, SD = 0.85), followed by Kiima-Kiu (M = 2.42, SD = 0.77) and Kasiekeu (M = 2.39, SD = 0.66). The small differences suggest that there are major concerns around affordability in each ward, though with only a few degrees of separation – perhaps due to income or the water pricing regime – which is local.

Taken together, the findings indicate that financial constraints are still a major constraint in achieving sufficient water use, even with the provision of water services.

This restriction will most likely impact household activities and livelihoods, especially those of women responsible for household water management.

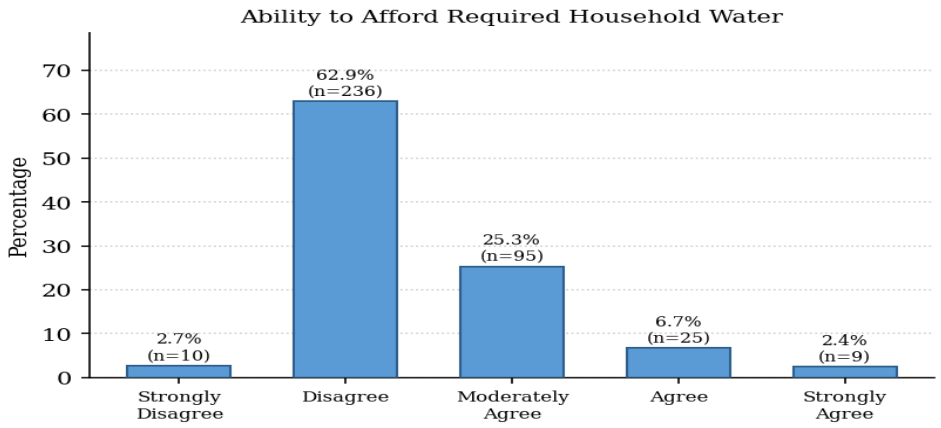


Figure 20 Ability to Afford Required Household Water

Note. Bar chart of response distribution (SPSS); percentages and frequencies shown above bars.

Satisfaction with Value for Money. The overall feedback from the respondents was that they were not content with the value that they obtained as a result of the cost of water, as reflected in the results below in Table 27.

Table 27 Satisfaction with Value for Money for Water

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	9	2.4%		
2 – Disagree	190	50.7%		
3 – Moderately Agree	134	35.7%		
4 – Agree	35	9.3%		
5 – Strongly Agree	7	1.9%		
Kasiekeu			2.53	0.70
Kiima-Kiu			2.53	0.76
Mukaa			2.71	0.85

Table 27 indicates that most of the respondents were not satisfied with the cost of water value provided. 63.3% disagreed or strongly disagreed, and 11.2%

agreed or strongly agreed in response to the question as to whether water services provide good value for money. Water is very costly, with an average score of 2.58 (SD: 0.77), compared to the benefits it provides.

However, there was not much variation at the ward level. Mukaa recorded slightly higher satisfaction (M = 2.71, SD = 0.85), compared to Kiima-Kiu (M = 2.53, SD = 0.76) and Kasiekeu (M = 2.53, SD = 0.70). The small differences suggest that the perceived value of money is relatively consistent throughout the study area, with the level of service and/or costs being the only factor that may account for the disparity.

In general, the findings suggest that households consider the water services to be costly and the returns less than what they derive from the services, which can engender less satisfaction and affect water consumption, particularly among the women who manage household water consumption.

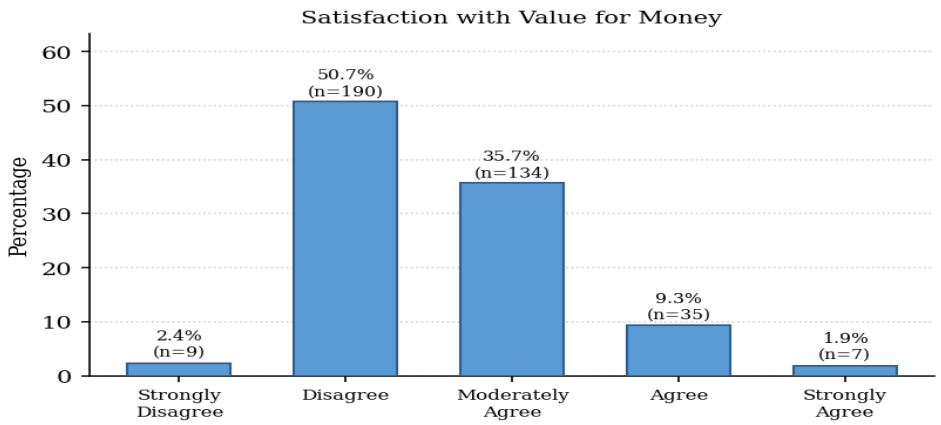


Figure 21 Satisfaction with Value for Money

Note. Bar chart of response distribution (SPSS); percentages and frequencies shown above bars.

Treatment Costs

Costs of Treating Water for Domestic Use. The expenses associated with the treatment of water for human consumption. Water for domestic use: costs of treatment. The price of purified water supply to domestic purposes was widely construed to be fairly expensive. The overall distribution and ward-level statistics are presented in Table 28 below. A majority of the people (50.1%) disagreed that treatment costs were under control - only 13.9% disagreed strongly. While 26.4% slightly agreed, and 9.6% (9.1% agree, 0.5% strongly agree) indicated that the cost of treatment was manageable, the overall average response value for cost of treatment was 2.32 (SD 0.84) – which indicates an overall tendency to disagree.

Table 28 Costs of Treating Water for Domestic Use

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	52	13.9%		
2 – Disagree	188	50.1%		
3 – Moderately Agree	99	26.4%		
4 – Agree	34	9.1%		
5 – Strongly Agree	2	0.5%		
Kasiekeu			2.31	0.78
Kiima-Kiu			2.27	0.86
Mukaa			2.42	0.89

The majority of respondents saw the cost of domestic water treatment as relatively high. The cost of treatment was not affordable or manageable for 63.9% of respondents, and was for 9.6%, as indicated in Table 28. The score for overall perception of the cost of water treatment to households (2.32, SD = 0.84) suggests a general feeling that water treatment is burdensome to households.

The differences at the ward level were very slight. Mukaa recorded a slightly higher mean (M = 2.42, SD = 0.89), followed by Kasiekeu (M = 2.31, SD = 0.78) and Kiima-Kiu (M = 2.27, SD = 0.86). The differences seen between these small variations imply that, in general, these experiences were similar and may only be marginally different in various wards because of differences in household income or treatment practices.

Overall, the results show that the total cost of water treatment is of significant importance to the overall cost of obtaining safe water. This could reduce household water consumption and add to women's workload, as they are traditionally responsible for household water management.

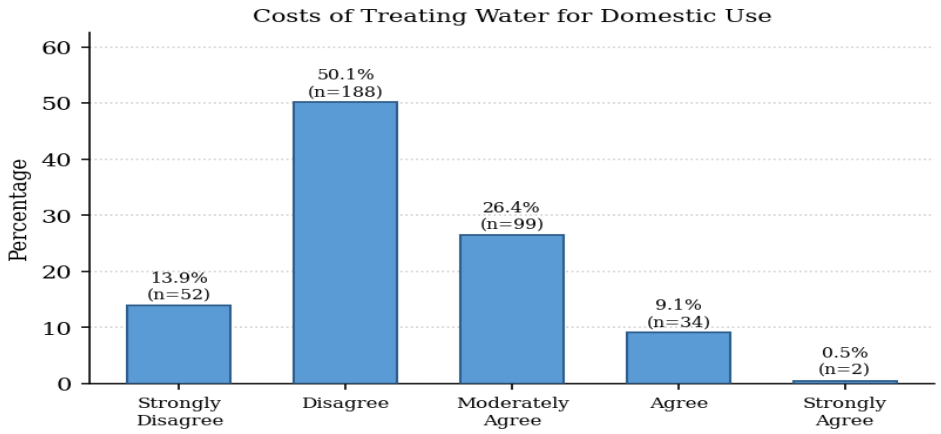


Figure 22 Costs of Treating Water for Domestic Use

Note. Bar chart of response distribution (SPSS); percentages and frequencies shown above bars.

Affordability of Water Treatment Methods. The perceived costs for the necessary water treatment procedures were usually low amongst the respondents. The overall response and ward-wide results are shown in Table 29 below.

Table 29 Affordability of Water Treatment Methods

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	20	5.3%		
2 – Disagree	231	61.6%		
3 – Moderately Agree	88	23.5%		
4 – Agree	31	8.3%		
5 – Strongly Agree	5	1.3%		
Kasiekeu			2.34	0.78
Kiima-Kiu			2.35	0.75
Mukaa			2.51	0.77

As seen in Table 29, the majority of the respondents believed that water treatment techniques are costly. 66.9% disagreed, and 9.6% agreed that they had access to treatment methods. The mean score of 2.39 (SD = 0.77) indicates that overall, people are not getting a good water treatment at the household level.

There were no significant differences between wards. Mukaa recorded a slightly higher perception of affordability (M = 2.51, SD = 0.77), followed by Kiima-Kiu (M = 2.35, SD = 0.75) and Kasiekeu (M = 2.34, SD = 0.78). The small variations shown in these differences indicate that affordability constraints are fairly consistent across the study area and are only slightly different, perhaps due to income or treatment options within the household.

The overall results show that water treatment costs remain a challenge for access to safe water. This may result in the misuse of water in the household and aggravate the load to women who are responsible for water safety in the household.

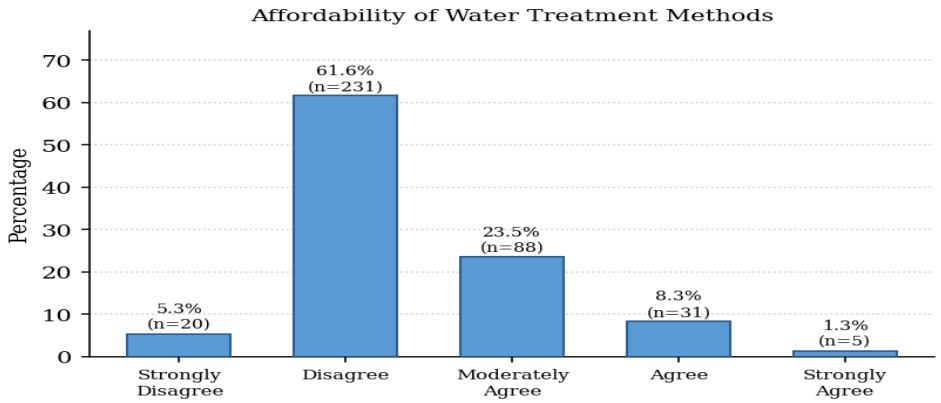


Figure 23 Affordability of Water Treatment Methods

Note. Bar chart of response distribution (SPSS); percentages and frequencies shown above bars.

Awareness of Affordable Water Treatment Options. The respondents also generally had limited knowledge of affordable water treatment options. The overall and ward-level statistics are shown in Table 30.

Table 30 Awareness of Affordable Water Treatment Options

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	21	5.6%		
2 – Disagree	227	60.5%		
3 – Moderately Agree	105	28.0%		
4 – Agree	15	4.0%		
5 – Strongly Agree	7	1.9%		
Kasiekeu			2.32	0.64
Kiima-Kiu			2.32	0.77
Mukaa			2.46	0.76

It is observed, as presented in the result of Table 30, that all the respondents have a low level of general knowledge about the available water treatment economically, which is available. Overall, 5.9% agreed or strongly agreed, and 65.1% disagreed or strongly disagreed that they knew such options existed. The mean score

of the study population is 2.36 (SD 0.73), which suggests that awareness of the population was overall low.

There were no significant differences at the ward level. Mukaa had some slight higher awareness (M = 2.46, SD = 0.76) as compared to the two other areas of low awareness (Kiima-Kiu M = 2.32; Kasiekeu M = 2.32). The small differences reflect poor awareness and potential for limited gains to be achieved if only at a local sensitisation and/or information availability level in each ward.

The overall result showed that there was limited awareness of the availability of affordable water treatment technology in the household, which might impact household water use safety and motivate households to use unsafe water sources, and consequently, women's health and livelihood activities.

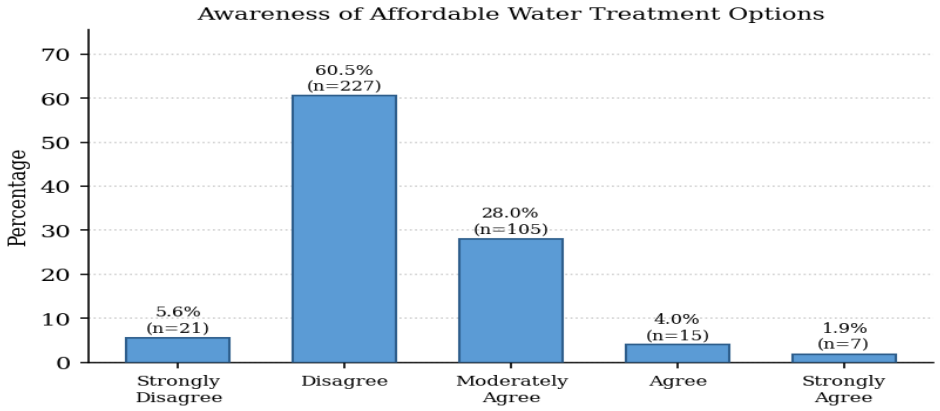


Figure 24 Awareness of Affordable Water Treatment Options

Note. Bar chart of response distribution; percentages and frequencies shown above bars.

Manageability of Water Treatment Costs. The general impression of the respondents towards the cost of water treatment for domestic purposes was that it was somewhat unmanageable. Table 31 provides the overall and ward-level responses in terms of the response distribution.

Table 31 Perceived Manageability of Water Treatment Costs

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	8	2.1%		
2 – Disagree	207	55.2%		
3 – Moderately Agree	94	25.1%		
4 – Agree	34	9.1%		
5 – Strongly Agree	32	8.5%		
Kasiekeu			2.64	0.93
Kiima-Kiu			2.76	1.07
Mukaa			2.54	0.87

Table 31 reveals that most of the respondents felt that water treatment expenses are difficult to manage. In total, 57.3% disagreed or strongly disagreed that treatment costs were "manageable," and 17.6% agreed or strongly agreed. The average score is 2.67 (SD=0.98), indicating that, in general, water treatment costs are not affordable by most households.

There was little variation in differences at the ward level. Kiima-Kiu recorded slightly higher perceived manageability (M = 2.76, SD = 1.07), followed by Kasiekeu (M = 2.64, SD = 0.93) and Mukaa (M = 2.54, SD = 0.87). These are small differences and broadly similar experiences within wards, with only small differences likely to be related to income levels or availability of cheaper alternative treatment.

The overall findings suggest that the cost of water treatment is still high, as it remains difficult to afford for the majority of households, which may have an impact on access to safe water and added pressure to women, as they are the main providers of household water for most of the households.

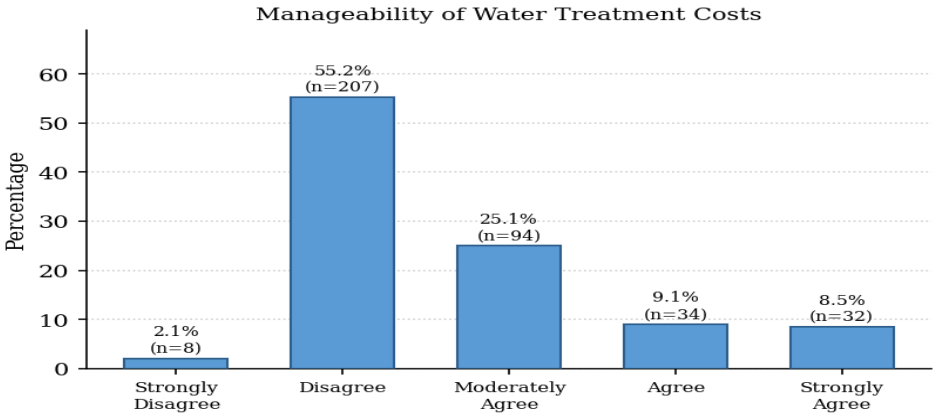


Figure 25 Manageability of Water Treatment Costs

Note. Bar chart of response distribution (SPSS); percentages and frequencies shown above bars.

Discussion on the Findings on Accessibility Infrastructure for Potable Water

Ease of Access

Ease of Access to Water Sources. The majority of the respondents thought that the water sources were not easily accessible, as indicated in Table 32.

Table 32 Ease of Access to Water Sources

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	14	3.7%		
2 – Disagree	234	62.4%		
3 – Moderately Agree	85	22.7%		
4 – Agree	37	9.9%		
5 – Strongly Agree	5	1.3%		
Kasiekeu			2.48	0.76
Kiima-Kiu			2.34	0.74
Mukaa			2.51	0.83

Table 32 shows that the majority of the respondents thought that the sources of water were not easily available. In total, 66.1% of people disagreed or strongly disagreed that water sources were conveniently located, with 11.2% agreeing or strongly agreeing. Overall, accessibility is rated as poor with a mean score of 2.43 (SD = 0.77) for the study area.

There was little variation at the ward level. Mukaa recorded slightly better perceived access (M = 2.51, SD = 0.83), followed by Kasiekeu (M = 2.48, SD = 0.76) and Kiima-Kiu (M = 2.34, SD = 0.74). The small differences indicate generally similar access conditions in the wards, which is assumed to be due to distance to water points and limited infrastructure coverage.

Overall, the results suggest that access to water sources is still a major challenge in the study area. This can also be an additional time and resource-consuming task for water collection, which is mainly done by women.

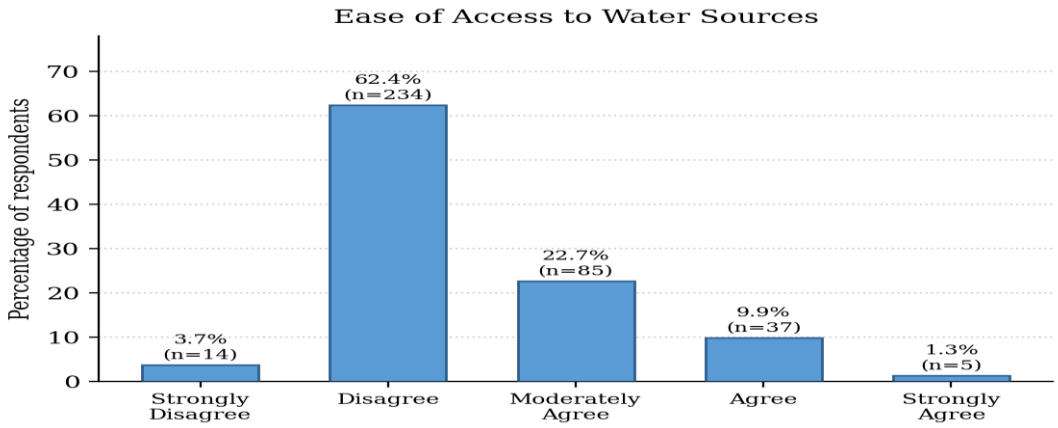


Figure 26 Ease of Access to Water Sources

Ease of Transporting Water from Source to Home. The findings on the transportation of water show that most of the respondents have difficulties in transporting water to their households, as shown in Table 33 below.

Table 33 Ease of Transporting Water from Source to Home

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	64	17.1%		
2 – Disagree	166	44.3%		
3 – Moderately Agree	113	30.1%		
4 – Agree	29	7.7%		
5 – Strongly Agree	3	0.8%		
Kasiekeu			2.24	0.85
Kiima-Kiu			2.29	0.88
Mukaa			2.41	0.87

Table 33 shows that the majority of the respondents have challenges in transporting water from the sources to their homes. Overall, 61.4% disagreed or

strongly disagreed that it was easy to transport water by water, while 8.5% agreed or strongly agreed. The mean score of 2.31 (SD = 0.87) indicates that, in general, households feel that transporting water is physically strenuous.

At the ward level, differences were minimal, with Mukaa recording slightly better ease of transport (M = 2.41, SD = 0.87), followed by Kiima-Kiu (M = 2.29, SD = 0.88) and Kasiekeu (M = 2.24, SD = 0.85). These differences suggest that the distance to water sources and lack of transportation have an equal influence on the households across the study area.

The findings are consistent with the UNICEF and World Health Organization (WHO) findings of 2021, indicating that water insecurity in the home is also reduced by water collection that involves long distances and much physical effort. Similarly, women's water transportation burden is greater than men's (Njora and Yilmaz, 2021), and transportation issues are also linked to water transportation burden.

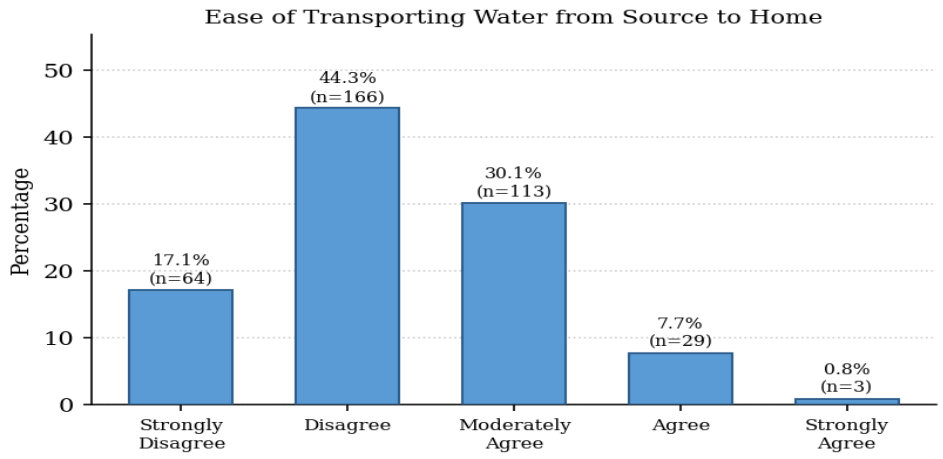


Figure 27 Ease of Transporting Water from Source to Home

Note. Bar chart of response distribution (SPSS); percentages and frequencies shown above bars.

Distance to the Water Source. The results show that the proximity to the water sources is inconveniencing to most of the respondents, as presented in Table 34 below.

Table 34 Distance to the Water Source

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	69	18.4%		
2 – Disagree	173	46.1%		
3 – Moderately Agree	114	30.4%		
4 – Agree	14	3.7%		
5 – Strongly Agree	5	1.3%		
Kasiekeu			2.20	0.82
Kiima-Kiu			2.18	0.79
Mukaa			2.36	0.93

Generally, 46.1% did not agree that distance to water sources was reasonable, and 18.4% did not agree strongly with this point, agreeing with 30.4% moderately agree, and only 5% (3.7% agreed, 1.3% strongly agreed) were satisfied with the distance. The overall trend is that it will be expected to be more negative than positive, and the mean score was 2.23 (SD = 0.84) to reflect this.

Ward-level analysis indicates that the respondents at the Mukaa had the most inconvenience (M = 2.36, SD = 0.93) as compared to Kasiekeu (M = 2.20, SD = 0.82), and Kiima-Kiu (M = 2.18, SD = 0.79). However, there is a perceived difference in spite of it, and even a perception that the best is a big problem. These results show that the distance to water sources is a significant burden on water at the household level, and this may be related to the frequency of water collection and the water security of the household overall.

The findings align with the previous findings that long distances to water sources reduce the frequency of water collection and have a negative impact on household water security, particularly for women and children who are tasked with collecting the water in most instances (Njora & Yılmaz,2021; UNICEF & WHO, 2021). Therefore, any physical change that reduces the distance to water is essential for improving access to sufficient and sustainable potable water.

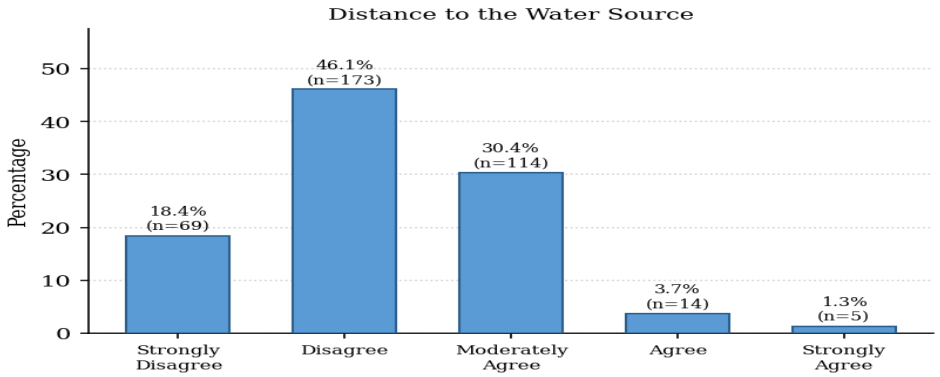


Figure 28 Distance to the Water Source

Note. Bar chart of response distribution; percentages and frequencies shown above bars.

Queueing and Waiting Times

Queue Waiting Time. As indicated in the table below (Table 35), most of the respondents are not going to view water collection times as too long.

Table 35 Waiting Times for Water Collection

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	16	4.3%		
2 – Disagree	225	60.0%		
3 – Moderately Agree	90	24.0%		
4 – Agree	38	10.1%		
5 – Strongly Agree	6	1.6%		
Kasiekeu			2.36	0.72
Kiima-Kiu			2.51	0.86

Mukaa	2.45	0.77

In general, 60 percent of the respondents disagreed, and 4.3 percent strongly disagreed that they were required to wait too long; 24 percent agreed moderately, and a smaller percentage (10.1 percent agreed, 1.6 percent strongly agreed) had a long wait. With an average of 2.45 (SD = 0.80), there is an overall disposition to disagree, which implies that the problem with ‘queueing' can't be a significant constraint to access to water.

In the ward level (Table 35), the respondents at the Kiima-Kiu had a slightly longer waiting time (M = 2.51, SD = 0.86) than at the Kasiekeu (M = 2.36, SD = 0.72) or Mukaa (M = 2.45, SD = 0.77). The general impression of the long queues is not that of the typical queue. At shared water points, these observations suggest that there are queues present but are typically under control and do not significantly impact water access. This is in line with previous research, which found that even if there is a possibility of queueing, this is not a major constraint on accessing water if household members can coordinate water collection times (Njora, 2021; UNICEF & WHO, 2021). Interventions that improve access to water, therefore, can better concentrate on minimising the distance to water sources and ease the transport of water instead of reducing queues.

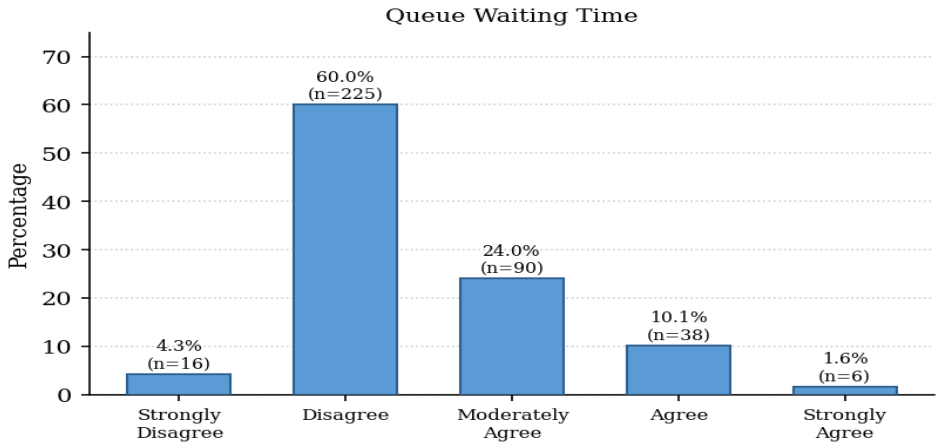


Figure 29 Queue Waiting Time

Note. Bar chart of response distribution; percentages and frequencies shown above bars.

Queueing System Organization. Table 36 below shows that the general perception of the respondents about the water source queueing system is that it is not well organized, or is absent at all.

Table 36 Perception of Queueing System Organization

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	14	3.7%		
2 – Disagree	234	62.4%		
3 – Moderately Agree	85	22.7%		
4 – Agree	37	9.9%		
5 – Strongly Agree	5	1.3%		
Kasiekeu			2.48	0.76
Kiima-Kiu			2.34	0.74
Mukaa			2.51	0.83

The general agreement on whether the queueing system was organized well or not was 62.4% disagree and 3.7% strongly disagree, with 22.7% (19.9% agree, 1.3 strongly agree) having a moderate response. It was only 11.2% (9.9% agreed, 1.3% strongly agreed) that the system was organised. The average (SD = 0.77) is 2.43,

indicating that the respondents in the given sample are slightly less satisfied with the organization of queues, thus suggesting that most of the respondents are not satisfied with the organization of queues.

Mukaa respondents had a slightly higher score (M = 2.51, SD = 0.83) than the results of Kasiekeu (M = 2.48, SD = 0.76) and Kiima-Kiu (M = 2.34, SD = 0.74) at the ward level (Table 36); though, the perception in all wards is low. The results of this study suggest that even though there are certain organizational measures, they are not enough to promote the efficient collection of water. This is in line with the previous studies, which pointed out poor management of existing water sources or informal water sources, which reduced the efficiency of water access, and physical and temporal costs of water collection, particularly for women and children who were the main collectors of water to their household (Njora & Yılmaz, 2021; UNICEF & WHO, 2021). The scheduling of the queues, therefore, would make it difficult to access the form of the water queue and would also save time and effort in water collection.

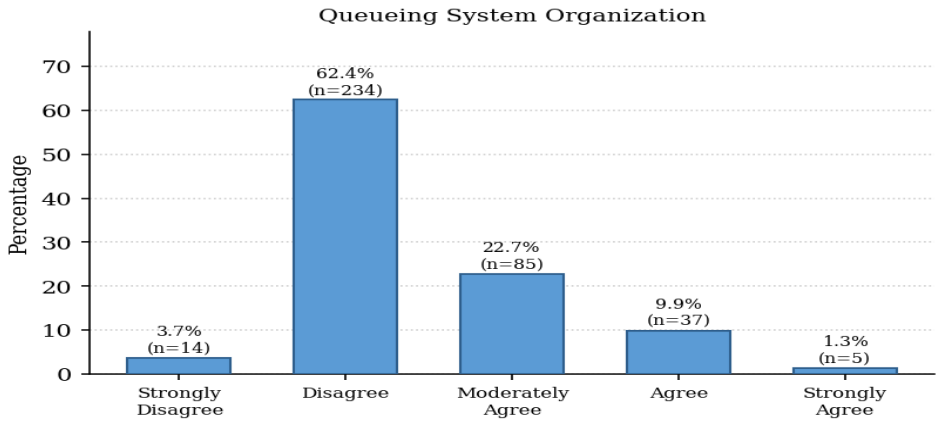


Figure 30 Queueing System Organization

Note. Bar chart of response distribution; percentages and frequencies shown above bars.

User-Friendliness

Maintenance and Cleanliness. Table 37 below shows that the overall perception of the respondents about the sources of water is either poor or unsanitary.

Table 37 Perception of Water Source Maintenance and Cleanliness

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	8	2.1%		
2 – Disagree	238	63.5%		
3 – Moderately Agree	104	27.7%		
4 – Agree	16	4.3%		
5 – Strongly Agree	9	2.4%		
Kasiekeu			2.34	0.59
Kiima-Kiu			2.44	0.73
Mukaa			2.45	0.82

Overall, 63.5% disagreed (and 2.1% strongly disagreed) that the water source was in good condition and clean; 27.7% (moderate agree; 2.4% strongly agree) considered the water sources in a good condition. There is a widespread concern about maintenance and cleanliness, and on average, 2.41 (SD =.72) respondents chose rather to disagree.

Respondents' overall perception of the sources being well-maintained and clean was low at all wards, but respondents in ward Mukaa (M = 2.45, SD = 0.82) were more satisfied with well-maintained and clean sources as compared to ward Kasiekeu (M = 2.34, SD = 0.59) and ward Kiima-Kiu (M = 2.44, SD = 0.73) (Table 37). The findings of this research suggest that improved maintenance and sanitation of water points are required to make water points user-friendly. These findings corroborate findings in previous studies, which indicated that poor maintenance and hygiene in water sources will discourage their use and the likelihood of waterborne

diseases (Mensah et al., 2020; Obeng et al., 2021). Therefore, improvement of the maintenance and cleanliness of the water source is significant so that it can improve the users' satisfaction and increase healthy water source usage.

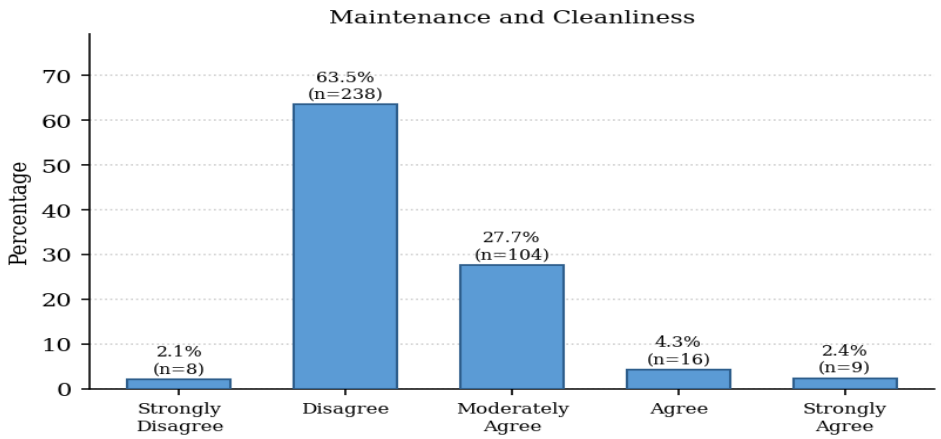


Figure 31 Maintenance and Cleanliness

Overall Condition of Water Access Points. According to the data provided in Table 38 below, the majority of respondents are not satisfied with the overall state of water access points.

Table 38 Satisfaction with the Overall Condition of Water Access Points

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	20	5.3%		
2 – Disagree	207	55.2%		
3 – Moderately Agree	93	24.8%		
4 – Agree	47	12.5%		
5 – Strongly Agree	8	2.1%		
Kasiekeu			2.42	0.77
Kiima-Kiu			2.48	0.90
Mukaa			2.66	0.87

Overall, fifty-five-point two percent (55.2) and five-point three percent (5.3) disagreed and strongly disagreed with the statement that they are satisfied with the water access points, respectively, while 24.8% were moderately satisfied. Satisfaction

was only 14.6% (12.5% agree, 2.1% strongly agree). The overall score is 2.51 (SD = 0.86), which indicates an overall dissatisfaction tendency in the users.

The ward level analysis provided in Table 38 shows that perceptions of satisfaction were slightly higher in the ward of Mukaa (M = 2.66, SD = 0.87) than in Kiima-Kiu (M = 2.48, SD = 0.90) and Kasiekeu (M = 2.42, SD = 0.77), but still negative. This has made the provision of better quality and location of water points more important, so that the water point is more user-friendly. Such findings corroborate previous studies, which showed that poorly maintained and poor quality water access points can reduce the satisfaction of the water users, quantity of water collected, and overall water security of households (Mensah et al., 2020; Obeng et al., 2021). Improvement of the infrastructure and water access points in general is important in order to improve accessibility and feedback on the satisfaction of water services.

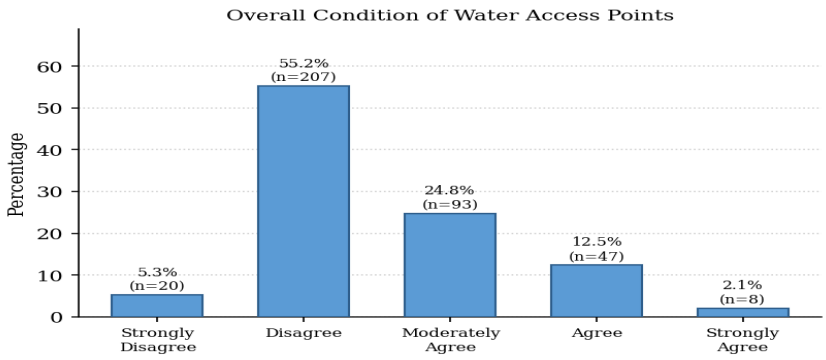


Figure 32 Overall Condition of Water Access Points

Note. Bar chart of response distribution; percentages and frequencies shown above bars.

Discussion on the Findings on the Livelihoods of Women

Income Generation

Influence of Potable Water on Income. As shown in Table 39 below, the earning potential of women is positively affected by the availability of clean water.

Table 39 Influence of Potable Water on Women's Income Generation

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	5	1.3%		
2 – Disagree	8	2.1%		
3 – Moderately Agree	28	7.5%		
4 – Agree	178	47.5%		
5 – Strongly Agree	156	41.6%		
Kasiekeu			4.18	0.81
Kiima-Kiu			4.31	0.81
Mukaa			4.26	0.75

On the whole, 47.5% of the respondents confirmed, and 41.6% vigorously confirmed that more access to potable water facilitated their earning higher income, with only 10.9% (1.3% strongly disagree, 2.1% disagree, and 7.5% somewhat agreed) indicating that it did not have a significant effect on them. The mean value of 4.26 (SD = 0.79) indicates that clean water at all times is a very sensitive parameter to support women's income generation processes.

The ward-level analysis (Table 39) indicates that the respondents of Kiima-Kiu reported the greatest positive impact (M = 4.31, SD = 0.81), then Mukaa (M = 4.26, SD = 0.75) and Kasiekeu (M = 4.18, SD = 0.81). These findings imply that in

all wards, safe and continuous water access is an important facilitator of women's economic activity.

These results align with the previous studies, which show that the increased access to safe water increases the productivity of women, their free time to engage in income-generating activities, and livelihoods in general households (Giné-Garriga et al., 2019; Komatsu et al., 2021; Njora and Yilmaz, 2021). Therefore, interventions in water need to be directed towards regular and reliable availability of water, and at the same time strengthen women's economic empowerment and livelihood.

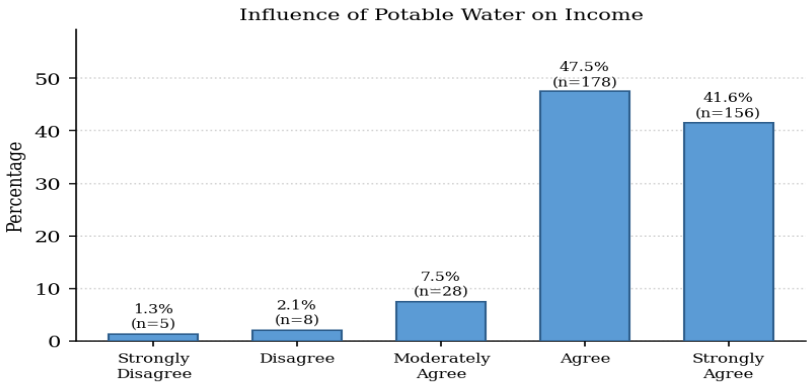


Figure 33 Influence of Potable Water on Income

Note. Bar chart of response distribution (SPSS); percentages and frequencies shown above bars.

Effect of Time Spent Fetching Water on Income. The findings in Table 40 below show that the time spent collecting water has a significant impact on the ability of women to engage in income-generating activities.

Table 40 Effect of Time Spent Fetching Water on Women's Income Generation

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	4	1.1%		
2 – Disagree	10	2.7%		
3 – Moderately Agree	22	5.9%		
4 – Agree	191	50.9%		
5 – Strongly Agree	148	39.5%		
Kasiekeu			4.28	0.76
Kiima-Kiu			4.35	0.63
Mukaa			4.05	0.95

Generally, 50.9 percent reported that water collection has an impact on their income-earning potential; 39.5 percent (1.1 percent strongly disagree, 2.7 percent disagree, 5.9 percent moderately agree) reported that water collection has a minor

impact. The average result of 4.25 (SD = 0.77) indicates that there is a high agreement that time spent on collecting water limits economic activities.

Table 37 shows that Kiima-Kiu respondents were impacted the most (M = 4.35, SD = 0.63), then Kasiekeu (M = 4.28, SD = 0.76), and Mukaa (M = 4.05, SD = 0.95). The results suggest that, in all the wards, the burden of collecting water by women negatively affects their livelihoods, with a differential impact in different areas.

The results are consistent with the findings of the earlier studies that highlighted the detrimental effect of distance and long travel time for drinking water on the effort of women and their income-generating activities (Komatsu et al., 2021; Njora & Yilmaz, 2021; World Bank, 2019). The results show that one of the key factors to increase economic empowerment of women and improve household health is to make water more accessible.

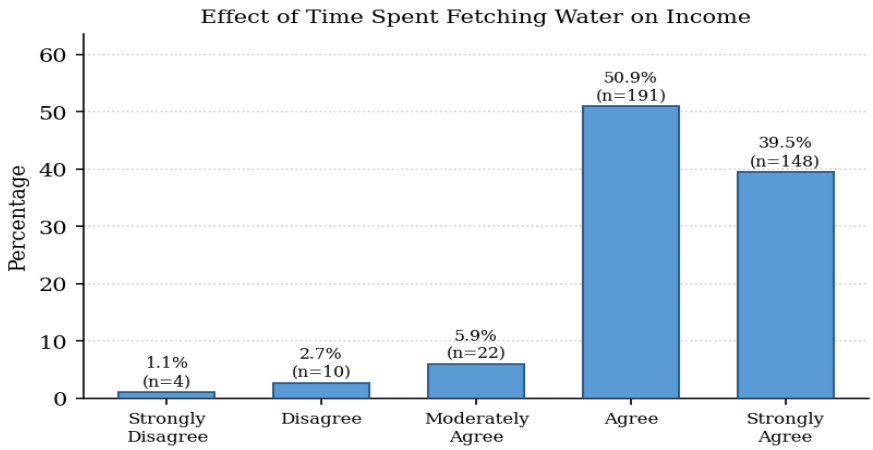


Figure 34 Effect of Time Spent Fetching Water on Income

Note. Bar chart of response distribution (SPSS); percentages and frequencies shown above bars.

Effect of Clean Water Availability on Income from Specific Activities. As shown in Table 41 below, access to clean water has a positive effect on women's income in different types of livelihood activities.

Table 41 Effect of Clean Water Availability on Income from Specific Activities

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	2	0.5%		
2 – Disagree	16	4.3%		
3 – Moderately Agree	32	8.5%		
4 – Agree	188	50.1%		
5 – Strongly Agree	137	36.5%		
Kasiekeu			4.05	0.88
Kiima-Kiu			4.24	0.71
Mukaa			4.22	0.83

Overall, 50.1% of the respondents indicated that having access to clean water impacted their income, while 36.5% strongly agreed and 13.3% didn't feel it had much impact. The mean score of 4.18 (SD = 0.80) shows that there was a high level of agreement that having access to reliable drinkable water is a big enabler to income generation.

On the ward level analysis, the perceived impact was highest among the respondents in Kiima-Kiu (M = 4.24, SD = 0.71), followed by Mukaa (M = 4.22, SD = 0.83) and Kasiekeu (M = 4.05, SD = 0.88). This, therefore, means that a clean water supply in any particular ward is directly related to livelihood income increment.

The results support previous studies that found improved access to safe water positively impacts women's working capacity in livelihoods and economic

empowerment (Komatsu et al. 2021; Njora & Yilmaz 2021; World Bank 2019). Regular availability of clean water is a consequence of the economic and household well-being of women.

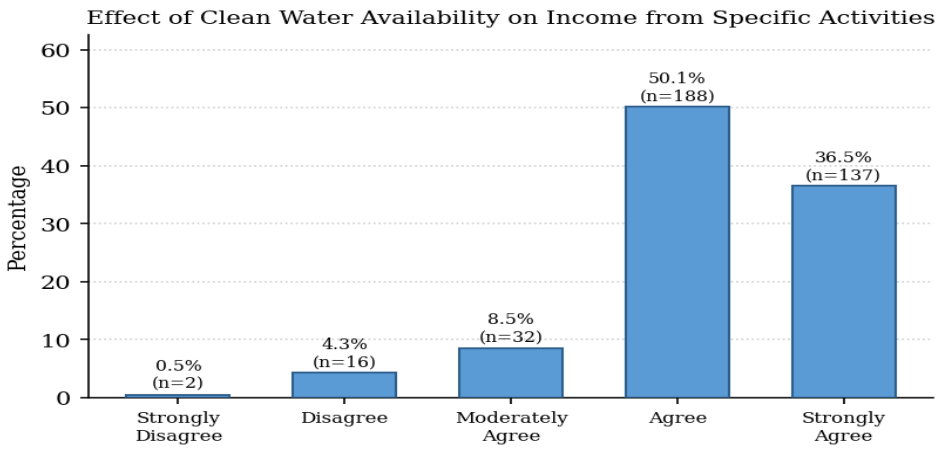


Figure 35 Effect of Clean Water Availability on Income from Specific Activities

Asset Ownership

Effect of Access to Potable Water on Asset Generation. As shown in Table 39 below, the availability of potable water has positively impacted the ability of women to accumulate assets

Table 42 Effect of Potable Water Access on Asset Generation

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	5	1.3%		
2 – Disagree	8	2.1%		
3 – Moderately Agree	28	7.5%		
4 – Agree	178	47.5%		
5 – Strongly Agree	156	41.6%		
Kasiekeu			4.18	0.81
Kiima-Kiu			4.31	0.81
Mukaa			4.26	0.75

Overall, 47.5% of the respondents indicated that their access to potable water has improved their asset generation activities; 41.6% strongly agreed, 10.9% moderately agreed, and 7.5% agreed. Generally, 47.5% of the respondents said they have improved their asset generation activities due to having access to potable water, while 41.6% strongly agreed to this, 10.9% moderately agreed, and 1.3% disagreed, and 2.1% strongly disagreed. A mean value of 4.26 (SD = 0.79) indicates a high level of some degree of agreement, showing that consistent access to water is key to the economic empowerment of women by means of amassing assets.

The analysis of ward-level (Table 39) demonstrates that the perceived impact was greatest among Kiima-Kiu respondents (M = 4.31, SD = 0.81), then Mukaa (M = 4.26, SD = 0.75) and Kasiekeu (M = 4.18, SD = 0.81). The results in all wards indicate that women feel that access to safe drinking water is an important asset creation facilitator.

The results are consistent with those of other studies, which have shown that better access to safe and reliable water helps women to earn income and build assets and thus improve the welfare of the household and empower women economically (Komatsu et al., 2021; Njora and Yilmaz, 2021; World Bank, 2019).

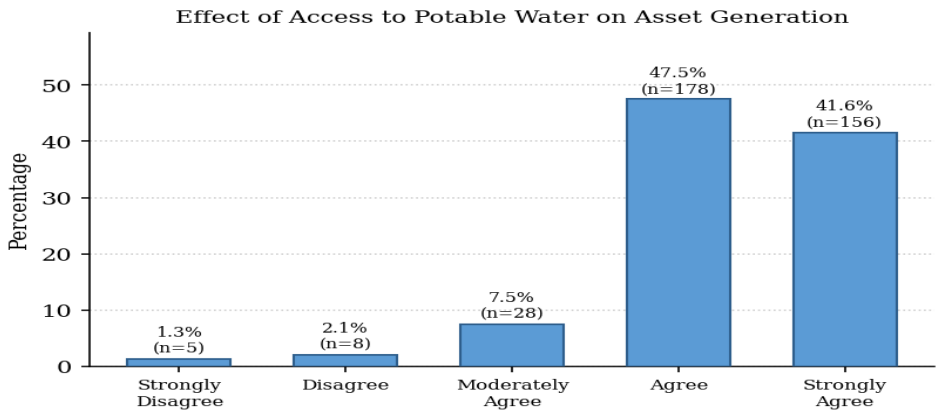


Figure 36 Effect of Access to Potable Water on Asset Generation

Note. Bar chart of response distribution (SPSS); percentages and frequencies shown above bars.

Influence of Clean Water on Income from Specific Activities. According to the results in Table 43 below, access to clean water has positively impacted the income of women in the given livelihood activities.

Table 43 Influence of Clean Water Availability on Income from Specific Activities

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	2	0.5%		
2 – Disagree	16	4.3%		
3 – Moderately Agree	32	8.5%		
4 – Agree	188	50.1%		
5 – Strongly Agree	137	36.5%		
Kasiekeu			4.05	0.88
Kiima-Kiu			4.24	0.71
Mukaa			4.22	0.83

In general, 50.1 percent of the respondents said that access to potable water was a source of income generation, 36.5 percent strongly agreed, and only 13.3 percent (0.5 percent strongly disagreed, 4.3 percent disagreed, 8.5 percent moderately agreed) said that access to potable water had minimal or no impact. The average of 4.18 (SD = 0.80) indicates a great degree of consensus, indicating that clean water is an important factor to support the income-generating activities.

The result of ward-level analysis shows that the respondents in Kiima-Kiu, Mukaa, and Kasiekeu felt the positive impact was slightly higher in Kiima-Kiu (M = 4.24, SD = 0.71), followed by the respondents in Mukaa (M = 4.22, SD = 0.83) and the respondents in Kasiekeu (M = 4.05, SD = 0.88), respectively, but all the wards recorded positive impact. This was consistent with the prior studies, which

demonstrated that women's productivity improves along with improved access to safe water, the reduction of time spent exchanging water, and an increase in income generation and household activities, enhancing women's economic empowerment (Njora & Yilmaz, 2021; Komatsu et al., 2021; World Bank, 2019).

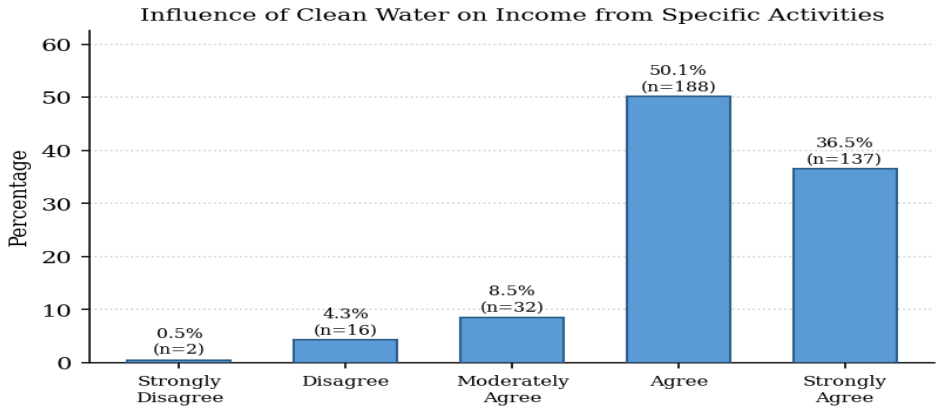


Figure 37 Influence of Clean Water on Income from Specific Activities

Note. Bar chart of response distribution (SPSS); percentages and frequencies shown above bars.

Influence of Water Access on Asset Accumulation Decisions. Table 44 below shows that the differences in the water availability have a considerable impact on the decisions of women concerning the accumulation of assets. On the whole, 48.0% strongly agreed, and 36.5% agreed that water availability impacts their accumulating asset capacity, whereas only 15.4% (4.5% no influence, 10.9% moderately influential) said there was no significant effect. There is a high level of consistency (mean score = 4.17, SD = 0.79) around the extent to which access to water at all times can be a determinant in financing and receiving other assets.

Table 44 Influence of Water Access on Asset Accumulation Decisions

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	0	0.0%		
2 – Disagree	17	4.5%		
3 – Moderately Agree	41	10.9%		
4 – Agree	180	48.0%		
5 – Strongly Agree	137	36.5%		
Kasiekeu			4.21	0.74
Kiima-Kiu			4.14	0.84
Mukaa			4.15	0.79

The ward-level analysis shows that the ward respondents in Kasiekeu felt the most impacted (M = 4.21, SD = 0.74), then Mukaa (M = 4.15, SD = 0.79), and Kiima-Kiu (M = 4.14, SD = 0.84), with all the wards reporting positive effects. The results could be compared with other researchers who found that reliable access to water allows women to save time and effort spent in collecting water, thereby facilitating their ability to plan their economies and build assets to support their livelihoods (Njora & Yilmaz, 2021; Komatsu et al., 2021; World Bank, 2019).

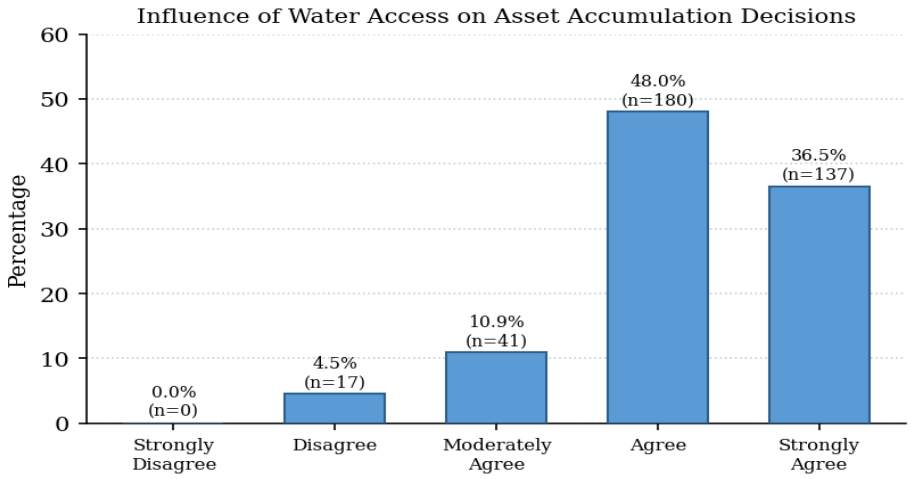


Figure 38 Influence of Water Access on Asset Accumulation Decisions

Note. Bar chart of response distribution (SPSS); percentages and frequencies shown above bars.

Occupational Diversity

Influence of Water Access on Income-Generating Activities. The findings in Table 45 below show that access to clean water has a positive impact on the interest of women in income-generating activities.

Table 45 Influence of Water Access on Occupational Engagement

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	5	1.3%		
2 – Disagree	8	2.1%		
3 – Moderately Agree	28	7.5%		
4 – Agree	178	47.5%		
5 – Strongly Agree	156	41.6%		
Kasiekeu			4.18	0.81
Kiima-Kiu			4.31	0.81
Mukaa			4.26	0.75

Overall, 47.5% of the respondents agreed with the statement (41.6% agreed strongly, 11.0% agreed a little or not at all). The mean score is 4.26 with a standard deviation of 0.79, showing a high level of agreement; therefore, a good access to water will result in involvement in work and better performance.

On the ward level, analysis shows that the respondents at Kiima-Kiu recorded a high level of influence (M = 4.31, SD = 0.81), followed by those at Mukaa (M = 4.26, SD = 0.75) and the lowest influence score at Kasiekeu (M = 4.18, SD = 0.81). The findings align with the literature available on the link between improved access to clean water and higher occupational diversity and productivity among women, as they can shift their time and effort away from water collection to other economic activities that are important both for the economy and in the household (Njora & Yilmaz, 2021; Komatsu et al., 2021; World Bank, 2019).

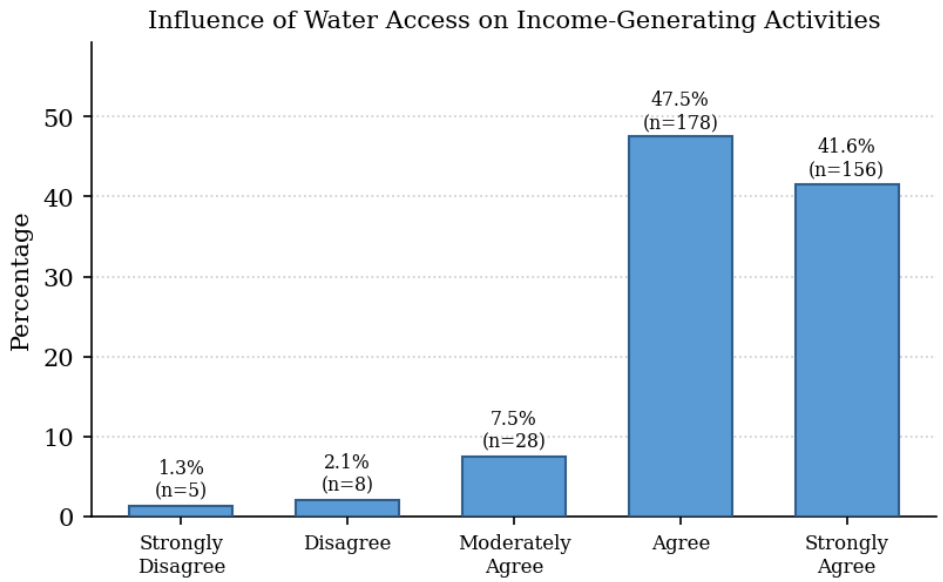


Figure 39 Influence of Water Access on Income-Generating Activities

Note. Bar chart of response distribution (SPSS); percentages and frequencies shown above bars.

Influence of Clean Water on Income from Specific Activities. The results of Table 46 below indicate that the supply of clean water has a positive impact on the income of women as they engage in different livelihood activities.

Table 46 Influence of Clean Water Availability on Income from Specific Activities

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	2	0.5%		
2 – Disagree	16	4.3%		
3 – Moderately Agree	32	8.5%		
4 – Agree	188	50.1%		
5 – Strongly Agree	137	36.5%		
Kasiekeu			4.05	0.88
Kiima-Kiu			4.24	0.71
Mukaa			4.22	0.83

All in all, 50.1 percent of those who responded to the question agreed, and 36.5 percent strongly agreed with the statement, with only 13.3 percent (0.5 percent strongly disagreed, 4.3 percent disagreed, and 8.5 percent moderately agreed) having minimal or no effects. The average score of 4.18 (SD = 0.80) is a strong degree of agreement, which implies that access to clean water is a very potent way of improving the economic opportunities and the economic involvement of women in productive activities.

Further analysis at the ward level revealed that the highest perceived impact was reported by the respondents of Kiima-Kiu (M = 4.24, SD = 0.71), followed by Mukaa (M = 4.22, SD = 0.83) and Kasiekeu (M = 4.05, SD = 0.88), with all the wards reporting a strong positive impact. The findings are consistent with studies conducted in the past, showing that safe water has the potential to boost productivity and economic participation of women by reducing the time and physical burden of fetching water, consequently enabling women to engage in other economic activities (Komatsu et al., 2021; Njora & Yilmaz, 2021; World Bank, 2019).

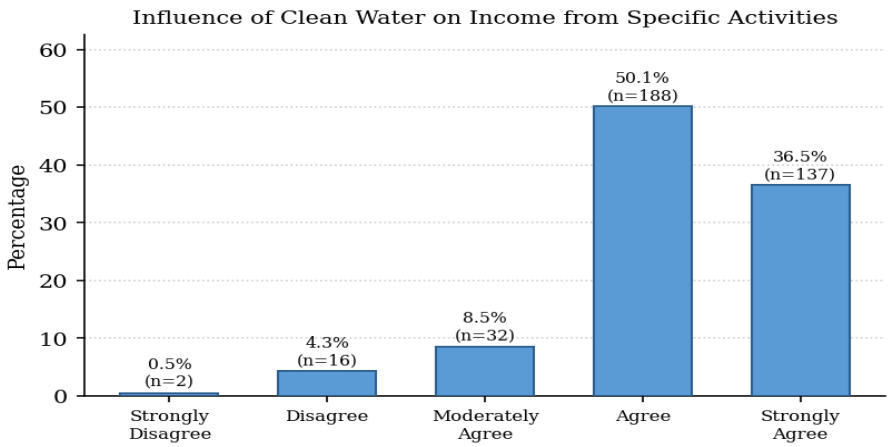


Figure 40 Influence of Clean Water on Income from Specific Activities

Note. Bar chart of response distribution (SPSS); percentages and frequencies shown above bars.

Influence of Water Access on Asset Accumulation Decisions. The results in Table 47 below suggest that differences in access to water are an important factor in deciding on asset accumulation by women. Overall, 48.0% agreed, 36.5% strongly agreed, and 15.4% (4.5% disagreed and 10.9% moderately agreed) said that they were hardly influenced by it. The mean score is 4.17 (SD = 0.79), representing a high level of agreement, which suggests that greater access to water is associated with positive impacts on financial planning and asset-related decisions of women.

Table 47 Influence of Water Access on Asset Accumulation Decisions

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	0	0.0%		
2 – Disagree	17	4.5%		
3 – Moderately Agree	41	10.9%		
4 – Agree	180	48.0%		
5 – Strongly Agree	137	36.5%		
Kasiekeu			4.21	0.74
Kiima-Kiu			4.14	0.84
Mukaa			4.15	0.79

The mean and standard deviation of the ward comparisons also show that the respondents of Kasiekeu reported the highest impact (M = 4.21, SD = 0.74), followed by Mukaa (M = 4.15, SD = 0.79) and then Kiima-Kiu (M = 4.14, SD = 0.84). All wards expressed a positive attitude toward the role water access plays in asset decision-making, although there were some variations. These results are aligned with the available literature that shows that the presence of reliable water access helps decrease the labour burden on women and liberate time and resources to invest in

long-term and engage in economic planning (Komatsu et al., 2021; Njora & Yilmaz, 2021; World Bank, 2019).

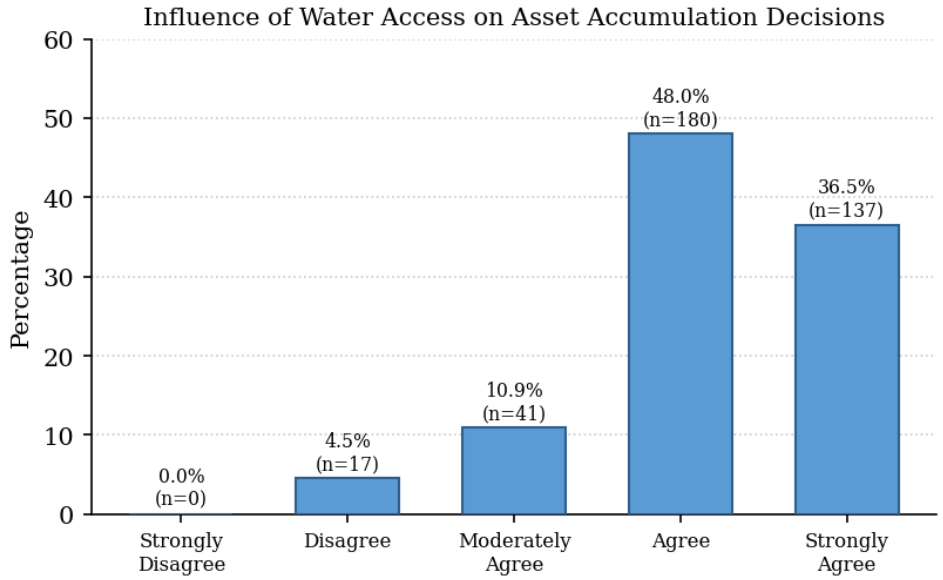


Figure 41 Influence of Water Access on Asset Accumulation Decisions

Note. Bar chart of response distribution (SPSS); percentages and frequencies shown above bars.

Effect of Time Spent Fetching Water. The results, as shown in Table 48 below, reveal that time spent in water gathering significantly affects the income-generating activities of women.

Table 48 Impact of Time Spent Fetching Water on Income-Generating Activities

Response / Ward	Frequency	Percentage	Mean	SD
1 – Strongly Disagree	4	1.1%		
2 – Disagree	10	2.7%		
3 – Moderately Agree	22	5.9%		
4 – Agree	191	50.9%		
5 – Strongly Agree	148	39.5%		
Kasiekeu			4.28	0.76
Kiima-Kiu			4.35	0.63
Mukaa			4.05	0.95

Overall, the majority (50.9%) agreed that water collection time is an important factor in their livelihood, while a small proportion (9.7%) disagreed, and (5.9%) agreed it was moderately important. The mean score (+/- SD) of 4.25 (+/- 0.77) reflects a high level of consensus on the time constraints of women obtaining water as the primary direct constraint to women's participation in economic activities.

The analysis of wards also indicates that the highest perceived impact is reported by the Kiima-Kiu (M = 4.35, SD = 0.63), followed by Kasiekeu (M = 4.28, SD = 0.76) and then Mukaa (M = 4.05, SD = 0.95). Although there are some variations regionally, the high scores on the wards indicate high levels of awareness of the time limitations on women's livelihoods when it comes to water collection. The findings are in line with the previous studies showing that reduced time spent fetching water for drinking and cooking contributes to saving time for productive activities and negatively affects the economic participation of women and the household's welfare (UNICEF, 2021; Komatsu et al., 2021).

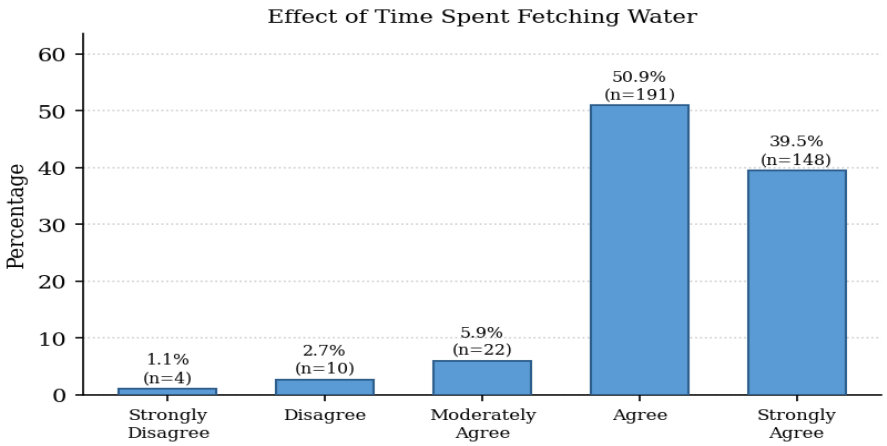


Figure 42 Effect of Time Spent Fetching Water

Note. Bar chart of response distribution (SPSS); percentages and frequencies shown above bars.

Qualitative Interview Findings: Key Informant Perspectives on Water Access and Women's Livelihoods

Profile of Key Informants

The demographic characteristics of key informants were analysed to contextualize the qualitative findings and establish the credibility of the perspectives provided. The profile of participants is presented in Table 49.

Table 49 Demographic Profile of Key Informants

Demographic Variable	Categories	Number of Respondents	Percentage (%)
Age Bracket	Less than 25 years	0	0%
	26–35 years	3	30%
	36–45 years	5	50%
	Above 45 years	2	20%
Gender	Male	6	60%
	Female	4	40%
Organization/Role	Local Administration Officials	2	20%
	Community Leaders	3	30%
	NGO Officers	5	50%
Ward of Residence/Operation	Kiima-Kiu	4	40%
	Mukaa	3	30%
	Kasiekeu	3	30%

Ten key informants took part as shown in Table 46; they were officials of the local administration (20 percent), community leaders (30 percent), and NGO officers (50 percent). The majority were aged between 36 and 45 years (50%), followed by those aged 26 and 35 years (30%), indicating that most informants possessed substantial professional and community experience relevant to water governance and livelihood issues. Male respondents comprised 60 percent, whereas the female respondents were 40 percent, which enabled gender-varied institutional viewpoints.

Table 47 summarizes the spatial and institutional distribution of informants and gives information on the representation of wards and organizational roles.

Table 50 Key Informant Distribution by Organization and Ward

Organization/Role	Ward	Number of Respondents
Local Administration Officials	Kiima-Kiu	1
Local Administration Officials	Mukaa	1
Community Leaders	Kiima-Kiu	1
Community Leaders	Mukaa	1
Community Leaders	Kasiekeu	1
NGO Officers	Kiima-Kiu	2
NGO Officers	Mukaa	2
NGO Officers	Kasiekeu	1
Total respondents		10

Table 50 shows that there were more ward representatives from Kiima-Kiu ward (40%), followed by Mukaa (30%) and Kasiekeu (30%). The qualitative data were triangulated by involving administrative officials, community leaders, and NGO actors in all the wards, which improved the credibility of the qualitative data.

Key Informant Interviews

The thematic analysis resulted in 8 main themes, all of which aligned with the study aims and theoretical framework. The Sustainable Livelihoods Framework, Gender Role Theory, and Access Theory are used to provide a foundation for interpretation and to understand how structural, social, and institutional factors affect women's livelihoods.

Theme One: Water availability as a structural constraint on livelihoods.

Water availability was a recurring theme as a major limiting factor on women's livelihood activities. Women have been reported to experience irregular and unpredictable water supply, having a significant impact on the time they spend

productively, deepening time poverty and thereby restricting access to income-generating activities, education, and community engagement.

A Local Administration Official commented:

Women frequently need to walk hours to fetch water due to water scarcity, thereby depriving them of time they could be spending on income-generating activities or education.

An NGO officer also pointed out:

Water is not always available, and this has significant effects on the capacity of women to carry out household tasks and productive activities.

A Community Leader also noted the “seasonality” of the situation:

When it's dry season, women go out very early in the morning, and sometimes they come back very late in the day, "and the whole day goes on searching for water".

Another NGO respondent commented:

Women drop out of farming and small businesses due to the lack of water. When there is a lack of water, survival is the No. 1 priority.

The accounts show that the direct impact of water scarcity is on women's livelihoods, diverting their time to livelihood maintenance activities. The results also indicate that socio-economically deprived females are more affected, as they do not have enough resources to buy water or invest in water storage facilities, and thus contribute to the widening of livelihood inequalities.

Theme Two: Water Affordability and Financial Constraints. Water availability was found to be one of the influencing factors for women's economic

participation. According to the respondents, increased water rates are affecting their financial resources and restraining investment in other livelihood activities like farming and small businesses.

A Community Leader:

Women in poor households have a hard time providing sufficient funds to purchase water, and must spend more time obtaining water from a distant location.

“An NGO officer touched on the issue:

However, women would be able to engage in productive work if they could have access to affordable water, and many households are in poverty as a result of high costs.

A Local Administration Official explained that:

“In some homes, people have to prioritize getting water, while neglecting their other basic needs, such as paying school fees.”

Another respondent noted:

In times of drought, low-income families will be the first to be affected by rising food costs, and they will resort to drinking unsafe water.

These findings show that the availability of water is a determinant of livelihoods as well as a service issue. More costly water has a negative effect on household disposable income, and it disproportionately affects low-income households, thereby creating socio-economic inequities in outcomes for livelihoods.

Theme Three: Water Quality, Water-based Health Burdens, and Livelihood Capacity. Water Quality, Water-based Health Burden, and Livelihoods

Capacity. Poor quality water was noted as one of the factors that could impact women's productivity and health. Consumers strongly noted that unsafe water makes them sick often, increases the workload of the caretakers, and leads to loss of economic activity.

A Community Leader explained that:

Household members have to carry out the responsibility of water, and hence, women are more vulnerable to frequent water-borne diseases.

“This is a rare occurrence that we are seeing, and it is not yet clear what the cause is.”

Women use most of their time to take care of sick children, in the presence of contaminated water, rather than be productive.”

A member of the security guard organisation at an NGO told me:

We have numerous instances of women not attending the market due to children's illnesses caused by unsafe water consumption.

Another respondent observed:

Low water quality results in increases in health care expenses and reduced earnings.

The findings indicate a direct and indirect livelihood impact due to poor water quality, poor labour productivity as a result of sickness, and increased unpaid care work. The effects of these impacts are greatest in poor households that lack access to water treatment, thus increasing health and economic inequalities.

Theme Four: Infrastructure and Physical Accessibility Barriers. Barriers: The lack of water infrastructure was a common structural barrier to access to water and women's livelihoods. Long distances to water sources, water tanker breakdowns, and crowding were mentioned as major issues.

An officer with an NGO pointed out:

Women in some areas have to walk a very long distance to fetch water and hence cannot engage in farming and business activities.

A Local Administration Official said:

There is a lack of infrastructure at water points, and women have to wait for hours.

A Community Leader responded:

In case of a borehole collapse, it can take several months to repair it, and women will have to walk longer distances to access the toilet.

Another NGO respondent commented:

With piped water, there is more time available for women to participate in income-generating activities and domestic chores.

These results show that better facilities drastically cut down the time and physical exertion needed to fetch water. A reliable water supply is a critical factor that enables women to engage in gainful livelihoods and, subsequently, the well-being of the whole household.

Theme Five: Socioeconomic Differences and Coping Strategies. Water insecurity is felt differently by different socio-economic groups, with respondents

highlighting this. The adaptive capacity was also greater for the richer households, as they had more water storage and/or financial resources to purchase water.

Community Leader said:

Availability of water to women and the time spent getting water depend on the income of the household.

An NGO officer commented:

The lack of storage tanks and private water supply has the most significant impact on poor households.

A Local Administration Official added, "It is a reflection on the importance of the role.

“Poorer families struggle with shortages every day, while those with more resources are better able to deal with them.

Another respondent observed:

Resilience to water shortages is related to socio-economic status.

The results indicate that water insecurity contributes to social and economic inequalities. The situation is even worse for women in poor households, as they have fewer coping resources, thus limiting their livelihood opportunities.

Theme Six: Cultural norms and gender norms around labour distribution. Water responsibilities were determined as one of the cultural factors. Respondents pointed out that women and girls are largely responsible for collecting water, thereby reducing their opportunities to engage in other productive activities.

The NGO officer added:

“When men are present, women are supposed to do the housework, cook, and carry water.

A Community Leader said that:

Girls are more likely to be taken to collect water, and this affects attendance at school and time spent studying.

Another respondent observed:

Water collection is considered one of the responsibilities of women and contributes to their workload.

The results reveal that the unequal distribution of labour between the genders exacerbates water insecurity for women and girls. This will continue to create inequities in structure and education, economic opportunity, and empowerment.

Theme Seven: Policy implementation and institutional gaps. Implementation of policy and institutional shortcomings. The fact that water-related policies and interventions were in place was mentioned; however, the discussion focused on implementing and sustaining these policies.

A Local Administration Official has stated that:

Although there are policies in place, there is a gap between implementation, and most policies are not reaching the most vulnerable households.

An NGO officer commented:

Some projects to improve access in the short term have maintenance issues.

A Community Leader has said:

Funding for donors running out is a major reason for projects' failure.

Another respondent added:

Coordination is important for water interventions to be sustainable.

The findings show that, while some policy documents exist, low implementation and sustainability impact on their effectiveness in boosting women's livelihoods.

Theme Eight: Recommended actions. Some of the interventions recommended by key informants to contribute to water security and women's livelihoods in Kilome Sub-County were noted. They noted that water availability, water cost, and water safety will significantly reduce the time pressure on women and give them more opportunities to be involved in productive economic activities. An NGO officer summarized that if water is accessible, affordable, and safe, women would have more time available to do income-generating and other productive works. Likewise, the Community Leader highlighted the advantage of being located near water sources; water should be brought to the household since women spend most of their time travelling to fetch water, and the process is time-consuming.

This view was reflected in the prioritisation of actions that were identified by the participants. This included enhancing and sustaining existing water system infrastructure that was already reliable, such as boreholes and piped systems, reducing distance and waiting time. They also called on low-income families to reduce their water bills to be affordable and thus reduce the burden of water on vulnerable families. The need for improvement of water quality monitoring systems and water treatment to prevent water-borne diseases and protect human health was called for. Moreover, respondents mentioned that women's sensitisation is an important problem to address in order to ensure a more equitable distribution of

water-gathering responsibilities within the home. Finally, it was proposed to give specific attention to vulnerable socio-economic groups, to ensure interventions are directed towards the most vulnerable to water insecurity.

To conclude, the recommendations point to the importance of a holistic and integrated approach to water governance – one that can address a range of infrastructure, affordability, and health concerns, as well as socio-economic and gender disparities that impact women's livelihoods.

Chapter Summary

The quantitative findings were presented and analysed together with the qualitative findings, which were presented and analysed separately. The reliability and validity testing were conducted at the beginning of the chapter, and the Cronbach's alpha values were obtained from the reliability of measurements of the study constructs, and the measurements used in the study had acceptable to excellent reliability.

Based on the findings of descriptive statistics, the constraint of water was found to be the most important constraint; neither the frequency nor the reliability was high. The accessibility and affordability issues are seen as a relative problem, whereas water quality issues are seen as a serious problem due to their health implications. The water availability in livelihood activities was generally positively correlated with livelihood indicators in the aspects of livelihood income production, livelihood asset acquisition, and livelihood workforce participation.

The outcome of the regression analysis showed that availability, accessibility, and the quality of water were statistically significant, while the affordability of water was statistically less influential on women's livelihoods. Education level and age

were also determined to be important demographic factors, and a focus on human capital for livelihood development was emphasised.

The convergences were very high in both the qualitative and quantitative analyses. The theme of unreliability of water supply was found in both data sources, and it was associated with time poverty, reduced economic involvement, and deep-rooted gender inequality. The Sustainable Livelihoods Framework, Gender Role Theory, and Access Theory were used to analyse the results, as it gives a lens to understand the structural, institutional, and sociocultural determinants of women's livelihoods.

The chapter concludes that multidimensional water security has a great influence on the economic empowerment of women, the well-being of the household, and social participation in Kilome Sub-County. The results emphasize the need for a comprehensive strategy, which encompasses water infrastructure, access to water at an affordable price, gender-inclusive programming, and strengthening of governance, as a means to tackle gender inequalities in water access and enhance women's livelihoods.

CHAPTER FIVE: SUMMARY OF FINDINGS AND RECOMMENDATIONS

The chapter will summarize the study results, utilize the research objectives to give the research conclusions, discuss implications of research results, and come up with policy/practical recommendations. The study looked at the water security position in Kilome Sub-County and the effects of the water security dimensions (availability, quality, affordability, and accessibility) on the women's lives.

Summary of Findings

The study aims to provide an understanding of the impact of water security on the household livelihood in Kilome Sub-County. The results are a list of outcomes of the quantitative survey and the analysis of interviews conducted with the representatives of the water officers, community leaders, and women's groups (Key Informant Interviews [KIIs]). They juxtaposed four water security dimensions (availability, quality, affordability, and accessibility) and livelihood indicators.

Water Availability

Generally, there was low water availability in the study area. The mean availability was 2.14 (SD = 0.50). The area of availability, frequency, and reliability shows that the respondents experience randomness in the supply of their supplies and a shortage in the quantity of supplies that they have to use in their domestic and productive activities. The most water-stressed households were in high-laying and dry areas, and in the dry season, some households in these areas used seasonal streams and water-trucking services. Examples include boreholes and piped schemes, both of which have irregular pump schedules, old pipe, and storage deficiency – all of which are major informant suggestions and result in inconsistent service. I was told by one of the local administrators that not enough to feed everyone, but where is it

available? Water is one of the key constraints for agricultural productivity and household livelihood security.

Water Affordability

Generally, there was low water availability in the study area. The mean availability was 2.14 (SD = 0.50). Average (mean) values of availability (1.55), frequency (2.09), and reliability (2.07) suggest that the respondents are subject to randomness in supply and shortage of quantities of supplies for both domestic and productive activities. Households living in the high-laying dry areas were found to be most water-stressed, and in the dry season, they relied on seasonal flow streams and water-trucking services. Examples include boreholes and piped schemes, both of which have irregular pump schedules, as well as old pipe and storage deficiencies, key informant suggestions, resulting in inconsistent service. One of the local administrators told me, "Not enough to feed everybody, where is there any supply? One of the major factors limiting agricultural production and livelihood security is water.

Water Accessibility

The score on accessibility was low, with an average score of 2.46 (SD 0.48). The challenges that were raised in the responses include long walking distances, long queuing times, and difficult terrain. The cause of the problem was the queuing, especially (Mean = 2.44, SD = 0.69), in which women woke up earlier in the morning to get water. KIIs identified that women and girls are the primary water collectors and that, in turn, is depriving them of time for school, care of children, and income generation. More women will participate in community enterprises and decision-making, and more people will have water, according to key informants.

Impact on Livelihoods

The overall situation in livelihood results was satisfactory, with a mean total score of 4.21 and an SD of 0.62, which means that household livelihoods are based on several livelihoods. The four dimensions of water security were sequentially entered into the model; the four dimensions accounted for 11.8 percent of the variation in the livelihood outcomes (Model 1), and when the socio-economic status and demographic factors (age and education) were added to the model, the four dimensions accounted for 39.1 percent of the variation (Adjusted $R^2 = .376$) (Model 2). This only added a small amount ($\Delta R^2 = .018$, $p = .028$), and this revealed that the socio-economic status added a small amount of partial moderation to the relationship. Overall, improved living conditions with access to water (especially water quality) were correlated with higher livelihood diversification, food production, and investments in small-scale businesses (especially for better-resourced households).

Important Predictors of Livelihood Results.

Access to and quality of water, education, and age were also important determinants of livelihoods. It does not mean that infrastructure alone is an indicator of how and whether households can enhance their well-being when they have access to water. KIIs identified the contribution of the community in water governance, such as the involvement of women in the water committee's leadership and the budgeting process.

Implications of the Findings.

The findings of this research have great implications for the water resources, livelihood, and gender responsive development of Kilome Sub-County. The findings also show that the concern of water security is not just about the provision of

essential water services, and hence water is an important factor that affects the social-economic well-being. Water security dimensions alone explained 11.8% of variance in livelihood outcomes, and when combined with water security, household socio-economic status, age, and education, the complete model explained 39.1% of the variance (Adjusted $R^2 = .376$), suggesting that water security operates in conjunction with socio-economic status, age, and education. Thus, water availability, affordability, quality, and accessibility, as well as the socio-economic status of the households, should be factored into livelihood interventions.

Policy Implications

Low perceived water supply (Mean = 2.14) and low perceived accessibility (Mean = 2.46) mean that the current water supply is inadequate to satisfy household and productive needs. The findings suggest the need for:

Investments in the water infrastructure, including rehabilitation of boreholes, extension of piped water supply, and expansion of household and community water storage.

Affordability by price/inequality of affordability – if prices go up, poorer households will be even more dependent on the less secure sources of water. Policy setups should offer protection to the poorest households from marginalization in the event of price changes.

The community water management is constantly improving, especially the participation of women, as it should be in the water management committees. The key informants have observed that the women have been involved in decision-making in relation to daily water use, and even time management.

Water and health policy integration: Higher water quality will be linked to a reduction in water-borne diseases, which will lead to increased productivity and a decline in household medical expenses, over time, due to this policy.

Overall, the Kilome water policy could be said to be a ‘supply' water security policy, albeit not a full ‘equity-based' water security policy.

Theoretical Implications

All of this helps to perpetuate livelihood and gender development paradigms that assume that once women and men are given access to what they need, it is their personal ability and ability to adapt as a family. Specifically:

Given the various theoretical links between availability, quality, and access and livelihood outcomes, the Sustainable Livelihoods Framework, which assumes that natural and physical capitals are foundations of economic and social wellbeing, is warranted.

The qualitative evidence about the burden of water collection corroborates Gender and Development Theory, which holds that apportionment of water to women reduces their opportunities for education, leadership, and enterprise.

Evidence for the role of education as a predictor of livelihood outcome provides a mediating variable of human capital and could be used to describe how far households can extend the water access benefits to gains in economic productivity.

This is indicative of the moderating effect of the socio-economic status of the household, as described in the Ecological Systems Theory, which suggests that the child's outcome is influenced by the nested environmental systems. The outcomes of

households' livelihoods were different in these water security systems, showing that water security is not independent of the wider socio-economic system.

Thus, the study contributes to empirical knowledge and understanding that water security is a precondition that not only facilitates livelihoods but can also obstruct them, particularly for women.

Practical Implications

It demonstrates that improved water security at the household and community level can translate to tangible and quantifiable impacts in terms of increases in productivity and well-being. This has implications for practice in that:

Women would also have extra time to invest in income-generating activities because they don't have to miss out time to fetch water. The respondents of KII have found a direct negative relation between the travel time and the productive hours in a day; similarly, a direct negative relation between the queuing time and the productive hours in a day has been found.

The other positive effect of improved drinking water would be a reduction in health care costs, as women would spend more of their time and resources on economic and educational activities, rather than on health care.

Community sensitisation and collective responsibility programmes for domestic work gaps can also contribute to reducing gendered labour gaps and slowly changing the social norms on gendered gaps in domestic work.

Improvement of water access should be linked with small enterprises and agricultural productivity, and women's leadership training in the development of the best livelihoods.

Finally, the results show that enhancing water security is not just about providing a service but also an economic empowerment tool, a health promotion tool, and a gender equity tool.

Conclusion

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Study Recommendations.

These recommendations are based on empirical evidence and qualitative insights with the aim of strengthening water security and livelihoods in the Kilome Sub-County. These are the recommendations to be implemented through policy, institutional, and community levels to achieve coherent and sustainable outcomes.

Policy/Governance Recommendations.

Enhance Water Availability and Reliability.

The county and national governments should provide adequate funding for rehabilitating borewells, implementing piped water supply using gravity, protecting springs, and water storage tanks. The mean score of the unavailability (2.14) should be interpreted as the wards that have chronic unavailability must be prioritized. Creating on-reserve supply channels (i.e., more than one supply source to villages) will minimize supply disruptions in case of droughts.

Improve the Water Quality and monitoring.

Monitor water quality at these community water sites on a regular basis, and follow national water safety guidelines. The scores are not consistent, but show improvement in terms of Means (Mean = 2.71). The use of low-cost decentralized water treatment systems (such as chlorination kiosks, filtration systems) could greatly reduce water-borne disease.

Water Tariffs Reconsidered: A Question of Fairness and Affordability.

Water access should be a part of the County's economic development planning process. Water security contributed 11.8% to the variation in livelihoods, among other factors (socio-economic and demographic) that accounted for 39.1% of the variation in livelihoods; the contribution of water security was not sufficient for livelihoods. The policies should thus be linked to water supply and agriculture, enterprise development, education, and health care.

Integrate Work Livelihood and Development Planning into Water Security.

The County's economic development planning process should incorporate water access. Water security, along with socio-economic and demographic factors, accounted for 39.1% of the variation in livelihoods, of which 11.8% was water security; water security is a necessary, but not sufficient, factor for livelihoods. The policies should therefore be related to water supply and agriculture, enterprise development, education, and health care.

Programmatic and Institutional Recommendations.

Empower women by enhancing Livelihood Support Programs.

The time when poverty begins to decrease is the time of enhanced water access – women are being targeted with programs for their use of this time in productive activities. These are micro-enterprise trainings, agricultural value chain support, or savings and credit cooperatives (SACCOs).

Enhance Community-Based Water Availability and Government.

Support and facilitate Water User Associations (WUAs) in terms of open leadership, budgeting, and planning. There is a need to implement and monitor the

current policy of 50% representation of women on committees, which ensures that committees are more responsive and that the management of the committees is aligned with the most affected.

Enhance the Infrastructure Maintenance Systems.

Establish special funds and technical capacities to constantly repair water systems. Many failures contributing to the absence of supplies may be due to failings in the infrastructure, but not because the infrastructure has not been built, rather because the system of repair, the stock of spare parts, or trained persons has failed.

Promote Local Water Protection and Catchment Reforestation.

Predictions will be made for the conservation of springs, river banks, and recharge plots, and will provide a more stable water supply, especially during dry periods, through conservation efforts. These actions can be sustained through the activities of schools and community organizations.

Government and County Government Policy Recommendations.

Based on the results of this paper, the following policy recommendations are made to the government leadership and county governments to tackle the water access problem and boost the women's livelihood in Kilome Sub-County:

1. **Equitable Water Tariffs and Affordability Policy.**

   The government should start the fair water pricing mechanisms so that all households can even afford water, particularly the less privileged ones. The study revealed that the cost of water is an issue for many, including women. The impact of the new tax system should be least on the poor, who should be protected by

implementing a graduated tax system, in which the rates are based on the socio-economic status of the household. It could also take into account the subsidy for a water treatment system or rainwater system, so clean water can be affordable.

2. **Enhancement of Water Infrastructure.**

   Rural areas will need to be improved in terms of water infrastructure as well, with a particular emphasis on those areas that rely on seasonal rivers and open earth pans, and this will be the role of the County. Investment needs to be allocated to the reliable sources like pipes, boreholes, storage, etc., to ensure more availability of water. The analysis revealed that those sections of the area with the more developed infrastructure (e.g., piped water and boreholes) had water quality that is good, and this has been correlated with few health problems. The infrastructure should be strengthened by providing an appropriate maintenance strategy for sustainability as well.

3. **Water Quality Standards and Surveillan**ce.

   The government should set up a high water quality standard and a water quality monitoring and inspection system for water sources in the county. The study reveals that poor or untreated water in the family is associated with waterborne diseases, which have a great effect on women's health and productivity. The priority should be to build the capacity of the local government in monitoring water quality and facilitating water purification, particularly among poor families.

4. **Empowering Local Government and Community Engagement.**

   The local governments at the county level should be enhanced in terms of governance with regard to water management. This means capacity building of local water committees and involvement of the local population in decision-making processes in the context of access to water. The participation of women as

water stakeholders should be enhanced. From this research, it can be concluded that if women are involved in water management, it can lead to better sustainability and distribution of water resources. Policies must be formulated to make sure that women are effectively participating in water planning, implementation, and maintenance.

5. **Policy on Livelihood Support and Women's Empowerment**

   Governmental policies need to be created to incorporate water security with women's economic empowerment. Particular attention should be paid to programmes which will enable the women to collect water and earn some money during that time. These programmes can be related to small-scale agriculture and/or entrepreneurship, or skills. Governments can help women tap into the time they save by providing access to water, and can also provide livelihood support to women to utilize saved time for livelihoods, as well as income generation.

6. **Sustainable Water Use and Environmental Protection**.

   Water catchment protection policies should be implemented, and water use should be encouraged to be sustainable in County policies. This includes good land use and planting of trees or conservation of soils around significant water catchment areas. The findings of the research reaffirm a crucial message – water security is dependent on environmental protection for the long-term. The policies of the government should be to ensure the sustainability of water sources and minimise the degradation of the environment, which makes water available in the region.

7. **Public Awareness and Education Campaigns backed by the government.**

   Community awareness on the collection, treatment, and storage of safe water should be promoted and supported through the efforts of the government and local authorities. Health risks can be reduced by educating the population,

particularly women, on the use of low-cost household water treatment technologies like boiling, using chlorination tablets, or ceramic filters. The study findings show that there is a high prevalence of families drinking untreated water, especially low-income families, adding to health-related issues. The advocacy of community health education to the community's leaders and health volunteers will play a major role in the decrease of these risks.

Recommendations for further research

Building on the findings of this study on water security and livelihoods in Kilome Sub-County, several important gaps remain that warrant further investigation:

1. **Longitudinal impacts of water interventions on livelihoods**

   Future studies should track households over time to determine how sustained improvements in water availability, quality, affordability, and accessibility influence income diversification, food security, and women's economic empowerment.

2. **Causal evaluation of specific water infrastructure investments**

   There is a need for quasi-experimental or experimental studies to isolate the effects of specific interventions (e.g., borehole rehabilitation, piped water systems, or tariff subsidies) on household welfare and productivity outcomes.

3. **Gender dynamics in intra-household water labor allocation**

   Further research should examine how shifts in water access affect the division of labor between men, women, boys, and girls, and whether reduced water-fetching burdens translate into improved education and economic participation for females.

4. **Climate variability and water security interactions**

   More detailed hydrological and climate-resilience studies are needed to assess how drought frequency, rainfall variability, and environmental degradation influence the sustainability of rural water systems and livelihood stability.

5. **Institutional effectiveness of community water governance structures**

   Future work should evaluate the performance of Water User Associations and women's participation in decision-making, particularly how governance structures affect equity, efficiency, and system maintenance outcomes.

6. **Pathways linking water security to health and productivity**

   Additional interdisciplinary research should quantify how improvements in water quality and access reduce disease burden and translate into measurable gains in labor productivity and household income.

These areas would deepen understanding of water-livelihood linkages and support more targeted, evidence-based policy interventions in similar semi-arid and rural contexts.

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APPENDICES

APPENDIX I: PAC ISERC CONSENT FORM

INFLUENCE OF ACCESS TO POTABLE WATER ON WOMEN'S

LIVELIHOODS IN KILOME SUB-COUNTY IN MAKUENI COUNTY, KENYA

I ....., agree to participate in the research project titled "INFLUENCE OF ACCESS TO POTABLE WATER ON WOMEN'S LIVELIHOODS IN KILOME SUB-COUNTY IN MAKUENI COUNTY, KENYA",

Conducted by NJERI ELIAS MWANGI, who has discussed the research project with me.

I have received, read, and kept a copy of the information letter/plain language statement. I have had the opportunity to ask questions about this research, and I have received satisfactory answers. I understand the general purposes, risks, and methods of this research.

I consent to participate in the research project, and the following has been explained to me:

The research may not be of direct benefit to me my participation is entirely voluntary my right to withdraw from the study at any time without any implications to me the risks, including any possible inconvenience, discomfort or harm as a consequence of my participation in the research project the steps that have been taken to minimize any possible risks public liability insurance arrangements what I am expected and required to do whom I should contact for any complaints with the research or the conduct of the research.

I can request a copy of the research findings and reports, and I can confirm the security and confidentiality of my personal information.

I understand that anonymized quotes from my responses may be used in the researcher's dissertation, academic publications, or presentations, but no identifying information will be attached to such quotes.

The limits to confidentiality: If I disclose information about abuse, neglect, or harm to a child or a vulnerable adult, the researcher is legally and ethically obliged to report this to the relevant authorities for protection purposes.

In addition, I consent to the audiovisual recording of any part of, or all of, the research activities (if applicable) and to the publication of results from this study, provided that my identity will not be revealed.

Name**:**

Signature.....Date:.....

APPENDIX II: ORAL CONSENT SCRIPT

Title of Research Project:

EQUITABLE ACCESS TO PORTABLE WATER, HOUSEHOLD SOCIO-ECONOMIC STATUS, AND WOMEN'S LIVELIHOOD IN KILOME SUBCOUNTY, MAKUENI COUNTY, KENYA

Oral Consent Script *(to be read by the Research Assistant in Kiswahili, Kikamba, or English as appropriate):*

"Hello, my name is _____, and I am part of a research team from Pan Africa Christian University.
We are conducting a study on how access to clean water affects women's livelihoods in Kilome Sub-County, Makueni County Kenya.
You are being invited to participate because you are a woman living in this community. If you agree, you will be asked questions about your household's water access and your daily activities. This will take about 30–40 minutes.
Your participation is entirely voluntary. You may refuse to take part or stop at any time, with no adverse consequences. You may also skip any question you do not wish to answer.
The information you provide will be kept confidential. We will not write down your name, and no one will be able to identify you in the report.
There may be no direct benefits to you, but your participation will help us understand challenges women face and may inform programs to improve water access in this area.
Do you agree to participate in this study?"

If the participant agrees orally, the research assistant will record ***"Oral Consent Given"*** *on the consent form, and a witness (e.g., a literate family or community member) will sign on behalf of the participant.*

Witness Name (Print): _____
Witness Signature: _____
Date: _____

Research Assistant Name (Print): _____
Research Assistant Signature: _____
Date: _____

APPENDIX III: KEY INFORMANT INTERVIEW GUIDE (LOCAL ADMINISTRATION OFFICIALS, COMMUNITY LEADERS, AND NGO OFFICERS)

Study Title: Equitable access to portable water, household socioeconomic status, and women's livelihood in Kilome Sub-County, Makueni County, Kenya.

Target Respondents: Local Administration Officials, Community Leaders

Introductory Statement

Thank you for agreeing to participate in this interview. The purpose of this discussion is to understand your perspectives on how equitable access to potable water influences women's livelihoods in Kilome Sub-County. Your insights will help identify challenges, opportunities, and potential interventions. Responses will be kept confidential and used only for academic purposes.

Section A: Demographic Information
Please provide the following information:

Age bracket:

Less than 25 years [ ]

26–35 years [ ]

36–45 years [ ]

Above 45 years [ ]

Gender:

Male [ ]

Female [ ]

Other [ ]

Organization/Institution: _____

Designation/Occupation: _____

Ward of Residence/Operation:

Kiima-Kiu [ ]

Mukaa [ ]

Kasikeu [ ]

Interview Questions

1. From your perspective, how does the availability of potable water sources in Kilome Sub-County affect women's daily livelihoods (e.g., time use, economic activities, household responsibilities)?
2. What are your observations regarding the quality of potable water available to households, and how does this affect women's health, productivity, and caregiving roles?
3. In your opinion, how does the cost of accessing potable water (tariffs, vendors, treatment costs) influence women's economic participation and household well-being?
4. What challenges do women in this community face with respect to water accessibility infrastructure (e.g., distance to sources, waiting times, reliability of supply)?

5. Based on your experience, do socioeconomic differences among households (such as income, education, or asset ownership) affect how women experience and cope with water-related challenges?
6. How have water-related issues (availability, quality, affordability, infrastructure) affected women's ability to engage in income-generating activities, farming, or education?
7. Are there any local policies, community initiatives, or government interventions currently addressing potable water access in Kilome Sub-County? How effective have they been in supporting women's livelihoods?
8. What role do cultural norms or gender expectations play in shaping women's responsibilities around water collection and use in this community?
9. In your view, what priority actions or interventions would best improve equitable access to potable water and enhance women's livelihoods in Kilome Sub-County?
10. Is there anything else you would like to add regarding the link between water access and women's livelihoods in this community?

APPENDIX IV: QUESTIONNAIRE

Section A: Demographic Information

1. What is your age bracket?

   Less than 25 years [ ]

   26–35 years [ ]

   36–45 years [ ]

   Above 45 years [ ]

2. What is your highest education level?

   Certificate level [ ]

   Diploma level [ ]

   Graduate/Degree [ ]

   Postgraduate [ ]

   Others (specify) _____ [ ]

3. For how long have you been a resident of Makueni County?

   Less than 1 year [ ]

   1–5 years [ ]

   6–10 years [ ]

   Over 10 years [ ]

4. Ward of residence (select one):

   Kiima-Kiu [ ]

Mukaa [ ]

Kasikeu [ ]

5. What is your primary source of income/occupation?

Housewife [ ]

Farmer [ ]

Self-employed [ ]

Employed [ ]

Other (specify) _____ [ ]

Section B: Availability of Potable Water

1. Using a scale of 1-5, where 1-strongly disagree, 2 = disagree, 3-Moderately agree, 4 = agree, and 5 = strongly agree, kindly indicate your agreement level to the statements below that relate to the availability of potable water.

Statements	1	2	3	4	5
Quantities Available					
The amount of water available for household use is sufficient for my needs.					
There is enough water for all household activities (cooking, cleaning, hygiene, etc.).					
Water availability is adequate throughout the year.					
Frequency of Water Availability					

I have access to water for household use daily.					
The water source I rely on provides water consistently.					
Water shortages are rare.					
Reliability of Water Sources					
The water source I use is dependable.					
I can rely on my water source to provide water consistently, regardless of the season.					
The water quality from my source is consistently good.					

Section C: Quality of Potable Water

1. Using a scale of 1-5, where one strongly disagrees, 2- moderately 2-disagrees, 3-Moderately agrees, 4- agrees, and 5-strongly agrees, kindly indicate your agreement level to the statements below that relate to the quality of potable water.

Statements	**1**	**2**	**3**	**4**	**5**
Physical Characteristics					
The water I use for household chores (e.g., washing, cleaning) is generally clear and free of visible particles.					

The water I use for drinking and cooking has an acceptable taste.					
The water source I use has an unpleasant odor.					
The color of the potable water in my community is acceptable.					
The turbidity (cloudiness) of the potable water in my community is within acceptable limits.					
I take measures to disinfect or purify my water before drinking it.					

Section D: Affordability of Potable Water

1. Using a scale of 1-5, where 1 strongly disagrees, 2-disagrees, 3- Moderate, 4-Agree, and 5-Strongly agree, kindly indicate your agreement level to the statements below that relate to the affordability of potable water.

Statements	**1**	**2**	**3**	**4**	**5**
Water Tariffs/Fees					
The current water tariffs/fees are affordable for my household.					
I can comfortably pay the water tariffs/fees.					
The water tariffs/fees place a significant financial burden on my household.					
I understand how the water tariffs/fees are calculated.					
I find the water tariffs/fees to be reasonable					

compared to the service provided.					
Cost per Unit					
The cost of water per unit (e.g., per liter or cubic meter) is affordable.					
I can easily afford the amount of water my family needs at the current unit cost.					
The cost per unit of water has increased significantly in recent times.					
I am satisfied with the value I receive for the cost per unit of water.					
The cost per unit of water is a significant expense for my household.					
Treatment Cost					
The costs associated with treating water for domestic use are manageable.					
I can afford the necessary water treatment methods for my household.					
The cost of water treatment makes it difficult to access safe drinking water.					
I am aware of affordable water treatment options available to me.					
The cost of treating water is a barrier to ensuring my family has safe water.					

Section E: Accessibility Infrastructure for Potable Water

1. Using a scale of 1-5, where one strongly disagrees, two disagrees, three moderately agrees, four agrees, and five strongly agrees, kindly indicate your agreement level with the statements below that relate to accessibility infrastructure for potable water.

Statements	1	2	3	4	5
Ease of Access					
The water source is conveniently located for me to reach					
The path to the water source is easy to navigate (e.g., not too steep, rocky, or slippery).					
I can easily transport water from the source to my home.					
The distance to the water source is reasonable.					
Queueing and Waiting Time					
I usually have to wait a long time to collect water at the source.					
The waiting time at the water source is acceptable.					
The queueing system (if any) at the water source is organized and fair.					
I can usually collect water quickly without much waiting.					
User-Friendliness					
The water collection point (e.g., tap, well, pump) is easy to use					

The water source is well-maintained and clean.					
I feel safe when I go to collect water at the source.					
I am satisfied with the overall condition of the water access point.					

Section F: Livelihoods of Women

1. Using a scale of 1-5, where one strongly disagrees, 2-disagree, 3-Moderately agree, 4-Agree, and 5-Strongly agree, kindly indicate your agreement level to the statements below that relate to principals' recruitment capacity.

Statements	**1**	**2**	**3**	**4**	**5**
Income Generation					
Access to potable water has influenced my ability to generate income.					
The time spent fetching water affects my income-generating activities.					
The availability of clean water has changed my income from [Specific Activity, e.g., farming, livestock, crafts].					
Improved water access has affected my ability to save money.					
Access to potable water has influenced my ability to participate in					

income-generating groups or cooperatives.					
Asset Ownership					
Access to potable water has influenced my ownership of (Specific Asset, e.g., livestock, land, household goods).					
The availability of clean water has affected my ability to acquire new assets.					
Changes in water access have influenced my decisions about asset accumulation.					
My ability to own assets has been affected by the time spent fetching water.					
Access to potable water has influenced my ability to maintain existing assets.					
Occupational Diversity					
Access to potable water has influenced the types of work I do.					
The availability of clean water has affected my ability to engage in different income-generating activities.					
Changes in water access have influenced my choices regarding occupational diversity.					
The time spent fetching water affects the range of income-generating activities I can pursue					
Access to potable water has influenced my involvement in (Specific					

Occupation, e.g., farming, livestock rearing, small business)					

APPENDIX V: AREA MAP



APPENDINX VI: NACOSTI RESEARCH LICENSE

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **175285**

Date of Issue: **09/October/2025**

RESEARCH LICENSE



This is to Certify that Mr.. Elias ELIAS Njeri of Pan Africa Christian University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Makueni on the topic: INFLUENCE OF EQUITABLE ACCESS TO POTABLE WATER ON WOMEN'S LIVELIHOODS IN KILOME SUB-COUNTY IN MAKUENI COUNTY, KENYA. for the period ending : 09/October/2026.

License No: **NACOSTI/P/25/4180536**

175285

Applicant Identification Number

Ag. Director General
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See overleaf for conditions

THE SCIENCE, TECHNOLOGY AND INNOVATION ACT, 2013 (Rev. 2014)
Legal Notice No. 108: The Science, Technology and Innovation (Research Licensing) Regulations, 2014

The National Commission for Science, Technology and Innovation, hereafter referred to as the Commission, was the established under the Science, Technology and Innovation Act 2013 (Revised 2014) herein after referred to as the Act. The objective of the Commission shall be to regulate and assure quality in the science, technology and innovation sector and advise the Government in matters related thereto.

CONDITIONS OF THE RESEARCH LICENSE

1. The License is granted subject to provisions of the Constitution of Kenya, the Science, Technology and Innovation Act, and other relevant laws, policies and regulations. Accordingly, the licensee shall adhere to such procedures, standards, code of ethics and guidelines as may be prescribed by regulations made under the Act, or prescribed by provisions of International treaties of which Kenya is a signatory to.
2. The research and its related activities as well as outcomes shall be beneficial to the country and shall not in any way;
    i. Endanger national security
    ii. Adversely affect the lives of Kenyans
    iii. Be in contravention of Kenya's international obligations including Biological Weapons Convention (BWC), Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO), Chemical, Biological, Radiological and Nuclear (CBRN).
    iv. Result in exploitation of intellectual property rights of communities in Kenya
    v. Adversely affect the environment
    vi. Adversely affect the rights of communities
    vii. Endanger public safety and national cohesion
    viii. Plagiarize someone else's work
3. The License is valid for the proposed research, location and specified period.
4. Neither the license nor any rights thereunder are transferable.
5. The Commission reserves the right to cancel the research at any time during the research period if in the opinion of the Commission the research is not implemented in conformity with the provisions of the Act or any other written law.
6. The Licensee shall inform the relevant County Director of Education, County Commissioner and County Governor before commencement of the research.
7. Excavation, filming, movement, and collection of specimens are subject to further necessary clearance from relevant Government Agencies.
8. The License does not give authority to transfer research materials.
9. The Commission may monitor and evaluate the licensed research project for the purpose of assessing and evaluating compliance with the conditions of the License.
10. The Licensee shall submit one hard copy, and upload a soft copy of their final report (thesis) onto a platform designated by the Commission within one year of completion of the research.
11. The Commission reserves the right to modify the conditions of the License including cancellation without prior notice.
12. Research, findings and information regarding research systems shall be stored or disseminated, utilized or applied in such a manner as may be prescribed by the Commission from time to time.
13. The Licensee shall disclose to the Commission, the relevant Institutional Scientific and Ethical Review Committee, and the relevant national agencies any inventions and discoveries that are of National strategic importance.
14. The Commission shall have powers to acquire from any person the right in, or to, any scientific innovation, invention or patent of strategic importance to the country.
15. Relevant Institutional Scientific and Ethical Review Committee shall monitor and evaluate the research periodically, and make a report of its findings to the Commission for necessary action.

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