# EFFECTS OF WATER SCARCITY ON THE LIVELIHOODS OF RURAL WOMEN IN THARAKA NORTH AND MAARA SUB-COUNTIES, THARAKA NITHI COUNTY, KENYA

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## DECLARATION AND RECOMMENDATION

**Declaration**

This thesis is my original work and has not been presented for an award of a diploma or conferment of a degree in any other institution.

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**Recommendation**

This thesis has been examined, passed and submitted with our approval as university supervisors.

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## DEDICATION

This work is dedicated to my wife, Millicent Kagendo, my mother, Caroline Gatundu Kiboro, and my children, Prince and Ariana, whose love, support, and encouragement have sustained and inspired me throughout this journey.

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## ABSTRACT

Water is a critical resource for rural development, poverty alleviation, and agricultural productivity. However, its availability in arid and semi-arid lands (ASALs) of Kenya remains limited, with scarcity threatening the livelihoods of millions of rural households. In Tharaka Nithi County, water scarcity not only undermines household welfare but also perpetuates poverty by constraining agricultural production, increasing women's workloads, reducing their economic opportunities, and eroding community resilience. This study investigated the causes of water scarcity, gender-differentiated access to and use of water, and its impacts on women's livelihoods in Tharaka Nithi County, Kenya. Data were collected between May and August 2023, during the long dry season when water scarcity is most acute. A total of 313 respondents were surveyed, comprising 113 from Tharaka North and 200 from Maara Sub-County. The uneven distribution reflected differences in population density, ecological conditions, and accessibility, with Maara being more densely populated and better connected than the drier and sparsely populated Tharaka North. Household surveys were complemented with focus group discussions, key informant interviews, direct field observations, and GIS mapping of water sources. Quantitative data were analysed using SPSS (Version 26), while qualitative data were subjected to thematic analysis. The findings revealed that Maara Sub-County relied primarily on tap water (85%), while Tharaka North depended on rivers (53.1%), showing significant disparities in water source usage ($\chi^2 = 179.57$, $p < 0.0001$). Drought and low rainfall were identified as the leading causes of scarcity, while governance issues and inadequate infrastructure further worsened the situation. Gender analysis showed that a majority of respondents in both regions perceived unequal access to water for women, with this association being statistically significant (Maara: $\chi^2 = 6.26$, $p = 0.0123$; Tharaka North: $\chi^2 = 7.84$, $p = 0.0051$). Economic impacts were also substantial, as water scarcity reduced agricultural productivity and income opportunities (Tharaka North: $\chi^2 = 32.35$, $p < 0.0001$; Maara: $\chi^2 = 41.95$, $p < 0.0001$). Women's coping strategies varied: in Maara, 43.0% engaged in trade, while in Tharaka North, 21.2% relied on livestock rearing. However, poverty constrained the adoption of technologies such as boreholes, storage tanks, and sand dams. The gendered impacts included increased burden in water collection, reduced time for productive and educational activities, compromised health, and diminished resilience to climate shocks. The study concludes that water scarcity in Tharaka Nithi County is not merely an environmental challenge but also a driver of entrenched poverty and gender inequality. Addressing it requires integrated interventions, such as investment in climate-resilient water infrastructure, community-based water management, poverty reduction programs, and dismantling of cultural barriers that limit women's agency. Strengthening women's participation in water governance and promoting affordable technologies like sand dams, aquifer recharge, and household water storage systems are essential for equitable and sustainable water access. These findings directly contribute to the achievement of Sustainable Development Goal (SDG) 5 on gender equality by reducing the disproportionate burden on women, and SDG 6 on clean water and sanitation by promoting universal, reliable, and sustainable access to safe water in ASAL regions.

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| | |
|---|---|
| **ArcGIS** | Aeronautical Reconnaissance Coverage Geographic Information System |
| **ASALs** | Arid and Semi-Arid Lands |
| **CDF** | Constituency Development Fund |
| **CIDP** | County Integrated Development Plan |
| **DFID** | Department for International Development |
| **FAO** | Food and Agriculture Organization |
| **FGD** | Focus Group Discussion |
| **FGDs** | Focus Group Discussions |
| **FPE** | Feminist Political Ecology |
| **GIS** | Geographic Information System |
| **GoK** | Government of Kenya |
| **GPS** | Global Positioning System |
| **ICESCR** | International Covenant on Economic, Social, and Cultural Rights |
| **IPCC** | Intergovernmental Panel on Climate Change |
| **KIIs** | Key Informant Interviews |
| **KMS** | Kenya Meteorological Services |
| **KNBS** | Kenya National Bureau of Statistics |
| **NACOSTI** | National Council of Science, Technology, and Innovation |
| **NCCAP** | National Climate Change Action Plan |
| **NEMA** | National Environment Management Authority |
| **NGO** | Non-Governmental Organization |
| **SDG** | Sustainable Development Goal |
| **SLF** | Sustainable Livelihoods Framework |
| **SSA** | Sub-Saharan Africa |
| **UN** | United Nations |
| **UNDP** | United Nations Development Programme |
| **UN-Water** | United Nations Water |
| **UNICEF** | United Nations Children's Fund |
| **WHO** | World Health Organization |
| **WRA** | Water Resources Authority |
| **WRMA** | Water Resources Management Authority |

| | |
|---|---|
| **WSP** | Water Service Provider |
| **WWDA** | Water Works Development Authority |

# CHAPTER ONE
# INTRODUCTION

## 1.1 Background Information

Water scarcity has emerged as one of the most pressing development challenges of the 21st century, posing a significant threat to global sustainability, livelihoods, and human well-being. According to UN-Water (2019), more than two billion people currently reside in countries experiencing high water stress, while nearly half of the global population lacks access to reliable, safe, and clean drinking water. The situation is further exacerbated by rising population levels, rapid urbanization, industrial expansion, and climate change, which collectively exert unsustainable pressure on freshwater resources (Boretti & Rosa, 2019). According to global research, water scarcity is not an issue of the far future anymore, but a reality that compromises socio-economic development, community health, and environmental sustainability (Adams, 2018).

Among the factors that cause water scarcity worldwide are excessive exploitation of water resources, contamination of the existing freshwater, and the increasing effects of climate change that are experienced through increased temperature, extended droughts, and variations in rainfall distribution (Khair et al., 2012; Gomez et al., 2019). The examples of such a developing crisis are countries like China and India, where economic development, urbanization, and industrialization have led to a sharp increase in demand for water resources and a general lack and destruction of the ecological environment (Jiang et al., 2013). According to the World Bank (2024), such scarcity will only increase unless aggressive measures are taken to mitigate such scarcity, which will endanger food security, industrial development, and human survival in most of the world.

Africa, Sub-Saharan Africa (SSA), has been making it one of the most water-insecure regions in the world. Over 300 million individuals do not have access to clean and safe drinking water, and millions are poorly supplied, and women and children are more likely to be affected (Dos Santos et al., 2017). Rain-fed agriculture in SSA implies that frequent droughts and unpredictable rainfall are directly affecting food security, water-borne diseases, and the decreased resilience of households (Mohamed, 2022). Sorenson

and colleagues (2011) also note that women and girls are greatly affected; they spend most of their time walking to get water, which is a heavy burden, therefore restricting their chances to get education, earn money, and engage in community development. The water scarcity in semi-arid and arid regions has increased the competition and the water resource conflicts, further increasing vulnerability among vulnerable communities, which are already marginalized.

Kenya, being part of Africa, is quite prone to water scarcity, especially around its Arid and Semi-Arid Lands (ASALs) that form over 80 per cent of the national territory (Mulwa & Fangninou, 2021). National statistics reveal that only about 41% of Kenyans have reliable access to safe drinking water, while the rest depend on rivers, shallow wells, boreholes, and seasonal streams, many of which are vulnerable to contamination and depletion (Bukachi et al., 2021).In the effort to solve the problem of water scarcity, the Kenyan government has implemented a number of policies and frameworks, including the Water Act of 2016, Climate Change Act of 2016, and the development agenda of Vision 2030. Nevertheless, the problems of ineffective infrastructure, weak implementation of environmental strategies, insufficient funding, and growing climatic unpredictability still weaken the water security status of households and communities (Wambango, 2013).

Tharaka Nithi County is a case study that is distinctive for use in the study of water scarcity due to its various ecological zones. Tharaka North Sub-County, which is located in the semi-arid zone, has low and unpredictable rainfall, frequent droughts, and marginal crop production. People rely heavily on seasonal rivers and shallow wells, which are not very reliable sources of water; they tend to run dry in prolonged drought. On the other hand, Maara Sub-County is located in the highlands, hence it receives comparatively more rainfall, hence more intensive agricultural activities. Despite the disparities, these two areas are faced with water scarcity but in different forms. Tharaka North faces the problem of absolute scarcity, i.e., drought, and Maara faces the problem of temporal scarcity and the rising competition over the water because of population and demand in agriculture. Such ecological variations render the two sub-counties a perfect comparative environment through which water scarcity is realized in the context of different climatic conditions within the same geographical location.

Women are the sole water providers in most rural Kenyan households. They are charged with the duty of providing water to drink, cook, sanitise, and do small-scale agriculture (Mwinzi, 2014). In cases where there is scarcity, women and girls tend to walk long distances in search of water, uncertain of exposure to physical stress, with less time to attend schools, and gender-based violence (Geere & Cortobius, 2017). In addition to domestic demands, women living in rural settings also use water to maintain livelihoods like subsistence crop farming, livestock farming, as well as small-scale trade. Nevertheless, these functions are often underestimated in the water management planning and policy frameworks (Amusan and Olutola, 2017). Guaranteeing the consistent water supply to women, thus, can lead to the improvement of household wellbeing, to the increase in food security, as well as to the possibility of economic empowerment (Chitja et al., 2016).

Climatic, geographic, and socio-economic factors determine the water scarcity in Tharaka Nithi County, and especially in Tharaka North and Maara Sub-Counties. The effects of scarcity extend beyond immediate survival, affecting household resilience, gender roles, and development. However, the literature in place tends to explore scarcity in very dry or wet areas; therefore, there is a knowledge gap in the comparison of how water scarcity can work out in different ecological zones. This research aims to address the gap through the analysis of the implications of water scarcity on the livelihoods of rural women in Tharaka North and Maara Sub-Counties. The results have led to evidence-based interventions to face the issues of water scarcity and support the idea of gender equality, sustainable livelihood, and better living conditions in rural communities.

### 1.2 Statement of the Problem

Water scarcity threatens human well-being, agricultural productivity, and socio-economic development, but its effects are not gender-neutral. In rural Kenyan communities, women and girls bear the primary responsibility of fetching and managing water, a task that intensifies during scarcity, limiting their education, health, and economic participation. Cultural norms and unequal land ownership further restrict women's decision-making and access to resources, thereby deepening poverty and gender inequalities. While much research has focused on the economic and

environmental aspects of water scarcity, limited attention has been given to its gendered impacts in rural areas like Tharaka North and Maara sub-counties. This study seeks to fill that gap by examining how water scarcity affects women's livelihoods across these contrasting ecological zones.

## 1.3 Objectives of the Study

### 1.3.1 General Objective

To investigate water scarcity and its effects on the livelihoods of rural women in Tharaka North and Maara sub-counties, Tharaka Nithi County, Kenya.

### 1.3.2 Specific Objectives

i. To assess the causes of water scarcity in Tharaka North and Maara sub-counties of Tharaka Nithi County.
ii. To examine gender-differentiated access to and use of water in Tharaka North and Maara sub-counties.
iii. To analyse the effects of water scarcity on women's socio-economic activities in Tharaka North and Maara sub-counties.

## 1.4 Research Questions

i. What are the causes of water scarcity in Tharaka North and Maara sub-counties?
ii. How is access to and use of water differentiated by gender in the two sub-counties?
iii. What are the effects of water scarcity on women's socio-economic activities in Tharaka North and Maara sub-counties?

## 1.5 Justification of the Study

This study contributes to both practical and theoretical knowledge. Practically, water scarcity continues to undermine rural livelihoods in Kenya, and understanding its impacts on women is essential for developing equitable and sustainable interventions. The findings are expected to inform policymakers, local governments, and NGOs on strategies to improve water access, promote gender equity, and strengthen community resilience. Theoretically, the study contributes to the Sustainable Livelihoods Framework (SLF) by demonstrating how natural capital (water resources) interacts with

other livelihood capitals, human, social, and financial, to shape outcomes for women. By showing how reduced access to natural capital increases workloads, restricts income opportunities, and limits social participation, this study highlights the centrality of gender in water management and rural development

### 1.6 Significance of the Study

The research findings provide critical insights for policy formulation in water governance, gender empowerment, and poverty reduction. By highlighting women's specific vulnerabilities and coping strategies, the study supports the achievement of Sustainable Development Goal (SDG) 5 and SDG 6. Furthermore, it will guide local interventions such as community water projects, water harvesting technologies, and gender-sensitive training programs.

Sustainable Development Goal (SDG) 5 focuses on achieving gender equality and empowering all women and girls, recognizing that gender disparities continue to limit access to resources, opportunities, and decision-making processes (United Nations, 2015). SDG 6 seeks to ensure the availability and sustainable management of water and sanitation for all, addressing challenges of water scarcity, pollution, and inadequate infrastructure that threaten health, livelihoods, and ecosystems (United Nations, 2015).

### 1.7 Scope of the Study

The study was conducted in Tharaka North and Maara sub-counties of Tharaka Nithi County. The population of interest comprised rural households, with women as the primary unit of analysis. Respondents were engaged in diverse livelihood activities, including crop farming, livestock rearing, small-scale trading, casual labour, and domestic work. Additional information was obtained from county natural resource officers, ward administrators, chiefs, and representatives of local NGOs. The study focused on the causes of water scarcity, gendered access to water, and the effects of scarcity on women's socio-economic activities.

### 1.8 Assumption of the Study

The study assumed that the selected sample was a true representation of the target population. It was further assumed that the respondents would demonstrate willingness

to participate and provide accurate, consistent, and credible information. Moreover, the study presumed that the data collection instruments, particularly the Global Positioning System (GPS), operated reliably and effectively across varying field conditions.

# CHAPTER TWO
# LITERATURE REVIEW

## 2.1 Overview of Water Scarcity

Seventy per cent of the Earth is covered with water, but only three per cent is freshwater, and less than one per cent is directly accessible in lakes, rivers, and aquifers (Döll et al., 2012). Water scarcity, defined as the inadequate availability of freshwater to meet human and ecological needs, is increasingly recognized as a global crisis (Pegram, 2014). Currently, one in three people worldwide struggles to obtain sufficient water daily (Aromolaran et al., 2019). Sub-Saharan Africa (SSA) is among the countries in Africa where water scarcity is severe due to the variability of rainfall, inadequate infrastructure, and financial constraints, which exacerbate the problem of accessibility (Dos Santos et al., 2017). Although there are large lakes and rivers, there is an unequal distribution hence resulting in water insecurity. In the year 2025, an excess of 230 million Africans will be without water, and in this case, women will be the most affected since they have cultural and gendered duties in the collection of water (Sorenson et al., 2011).

The annual availability of clean drinking water is considered reliable by only 41 per cent of the population in Kenya (Bukachi et al., 2021). The most severe scarcity is experienced in the Arid and Semi-Arid Lands (ASALs) that cover 80 per cent of the nation (Mulwa & Fangninou, 2021). Consideration of counties like Tharaka Nithi, rainfall is erratic, drought and poor water management exacerbate scarcity, thus making the rural families dependent on rivers and seasonal streams. Women and girls do most of the water collection, limiting their participation in education and income-generating activities (Mwinzi, 2014).

### 2.1.1 Legal and Policy Frameworks on Water and Gender

Kenya has put up a wide legal and policy framework that serves to respond to sustainable management of water resources, the effects of climate change, and the encouragement of equitable access. The Constitution of Kenya (Republic of Kenya, 2010) explicitly recognizes water as a fundamental right, with Article 43(1)(d) guaranteeing every person the right to clean and safe water in adequate quantities. Additionally, Article 62 mandates that the national government holds rivers, lakes, and

catchment areas in trust for the people, while Article 69 calls for the sustainable exploitation, conservation, and equitable sharing of benefits derived from natural resources. To address historical inequalities in access to essential services, Article 204 establishes the Equalization Fund, which is particularly relevant for marginalized groups living in water-stressed regions such as Tharaka Nithi County.

In line with constitutional provisions, Parliament has enacted several laws to provide institutional frameworks for water governance and climate resilience. The Water Act (Republic of Kenya, 2016a) has reorganized the water governance system by disaggregating the policy, regulation, and service delivery practices, enhancing devolution and the capacity of counties to manage water more efficiently. The Water Works Development Authorities (WWDAs) were also established by this Act and are required to develop and maintain public waterworks and also give professional advice to counties and Water Service Providers (WSPs). In line with this, the Forest Conservation and Management Act (Republic of Kenya, 2016b) emphasize the need to protect forests, which are important in protecting the catchment areas, soil and water conservation, and carbon sequestration.

The adaptive capacity in the country through the Climate Change Act (Republic of Kenya, 2016c) is the mainstreaming of climate change considerations in all sectors, such as water. It allows the creation of the National Climate Change Action Plan (NCCAP) and a Climate Change Fund, which can be used to fund mitigation and adaptation projects. The provisions are in close association with Kenya Vision 2030 and Sustainable Development Goals (SDGs), especially Goal 6, which highlights the element of universal access to clean water and sanitation (United Nations, 2015). On the county level, the Tharaka Nithi County Integrated Development Plans (CIDPs) (Tharaka Nithi County Government, 2018; 2023) focus on the development of the water infrastructure, encouragement of rainwater collection methods, and replenishment of eroded catchments. Notably, these schemes indicate the incorporation of women in water governance frameworks, yet gender mainstreaming is not fully exercised in reality.

With all these strong structures, problems still exist in implementing the policy into practical gains to women, who are the most important water gatherers and administrators at the household level in rural Kenya. The arid and semi-arid lands (ASALs) are the places where implementation gaps are the most evident because the development of infrastructure does not match the demand. The involvement of women in water management committees is nominal, and they do not have much influence on the process of making decisions (Njuki, Parkins, & Kaler, 2016). This continues to perpetuate gender inequalities because their experiences and local knowledge are not highly valued in the development of water governance and climate adaptation plans. Besides, there is a lack of gender sensitive monitoring and accountability systems that undermine the power of these policies to respond to the special load on women in the conditions of water scarcity. Consequently, although the legal and policy frameworks in Kenya can offer a strong base to tackle water scarcity and climate resilience, there is an imperative need to have more gender insights implemented. Good water governance should not merely be on paper in such a way that the voices of women are listened to in the planning, implementation, and monitoring of water. The measures that must be taken in the strength of localized governance mechanisms, development of technical and leadership capacity of women, and accountability in gender mainstreaming are steps to a solution of equitable access to water resources and getting communities, such as that of Tharaka Nithi County, more resilient.

### 2.1.2 Human Right to Water and Sanitation

Human right to water and sanitation has been increasingly gaining prominence in international law and policy as one of the primary requirements of life, dignity, and sustainable development. In July 2010, the United Nations General Assembly came up with a Resolution 64/292 expressly recognizing the right to safe, clean, accessible, and affordable drinking water and sanitation as an internal requirement in the realization of all human rights. The resolution binds the states and governments to ensure that they prioritize the provision of adequate, safe, acceptable, physically accessible, and affordable water to both personal and domestic needs without any discrimination (UN, 2010). This recognition was also justified by the fact that the Human Rights Council Resolution (2010) was in effectual interpretation that the right to water and sanitation did not just exist in law but rather that the right to adequate standard of living (Article

11) of the International Covenant on Economic, Social and Cultural Rights (ICESCR) came into existence as bequeathing the right to water and sanitation. It therefore follows that governments have the responsibility to engage in legislative, policy, and institutional structures that are progressive in achieving universal accessibility of water and sanitation.

This right is enshrined in the Constitution of Kenya 2010 in Kenya. Article 43(1)(d) stipulates that all human beings have a right to clean and safe water in reasonable amounts, and so, at the domestic level, it strengthens the international human rights framework. The Water Act 2016 is an implementation of this constitutional guarantee, as it establishes institutional means of managing water resources and delivering water and sanitation services, with there being more policy anchors on providing universal and equitable access to water and sanitation in the Kenya Vision 2030 and the Sustainable Development Goal 6 (SDG 6).

Despite such robust normative structures, there has been a tremendous and uneven implementation in Kenya, particularly in arid and semi-arid lands (ASALs), where people are affected at all times by water scarcity. Rural families normally walk long distances to obtain water, and women and girls are usually subjected to the disproportionate role of water collection. This not only contravenes the principle of equity in human rights, but it also increases gender inequality, restricting women's access to education and income generation, as well as engagement in the decision-making processes. The lack of sanitation amenities in rural and marginalized communities makes them riskier to human health, undermines human dignity, and perpetuates the practice of poverty.

The conceptualization of water scarcity as a human rights concern is a shift in the thinking process where water is perceived as a human right and subject under equity, justice, and accountability rather than strictly as an economic or natural resource. It also demands that the government implement a rights-based approach that is characterized by transparency, non-discrimination, participation of the people, and prioritization of vulnerable groups in the planning of water and sanitation. It proposes more powerful

mechanisms that can keep state and non-state actors answerable for the lack of accountability in delivery.

The disparity between the constitutional rights and the real access to water in the Tharaka Nithi County and other rural ASALs is indicative of why it is important to put water scarcity into the human rights perspective. The women in the areas still face the workload in the form of collecting water as they walk miles daily to unreliable and unsafe water bodies. This not only restricts their socio-economic potential, but it also puts them at risk of health and gender vulnerabilities. Placing the issue of water scarcity in a human rights context, this research gives a normative prism through which the equity, justice, and gender aspects of water access may be viewed critically. This strategy is at the Centre of the realization of how the lack of proper water and sanitation sustains the structural inequalities and poor rural development.

### 2.2 Causes of Water Scarcity

Water scarcity is both a natural occurrence and a man-made phenomenon that puts restrictions on both man and nature to have sufficient and quality water. Understandably, a significant reason for water scarcity is frequent droughts and climate change, particularly in arid and semi-arid regions (ASALs) in which rainfall is low and is unevenly distributed (Njiru, 2012; Mnyiri, 2014). These problems have been further exacerbated by climate change due to alterations in the rainfall patterns, increasing the occurrence of long dry spells, and these extreme events, such as floods and droughts, are even more pronounced (Ungureanu et al., 2020). The scarcity of water is further increased by the fact that the low rate of replenishment is sweeping out the groundwater, and the wetlands and rivers are being dried up. To exemplify, more than half of all wetlands worldwide have been destroyed, depleting the receiving places of freshwater and bringing the ecological balance into the open (Sofi et al., 2020). These natural calamities are an indication of the increased vulnerability of the ecosystem and human life to environmental stressors and climate change.

Human-induced factors also cause another significant fraction of water scarcity in Kenya and other developing regions. There is a lack of proper infrastructure, such as the absence of proper roads, no bridges exist, etc., and the ability to access the available

water resources and provide transportation and distribution is undermined, in particular, among the rural population (Tshabatau, 2021). Water storage systems are inadequate, and people do not have a safe alternative, such as collecting and storing water during periods of scarcity. Rural families tend to use drums, which are unsafe and prone to contamination (Masenya, 2015). Deforestation, unsustainable agricultural practices, and degradation of catchment destroy significant water towers such as Mt. Kenya, which provides rivers to Tharaka Nithi and other neighbouring counties (University of Nairobi, 2020). Water pollution is caused by agricultural runoffs, industrial discharge, and poor sanitation, which reduces the water quality, rendering much of it inappropriate as drinking water and unable to sustain life in the ecosystem (Mateo-Sagasta, J. et al., 2018; Sofi et al., 2020).

The overpopulation and the high rate of urbanization put pressure on the demand at the cost of the existing water-carrying structures, which are already overloaded (KNBS, 2019). Also, poor water governance compromises good management and fair distribution of water, which is defined by poor institutional coordination and poor implementation of water policies (Ogallo, 2010). Combined with the above natural stressors, they become acute factors contributing towards the dangers of water scarcity and were well justified in integrating management of water resources, stronger governance regimes, and the necessity to adopt sustainable production that can ensure the sustainability of water security in the long run. The combined effect of these natural and human-induced factors is particularly severe when it comes to affecting vulnerable communities, more so women and girls in rural ASAL regions, who are then disproportionately tasked with the burden of obtaining water to address domestic and livelihood needs.

### 2.3 Gender Differentiation in Access to and Use of Water

One of the areas of focus of how water scarcity is perceived and the overall implications of the same on human development has been gender, and this has been particularly more impressive in the developing countries where the inequalities are most pronounced. The most affected people of the poor water supplies in the world are women and children, especially in the rural areas of African societies, where women have the greatest responsibility of providing water to the households (Ngene et al.,

2021; Amusan and Olutola, 2017). Nevertheless, they continue to suffer from inaccessibility to water resources due to culture, unequal land tenure, as well as the entrenched gender inequalities despite this obligation. Women and girls have had to dedicate hours and days a day to water collection, and this implies that they do not have time to get an education and take care of their children, as well as income-generating activities (WHO/UNICEF, 2010; Sorenson et al., 2011). It has been shown that the lack of access to water directly and negatively affects women and their children and increases the existing disparities, as people who have access to higher resources and are richer and have better political connections receive more advantageous access to the limited water supply (Wunder, Nweke, 2019; Veldkamp et al., 2017; Tshabatau, 2021).

Feminist Political Ecology (FPE) in theory identifies gendered, environmental, and power relations as the means to comprehend the availability of water, yet the bulk of water management practices fail to take into account these forces (Truelove, 2011). Inclusion of women in water governance has been known to establish superior and sustainable water systems as they are more knowledgeable and involved practically in water resources (Caruso et al., 2015). However, the representatives of the older age groups and women in general are more likely to have extra barriers, and this is why intersectional solutions must be adopted and implemented to take into account the age, socioeconomic status, and ethnicity in water management (Caruso et al., 2015). Thus, to address the issue of water scarcity, gender sensitive policies and direct inclusion of women in the decision-making process should be implemented in the global systems, including the UN General Comment on the Right to Water and the International Conference on Freshwater (Tully, 2017). The fight to achieve a world without water, without training planners and policymakers on how to identify and integrate gender issues, could even serve to perpetuate the inequalities that are already being experienced, besides ensuring that the sustainability agenda is nullified.

### 2.3.1 Connection between Gender Studies and Water Management Theories

The traditional water management approaches have paid more attention to the technical efficiency, conservation, and sustainability at the expense of other factors like the socially gendered dimension of water accessibility and use. But gender studies emphasize that the resource of nature is not the sole entity of water, which is rather a

socially generated and contradictory resource between which the relations of power hold the most significant role in the distribution of access, control, and advantages (Hlahla et al., 2022). The feminist theory shows the exclusion of women, especially in rural and marginalized societies, in decision-making, even though it is them who are the most involved in the provision and use of water at home (Sehring, ter Horst & Zwarteveen, 2023).

Feminist Political Ecology (FPE) provides a more nuanced lens by linking gender, power, and environmental governance, highlighting how water scarcity and management practices are shaped by broader social structures such as patriarchy, class, and cultural norms (Rocheleau, Thomas-Slayter, & Wangari, 1996; Elmhirst, 2011). For instance, women's disproportionate labour burden in fetching water is not only a result of resource scarcity but also of entrenched gendered divisions of labour and limited access to decision-making platforms (Cameroon study 2021). Thus, FPE challenges the neutrality of water management frameworks and pushes for equity-oriented approaches that address systemic inequalities.

Integrating FPE with the Sustainable Livelihoods Framework (SLF) strengthens the theoretical foundation of gender-sensitive water management. The SLF emphasizes five types of capital, natural, human, social, physical, and financial, that determine livelihood sustainability (Jaren et al., 2022; Hlahla et al., 2022). In contexts of water scarcity, women's limited access to natural capital (water) undermines their ability to enhance human capital (education, health), social capital (community networks), and financial capital (income-generating activities). For example, time spent fetching water often reduces opportunities for schooling or productive work, reinforcing cycles of poverty and (Caruso et al., 2020; Kaiser & Bationo, 2022; UN Women, 2023).

Therefore, the intersection of gender studies and water management theories demonstrates that addressing water scarcity cannot be achieved through technical fixes alone. It requires integrating feminist insights to recognize women as active agents in water governance, while also situating water within broader livelihood and power dynamics. This holistic approach not only promotes equity but also enhances the

effectiveness and sustainability of water management interventions in arid and semi-arid lands (ASALs) where gender disparities are most pronounced.

### 2.4 Water Scarcity's Impact on Women's Social and Economic Activities

In addition to being one of the largest barriers keeping women from getting access to water, the lack of real land ownership and access contributes significantly to the rising rates of poverty among families led by women (Doss et al., 2018; Agarwal, 2021; FAO, 2023; UN Women, 2022). The main issues that the water industry faces worldwide are still inadequate funding, underdeveloped institutional capacity, weak government commitment, inadequate market access, poor agricultural water management, lack of institutional platforms and services, and inadequate infrastructure (Wright et al., 2014).

(UNICEF & WHO, 2023; UN-Water, 2023; UN Women, 2023). asserts that the global water crisis has a human face. For instance, a girl might not be allowed to attend school so that she can fetch water, a child might experience fatal episodes of diarrhoea, or a mother might not be able to realize her full potential due to the obligations of tending to family members who have become ill from contaminated water. For women and girls, having access to clean water is essential. This will force them to seek employment, build and maintain water and sanitation infrastructure, and pursue education, all of which are necessary for giving women access to productive resources and promoting economic empowerment (Caruso et al., 2020; World Bank, 2022; UNICEF & WHO, 2023; UN Women, 2023). From planting to harvesting and food preparation, rural women are directly involved in every aspect of agricultural work. Water availability declines result in low agricultural and animal yields, which eventually have an impact on family food security and financial stability (Mwinzi, 2014). Water resource abuse, depletion, and pollution present a myriad of challenges for women. These challenges include increased work demands; lost time spent looking for water, hygienic concerns, and problems with living conditions, displacement, and a loss of control over resources and knowledge.

#### 2.4.1 Increase in Workload

The lack of readily available water sources disproportionately affects women and children, who typically shoulder the burden of providing water to their families. This

work is not only tedious, backbreaking, and time-consuming but also takes a considerable working time for women and children. This makes women less productive in society, as they cannot engage.

### 2.4.2 Time Wastage in Search of Water

In low-income nations, a significant portion of women's working hours is spent transporting fuel wood, water, and food. This is especially true in regions that frequently experience drought, as these products are in short supply. An average 17-year-old woman in Africa is thought to spend between one and four hours each day looking for water (WHO/UNICEF, 2010). According to research conducted in Ghana, rural men use a third of the time and a quarter of the energy on load carrying than rural women. To give women more time and energy to be involved in current productive activities and new business ventures, it may be necessary to provide water sources that are near their homestead, either piped water, a borehole, or a well.

### 2.4.3 Health Problems

Water scarcity may lead to diarrhoea, TB, hepatitis, stillbirths and miscarriages, as well as thyroid, skin and eye issues, especially among women. It might be the result of neglected water use. Most of these women complain that their suffering is caused by a lack of access to clean water, according to Baumgartner and Pahl-Wostl (2013). Women's reproductive health is negatively impacted by a heavy workload, social expectations, and poor water quality. Because they water containers from water points to their household/homes, personal hygiene and sanitation requirements are neglected when there is a water scarcity.

### 2.4.4 Limited Economic Opportunities

The primary use of water resources is agriculture, which employs 52 % of the labour force overall, including 73 % of women who work as farm labourers (Doss, 2014). Women's workloads are significantly increased as a result of the environment's decline, and the need to labour to supplement household income. Due to their social obligations, the women at home are essentially stationary, which leaves them with few economic alternatives, makes them open to exploitation, and forces them to work for pitifully low wages while the men go on. They commonly lose their jobs since they don't have the

endurance to work lengthy hours for a long time (UNDP, 2021; World Bank, 2022; ILO, 2022; UN Women, 2023).

### 2.4.5 Livelihoods

A livelihood is the set of abilities, materials, pursuits, and tasks required to sustain a way of life (Scoones, 2015; FAO, 2022). In addition to crafts like weaving and woodworking, they also encompass activities like farming, herding, hunting, gathering, trading, and hawking. The ultimate goal of these activities is to provide people with food and money while also satisfying their needs and wants. While some of the outcomes are frequently used immediately, others are generally saved for future use. Activities related to a livelihood may impact the available resources. For instance, livelihood actions might cause deforestation, soil erosion, and water table declines. However, livelihood activities may boost the productivity of the land and other renewable resources like air and water by putting into practice efficient methods for gathering and preserving water, organic soil fertility, and other tactics (Chawanda et al., 2024; Diop et al., 2022; Pazola et al., 2024). For women and girls to pursue their education and earn a living, they need to have access to clean water. Women will be able to obtain useful resources as a result, increasing their economic empowerment.

Women are more involved than men in the use and preservation of natural resources in rural areas. Additionally, because of their traditional gender roles, women frequently interact with the environment, including the land, the river, the forest, and the wildlife. Since they are frequently in poverty and depend heavily on these resources for their livelihood, women are forced to utilize them. Women bear the brunt of resource exploitation and destruction. Women benefit most when they are used sustainably. Both directly through their work and indirectly through their involvement in the community and as parents, women make significant contributions to the increase in productivity (Duflo, 2012). Women are innovative economic actors who contribute in many different ways to the uplift of communities and the income of families. In addition to working in family businesses, as independent contractors, as large businesswomen, and as farm and non-farm labourers, they also perform a disproportionate amount of unpaid labour at home (Queen Chetia, Das, & Hazarika, 2018). To be fully included, though, they must address issues like unequal resource access, persistent discrimination, and

gender stereotypes. Women labour not only for the family but also for a variety of business endeavours. Together with men, they engage in both agricultural and non-agricultural tasks. The area around the homesteads and small farms is heavily utilized by women (Muriithi et al., 2023). The two primary types of livelihood activities for rural women are agriculture and non-agriculture employment.

### 2.4.6 Agricultural Activities

The agricultural practices involve the rearing of animals and planting. Water scarcity is one of the issues that affects food security in the world. According to Cosgrove and Loucks (2015), the first one that impedes the nourishment of the expanding world population and addresses the disjuncture of food, energy, climate change, economic development, and problems of human security is water. A few of the most significant agricultural practices are enumerated by Rana and Chopra (2013), home vegetable gardening, crop production, post-harvest farming, poultry management, animal management, fisheries, beekeeping, and sericulture. From planting to harvesting and cooking the meals, rural women are actively involved in all aspects of agricultural activity. Reduced water availability causes lower crop and animal yields, which eventually has an impact on household food security and financial stability. Small-scale operations account for the majority of production, with extremely high participation rates in farming as well as related sectors like processing and marketing. As a result, a lack of water makes these activities very unsustainable, which typically has an impact on the local population's capacity to support them.

## 2.5 Study Gap

The current research on the water scarcity situation in Kenya has mainly paid attention to the technical factors of water supply, such as physical availability, hydrological variability, lack of infrastructure facilities, and governance inefficiencies (Boretti and Rosa, 2019; Ngene et al., 2021). Although these studies present good information on the causes and distribution of water scarcity, they usually do not reflect the intricate social aspects that determine disparate experiences of scarcity among different groups. Specifically, the intersection of water scarcity, gender inequalities, and sustainable livelihoods has not been given much attention despite the increasing awareness of the fact that women are often the ones bearing the burden of water collection and

management in rural households (Amoyaw-Osei, M., et al., 2023) Most livelihood literature on arid and semi-arid areas (ASALs) focuses on broad household-related vulnerabilities, and there is insufficient inquiry into gender relations within the household (Mutuku, 2020).

Consequently, agency, coping, and limitations of women in the process of navigating water scarcity are undocumented. This loophole makes interventions aimed at promoting resilience in water-stressed communities less effective (UN Women, 2019). The other gap that is critical is the lack of strong inclusion of the county-level water and climate policies with the lived reality of women in rural areas. Although the inclusion to water resources is in the focus of policies, including the Constitution of Kenya (2010), Water Act (2016), Climate Change Act (2016), and County Integrated Development Plans (CIDPs), there is some paucity of empirical data about the implementation of these frameworks at households and community levels (Gok, 2018; World Bank, 2021).

In particular, the lack of congruence between the policy agenda, on the one hand, and the daily lives of women in rural Tharaka North and Maara sub-counties, on the other hand, generates a knowledge gap that makes it difficult to implement gender-sensitive strategies by policymakers and practitioners (McCarthy et al., 2021; Guthridge et al., 2022). This paper attempts to fill these conceptual gaps by making a direct connection between theory, policy, and practice in a bid to examine the gendered effects of water scarcity on sustainable livelihoods. It places the water scarcity in more socio-economic and environmental perspectives, as well as anticipates the lived experiences of the female population in ASALs by adopting such frameworks as The Sustainable Livelihoods Approach (Serrat, 2017; Mdee & Harrison, 2019). and Feminist Political Ecology (Jalisa, L., 2023). By so doing, the paper contributes to more comprehensive knowledge of water scarcity as an environmental development issue as well as a gender development issue.

## 2.6 Theoretical Framework

### 2.6.1 Feminist Theory

Feminist theories encompass a broad spectrum of thoughts and aim at explaining as well as finding proper solutions to how both men and women are oppressed in society. It was proposed by Nkansah, J. N. (2023) to champion women's rights and equality. According to this view, patriarchy prevents both men and women from reaching their greatest potential. The patriarchal concept, according to feminist academics, stresses the need to rule and control rebellious women and the untamed environment (Chakravarti, 2018). Men and women should be treated equally in politics, the economy, and society. Moreover, resources and opportunities should be distributed equally, according to feminists who fight for women's empowerment. In an attempt to better the lives of women, the theory examines how society views men and women, and it is one of the most significant sociological concepts still in use today. Giving women a voice and recognizing the many contributions they have made to society is at the core of feminism (Aulia et al., 2024; Mukhopadhyay, 2024; Bhandari, 2024)

Some critics claim that feminist theory's main flaw is its emphasis on women. It is claimed that men and women see the world from different perspectives, even though the theories also touch on topics unrelated to women. Although the theory concentrates primarily on the oppression of women in society, which may be true to some extent, it does not address the role that women play in the same society, which is why a second theory is necessary.

### 2.6.2 Feminist Political Ecology

To challenge and advance knowledge of how gender and other social categorizations affect how people interact with and react to the natural world, particularly how they have access to water, feminist political ecology tries to examine gender issues. The four dynamics that Centre the methodology are degradation, social movements, environmental conflict and marginalization, conservation and control, and environmental identity. The major topic is the difficulties associated with managing and making resources available. Feminist political ecology is a method for examining power relations in the political, economic, and ecological spheres from a female perspective (Truelove, 2011). Resource-based conflicts, whether they take place in rural

or industrial metropolitan contexts, take gender issues into account. There are several links between ecofeminism and feminist political ecology. In contrast to the latter perspective, this links women's oppression to environmental dominance; feminist political ecology views gender as a component of economic, ecological, and political production relations (Truelove, 2011).

The concept outlines a variety of organizational settings where women are becoming more involved. These can function in a local, regional, or global setting and comprise official and informal networks, registered movements, as well as movements that are not registered. Many issues, such as resource use for development, health, and environmental preservation, are highly valued by these feminists. Consequently, proponents of this philosophy unite to protect the resources required to uphold their way of life (Urselmans, S., & Khan, S., 2024). The advent of anti-essentialist gender framings has disrupted presumptions about who qualifies as the (natural) topic of feminist-focused research, which is partly to blame for the apparent absence of FPE. In addition to Butler's claim, as was previously mentioned, postcolonial academics have contested homogenizing notions of women as a pre-given, cohesive category that is researched using comparable theoretical frameworks worldwide (Resurrección, B. P., 2024). Feel that the theory explains women's roles in the conservation and management of water scarcity, despite its limitations. As a result, the theory was crucial to this research.

### 2.7 Conceptual Framework

The conceptual foundation of the study is the hypothesis that there is a relationship between the reduction in women's economic productivity and the limitations placed on the water supply, and that this relationship affects women's capacity to oversee and carry out household duties. Utilizing an anti-poverty strategy, it draws attention to the financial responsibilities that women bear in the home and the implications that this has for them, their spouses, and their children. This method's fundamental tenet is that women's empowerment, well-being, and gender relations will all shift in tandem with changes in their economic circumstances.

Households in locations with inadequate water supply conditions are intended to get drinking water from an improved and dependable water supply. Water may be utilized sustainably to provide particular social advantages, as well as increased overall social welfare and financial gains, even though the primary goal is to provide water for home consumption. A few of these benefits include favourable impacts on matters of women's welfare, such as less work for women and more time and water for domestic use. It's a frequent misconception that women would use these improvements to become more hygienic in their personal and home lives and spend more time caring for children, cooking, and doing other household chores. The well-being and health of the entire family are positively impacted by the advantages of this domestic activity. Women should have access to water since they are heavily involved in collecting and using it as home managers, which will increase their output.

There can be short, medium, and long-term impacts from a water shortage. Since women are the ones who collect water, they have to search for it for a long time. Finding water would have been a less productive use of this time than taking on other household chores and launching a new venture. Many issues arise when there is no access to water, such as inadequate child care, unhygienic personal and family habits, and disputes within the family over who gets to use the few resources. It also contributes to poor nutrition because it can negatively impact the family's ability to support itself financially through agricultural farming and other non-farm jobs. Lack of access to water makes many farm and non-farm activities impossible, including the production of small-scale goods by women, the care of animals, the preparation and sale of food and beverages, and the growing of vegetables. It may also be impossible for them to look for other jobs to diversify their income streams, depending on the culture.

This leads to a decline in small and medium-sized enterprises, which boosts their earnings. The secondary consequences of this economic impact include the general increase in poverty, gender dynamics in unstable households due to unstable families, and low participation and access to social services like credit, health, and education. Through constant engagement with other traders, it also decreases their morbidity and awareness, endangers their capacity to manage how their revenue is used, and makes them more vulnerable. The long-term effects of inadequate catastrophe preparedness,

increasing vulnerability owing to a lack of viable economic options, and persistent poverty levels are caused by irregular access to the water supply.

Water shortage, water access, and socioeconomic activity were independent variables. The Water Act of 2016 is a moderating factor. Water Resource Management Authority (WRMA), Constituency Development Fund (CDF), and Equalization Fund are the intermediary variables. Women's livelihood is the dependent variable.

Water stress is a condition where there is very little water supply. This condition gets worse due to climate change, which increases competition for water and could lead to war. From 2001 to 2018, more than 74% of all natural disasters were related to water, including floods and droughts (Lee et al., 2020). Climate change is only predicted to make such catastrophes more frequent and more intense.

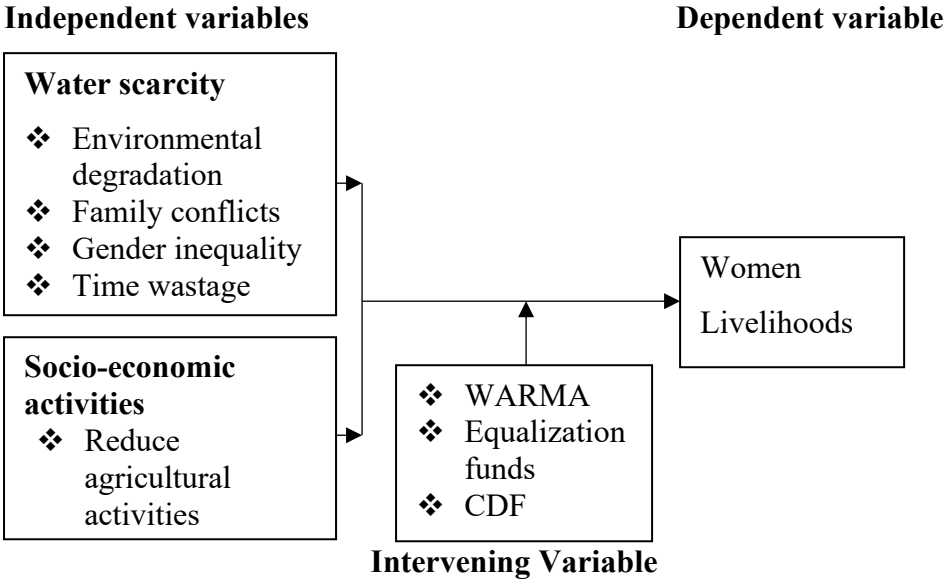


Figure 1: Conceptual Framework

# CHAPTER THREE
# MATERIALS AND METHODS

## 3.1 Study Area

The study was conducted in Tharaka Nithi County. The county borders Embu County to the south and southwest, Meru County to the north and northeast, and Kitui to the east and southeast. On the western side, the county shares Mount Kenya with Kirinyaga and Nyeri. The study area is located between latitudes 000 07' and 000 26' South and longitudes 370 19' and 370 46' East. The total area of the county is 2,662.1 km2 (Gok, 2013). Formerly, the county was subdivided into four sub-counties: Chuka, Maara, Tharaka North, and Tharaka South (Figure 2). Recently, three additional sub-counties (Igambango'mbe, Chiakariga, and Muthambi) were created from the County. However, for this study, only Maara and Tharaka North sub-counties were sampled to represent the upper and lower regions, respectively. Maara was selected due to its location in the highland region, characterized by relatively higher rainfall, fertile soils, and agricultural activity, which are critical in assessing livelihoods dependent on favourable environmental conditions. While Tharaka North, situated in the lowland area, experiences arid and semi-arid conditions, with water scarcity and marginal livelihoods influenced by harsher climatic conditions. This selection provided a comprehensive representation of the environmental and socioeconomic diversity within the county, ensuring the study captured the varying impacts of water scarcity across different ecological zones.

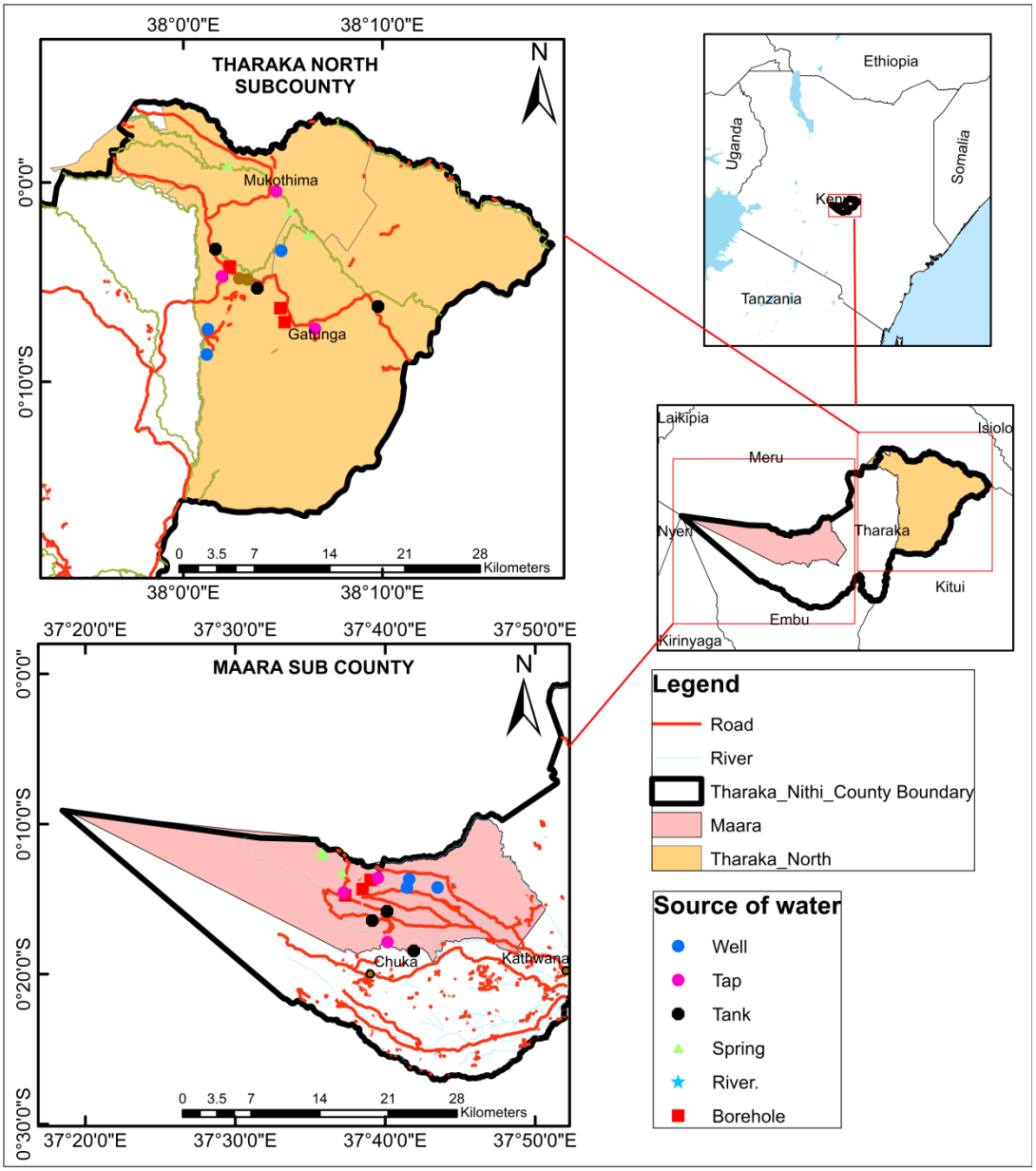


Figure 2: Map of the Study Area

Source: Author (2024)

### 3.1.1 Geology, Soils, and Climate

A wide range of rocks, mostly volcanic or sedimentary rocks with volcanic origins, make up the region's geological composition. Schist, psammitic rock, migmatites, and intrusive comprise the basement system (Kamunde, 2016). The majority of Tharaka Nithi's soils are clay, loam, and sand. Red loam soils that are suitable for agriculture predominate in the county's upper region (Muriu-Ng'ang'a et al., 2017). In the highlands, temperatures are between 140 and 300 degrees Celsius, while in the lowlands, they range from 220 to 360 degrees Celsius. While temperatures in the lower-

lying sub-counties of Tharaka South and Tharaka North may reach as high as 400C.The region is characterized by two rainy seasons: The April to June season is long rains, and October through December brings short rains. These are the two distinct rainfall seasons in the County. The Tharaka region receives an average annual rainfall of 500 mm, while the Maara bordering Mt. Kenya Forest receives an average annual rainfall of 2,200 mm. High-altitude regions usually experience steady rainfall, while low-altitude regions experience irregular and uneven rainfall (Mnyiri, 2014). However, uncommon weather occurrences resulting from climate change are experienced in the region at present. One of the major elements of weather that has been adversely affected is rainfall. The rainfall has become increasingly unreliable and unpredictable, consequently exacerbating water scarcity for agricultural and domestic uses.

### 3.2 Research Design

The study used a mixed-methods research design, which combined the quantitative and qualitative methodologies that would help define the measurable and experiential aspects of water scarcity. The structured household surveys were used to collect quantitative data, which included demographic details, water access, distance travelled, and livelihood activity. Key informant interviews (KIIs), field observations and focus group discussions (FGDs) provided complementary qualitative data that provided more insight into the lived experiences, perceptions and coping mechanisms. The triangulation of methods increased the validity of the findings and provided the possibility to see the gendered effects of water scarcity in a comprehensive way.

### 3.3 Target Population

The study targeted rural households, with women as the main unit of analysis because of their central role in water collection and household livelihoods. Respondents included women engaged in crop farming, livestock keeping, small-scale trading, casual labour, and domestic work. To capture intra-gender variations, respondents were differentiated based on age, marital status, education level, and type of livelihood activity. This enabled a comparative analysis of how water scarcity affected women differently depending on their social-demographic characteristics. Key informants included ward administrators, chiefs, water officers, and NGO representatives working on water and gender issues in the study area.

### 3.4 Sample size and Sampling Procedure

#### 3.4.1 Sampling Procedure

This study focused on two sub-counties, Tharaka North and Maara, selected based on their distinct agro-ecological zones. Maara is situated in the Upper Highlands, which receives adequate rainfall, while Tharaka North is located in the Semi-Arid zone with an annual average rainfall of about 500 mm. Tharaka North, on the leeward side of Mount Kenya, experiences a unique semi-arid climate compared to Maara, which benefits from the mountain's cooler and wetter influence. Sampling was carried out using a multi-stage approach. At the first stage, villages were stratified at the ward level based on location and physical features, after which random selection was done with the aid of Qualtrics XM. This web-based survey software supports randomization and household selection. In the second stage, households within the selected villages were randomly sampled using registered household lists, ensuring unbiased representation.

In total, 313 households participated in the survey: 113 from Tharaka North and 200 from Maara. The proportional allocation was determined using the National Housing Survey household distribution (KNBS, 2022), thereby ensuring representation reflective of actual population patterns. Purposive sampling was further applied to identify key informants, including county officials, water officers, local administrators, and community leaders, owing to their expertise in water scarcity and livelihood issues. Additionally, women's groups were engaged through focus group discussions (FGDs) to capture gendered perspectives.

#### 3.4.2 Sample Size Determination

Sample size was determined by a formula put forward by Fisher et al. (1983). The formula was selected based on its power to select the minimum sample size that is not prone to type 1 error.

$$n = \frac{z^2.\,\mathrm{p}.\,\mathrm{q}.\,\mathrm{N}}{e^2\,(\mathrm{N}-1) + z^2.\,\mathrm{p}.\,\mathrm{q}}$$

Where:

***n***-is the sample size**,** and ***p*** is the proportion of the population with the required characteristics of the study.

***q***-is the proportion of the population without the required characteristics of the

study (1-P)

**N**-is the total households (9,500)

***e***-is the accuracy level required/ margin of error. Standard error=10%

***z***-Confidence level at 95% (standard value of 1.96)

According to the National Housing Survey, the total number of households in Tharaka North and Maara sub-counties was 9,500 and 13,652, respectively. Accordingly, the number of households to be studied in Tharaka North, based on Fisher's formula, was determined as follows.

$$n = \frac{z^2.p.q.N}{e^2\,(N-1) + z^2.p.q}$$

$$= \frac{(1.96)2 \times (0.5) \times (0.5) \times 9{,}500}{(0.04)2\,(9{,}500-1) + (1.96)2(\times 0.5)(\times 0.5)}$$

= 112.706:

Therefore, the sample size =113

And the total numbers of households to be studied in Maara were;

$$= \frac{(1.96)2 \times (0.5) \times (0.5) \times 9{,}500}{(0.04)2\,(13652-1) + (1.96)2(\times 0.5)(\times 0.5)}$$

= 199.798

Sample Size =200

The total sample size in the two study areas was 113 + 200 = **313,**

The uneven distribution reflected actual variations in household numbers, settlement patterns, and population densities between the two sub-counties.

### 3.5 Pilot Study

The pilot study was conducted at Galbatulla Sub-County in Isiolo County to test the reliability and validity of the research tools. Validity was determined using criterion-related validity to test the respondents' understanding and answering of the questionnaires, while test and retest were used to determine reliability, where the calculation was found to be 0.89 Cronbach's Alpha. According to Creswell and Creswell (2018), the reliability and validity of these instruments are adequate to collect data using the tested tools. A pilot test of the questionnaire was conducted to ensure its clarity, consistency, and readability. The pilot test adhered to the widely recommended Eldridge et al. (2016) standard range of 5% to 10%. Galbatulla sub-county was selected

for the pilot study based on its climatic conditions that are somewhat similar to the study area. Moreover, it was closer to the study areas and can therefore be accessed easily.

In this pilot study, 313 participants who were sampled included 10 per cent of the population. In particular, 32 individuals were given questionnaires, after which they were not allowed to take part in the main study to exclude any bias. Pilot testing was done using Chuka and Tharaka South sub-counties because of their closeness in the environment as well as in the demographics to the Maara and Tharaka North sub-counties. This enabled the detection and remedy of possible problems that would affect the validity and reliability of the study findings.

### 3.5.1 Validity of Research Instruments

It consists of internal and external validity. Internal validity is concerned with the causation of variables, whereas external validity is concerned with how well the result can be extended to the entire research context (Bryman, 2012). To acquire the external validity, it is important to have a representative study sample that is free of biases, and the findings can be generalized (Findley, M. G., Kikuta, K., & Denly, M., 2021). Content and construct validity were also covered in the study. Consultation with experts also improved the content validity, which determines whether the research instruments fully address the topic of study, as proposed by (Pérez-Rivas, F. J., & Martínez, M. (2023) These professionals, among whom is the study supervisor, were going through the research instruments to verify that they are in tandem with the objectives and content areas of the study. Their responses were included to increase the validity of the instruments. Principal component analysis was involved in the evaluation of construct validity, which measures the ability of the instruments to measure the intended concept. In accordance with the rule that personal loadings should be greater than 0.5, this approach proved the appropriateness of the instruments (Brahmi, M., 2025).

### 3.5.2 Reliability of the Research Instruments

Reliability means the consistency and precision of the means and tools of data collection, which showed how accurately they had measured the variables to be measured (Bryman, 2012). It guaranteed that the measurements were not going to

change over time or between various sections of the gauge, and therefore, the data is not biased (Sekaran & Bougie, 2023). The internal consistency reliability was used in this study because it was deemed to be the most appropriate measure used in research conducted in the real world, since the measure is practical. One data sample was applied in measuring internal consistency, which is effective and efficient (Peterson et al., 2024).

Cronbach's alpha was one of the common statistics employed in measuring the reliability of the data collection instrument. This measure was used to determine the consistency with which the respondents responded to the questions. The Cronbach's alpha of 0.80 or higher was aimed for because it means that the instrument is consistent and can be used to generate consistent, stable results (Sreevidya and Sunitha, 2011). To obtain a high value of Cronbach's alpha in the study, it was crucial to have the reliability of the data, which enhances the validity of the research findings.

### 3.6 Methods of Data Collection

All natural water sources were visited, and their GPS coordinates were recorded for geospatial mapping. Household heads were engaged through structured questionnaires (Appendix I), while focus group discussions and structured interview schedules (Appendix II) were used to obtain in-depth information from purposively selected respondents. These approaches ensured that both quantitative and qualitative dimensions of water scarcity and its gendered impacts were adequately captured.

#### 3.6.1 Location of Watering Points

GPS technology was utilized to record the precise locations of water sources, including taps, rivers, boreholes, wells, tanks, and springs. These data were integrated into ArcGIS software to map the spatial distribution of water points, assess accessibility, and analyse usage patterns. Spatial correlation analysis was further conducted to determine whether women residing closer to water points experienced improved livelihood outcomes, such as reduced time spent on water collection and enhanced agricultural productivity, compared to those living farther away.

### 3.6.2 Household Surveys

Structured questionnaires were administered to sampled households to obtain quantitative data on household demographics, water collection patterns, and the socio-economic impacts of water scarcity.

### 3.6.3 Questionnaires

Questionnaires were used in the two sub-counties to gather data on gender disparities in access to water use, socioeconomic activities, water sources, causes of water scarcity, and the effects of water scarcity on women. For the respondents to comprehend the questions and give concise answers, the researcher and two assistants assisted them in doing so. After the researcher and two assistants gave the respondents the questionnaires, the data were gathered during working days, Monday through Friday, from 0900 to 1600 hours.

### 3.6.4 Key Informants Interview Guide

The County environmental and natural resource officers, WRMA representatives, Sub-County water officials, local women leaders, and personnel of a local non-governmental organization (NGO) were crucial informants in this study. These respondents were able to clarify the role of women in water management due to their apparent depth of knowledge and understanding of the subjects being studied. The researcher conducted in-person interviews with the primary informants. The researcher sought permission from the interviewee for the use of the recording devices. The mobile recording application was used, and then later the recorded conversations were transcribed using transcription software like Sonix.

### 3.6.5 Focused Group Discussions

In an effort to resolve divergent viewpoints from individual interviews, survey or questionnaire responses, a focus group may be helpful. The researcher was able to gather women in selected areas of the research. The conversation was guided by a list of relevant questions or subjects. Focus groups provided the researcher with detailed information that the questionnaires were unable to obtain. To fully understand the long-term effects of water scarcity on women, important information was gathered through perceptive inquiry. The FGD was made up of 10 people, with six women and four men,

and the session lasted for one hour. The current study shows that 63% of women in the study area are not accessing water. The inhibiting factor has been the issue of women's land ownership and cultural issues, which are well captured in the thesis. This is why we had more women in the FGD than males. The size is manageable and provided the respondents with ample time to express themselves in a specified time-bound schedule.

### 3.6.6 Observations

Direct observation was the main method of data collection used for this research. It let the researcher directly acquire information about the women's day-to-day activities, their interactions with water sources, distances travelled, time taken, and the water scarcity consequences on their lives. Through the direct observation of women, the researcher could comprehend more of the hardship's women had to face and also find out the means of their dealing with water scarcity. First, the researcher asked for permission from the local authorities. The Chief of the area where the research was conducted, and then, he also got the consent of the women involved in the study by promising to keep their identities secret. The confidentiality of the study was one of the reasons why the researcher got the permission of the women. The researcher was taking an interest in the women's water activities in the case of scarcity. Thus, he went to the watering places frequently and collected a lot of information through the sample women about the distance to the nearest watering point.

The researcher also wanted to find out about the consequences of water scarcity on women and which economic activities they were involved in. Besides that, the researcher observed and wrote detailed notes of their actions and interactions and also noted the environment of the observations. The information was later used to analyse the data and arrive at a conclusion about the water scarcity impacts on women. In addition, the researcher's experience after every observation session was very useful in minimizing the introduction of personal bias in interpretation and keeping the researcher focused on study objectives. Post observations, the researcher executed an intensive data analysis to find water scarcity and its effects on women's socio-economic activity patterns, trends, and the major issues. The findings were of the essence in terms of drawing conclusions and suggesting ways to cope with the water scarcity's negative consequences on women

### 3.6.7 Data Collection Timeframe and Seasonal Considerations

Data gathering took place from May to August 2023, coinciding with the long dry season in Tharaka Nithi County. This dry period was intentionally chosen as the water scarcity is at its highest, thereby the most favourable time for drawing the women's daily struggles with water access. Conducting the research during this season helped in living the times when the existence of water scarcity has the most adverse effects on the people's means of living, agricultural production, and even the well-being of the household. By focusing on the dry season, the study provided deeper insights into how water scarcity intensifies gendered burdens, particularly the time and energy women invest in water collection, and how this affects their economic activities and wellbeing.

## 3.7 Data Analysis and Presentation

The analysis of data was done using statistical and geospatial analysis. Household characteristics and patterns of water access were described using descriptive statistics: percentages, frequencies, means, and standard deviations. Fisher information tests (chi-square, contingency, Spearman, and multiple regression) were used to test relations and determine the main determinants of impacts caused by water scarcity on the livelihoods of rural women in Tharaka North and Maara sub-counties, and the significance was measured against 5 per cent. Geospatial data were processed in ArcGIS to map the distribution of water sources, measure distances to watering points, and analyse spatial patterns of access. Spatial correlation was conducted to test whether proximity to water sources influenced women's livelihood outcomes, particularly in terms of time spent on water collection, economic productivity, and agricultural performance.

$y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + e$

Where:

y - water scarcity

$\alpha$ -Y Intercept

$\beta_1$- $\beta_4$ = the changes caused by the various independent variable constructs

e-error

X1-Causes of water scarcity in Tharaka North and Maara Sub-counties

$X_2$- Gender differentiation in access to the use of water

$X_3$-Effect of water scarcity on women's social-economic activities

X4-Effect of water scarcity on agricultural performance.

### 3.8 Ethical Considerations

Before the study started, a research permit was obtained from the National Council of Science, Technology, and Innovations (NACOSTI). By guaranteeing participant participation and confidentiality, the study complied with the code of ethics. The Institutional Scientific and Ethics Review Committee granted permission to the researcher. The researcher assured the respondents that the study was only meant for academic use.

# CHAPTER FOUR

# RESULTS

## 4.1 Socio-Demographic Characteristics of Households Studied

A total of 313 households (200 in the Maara and 113 in Tharaka North) were sampled. They included the following variables: household size, age of household head, gender distribution, education level, primary occupation, and household income. The nature of these features determines the demand for water and the coping mechanisms people employ to deal with scarcity. Most of the respondents (42%) were aged between 30 and 49 years, indicating that middle-aged adults, who are in their most productive years, are the primary victims of water shortages. The level of education was also low, with 48 per cent only having a secondary education. Agriculture was the main source of livelihood, but Maara household subsistence was more crop-oriented compared to Tharaka North households, which engaged in mixed farming since the rainfall was less and less predictable. The sub-counties recorded an average household income of less than KSh. 6,000, which highlights the economic vulnerability. Greater household size, which was 6-7 persons on average, also contributed to the higher water demand.

Table 1: Social Demographic Characteristics of Households of the Respondents from Maara and Tharaka North Sub-County

| Attributes | Description | Maara Sub County | | Tharaka North Sub county | |
|---|---|---|---|---|---|
| | | Frequency (n=200) | Percentage (%) | Frequency (n=113) | Percentage (%) |
| Age | 20-29 years | 35 | 17.5% | 27 | 24.0% |
| | 30-39 years | 80 | 40.0% | 46 | 41.0% |
| | 40-49years | 47 | 23.5% | 21 | 19.0% |
| | 50-59 years | 25 | 12.5% | 13 | 11.0% |
| | 60 years and above | 13 | 6.5% | 6 | 5.0% |
| | Total | 200 | 100.0% | 113 | 100.0 |
| Education Level | Never attended school | 21 | 10.5% | 14 | 12.0% |
| | Primary | 60 | 30.0% | 36 | 32.0% |
| | Secondary | 99 | 49.5% | 53 | 47.0% |
| | Tertiary | 20 | 10.0% | 10 | 9.0% |
| | Total | 200 | 100.0% | 113 | 100.0% |
| Occupation | Crop Farmer | 96 | 48.0% | 12 | 11.0% |
| | mixed farming | 43 | 21.5% | 52 | 46.0% |
| | Salaried employment | 13 | 6.5% | 10 | 9.0% |
| | Unemployed | 27 | 13.5% | 23 | 20.0% |
| | Business | 21 | 10.5% | 16 | 14.0% |
| | Total | 200 | 100.0% | 113 | 100.0% |
| Income Generation | Father | 108 | 54.0% | 48 | 42.0% |
| | Mother | 71 | 35.5% | 28 | 25.0% |
| | Guardian | 21 | 10.5% | 37 | 33.0% |
| | Total | 200 | 100.0% | 113 | 100.0% |
| Monthly income | 3000 and below | 60 | 30.0% | 33 | 30.0% |
| | 3001-6000 | 38 | 19.0% | 23 | 20.0% |
| | 6001-9000 | 23 | 11.5% | 15 | 13.0% |
| | 9001-12000 | 22 | 11.0% | 11 | 10.0% |
| | 12001-15000 | 20 | 10.0% | 10 | 9.0% |
| | 15001-18000 | 17 | 8.5% | 9 | 8.0% |
| | 18001-21000 | 13 | 6.5% | 7 | 6.0% |
| | 21001 and above | 7 | 3.5% | 5 | 4.0% |
| | Total | 200 | 100.0 | 113 | 100.0% |
| Household Size | 3 | 9 | 4.5% | 6 | 5.0% |
| | 4 | 38 | 19.0% | 13 | 12.0% |
| | 5 | 80 | 40.0% | 36 | 32.0% |
| | 6 | 53 | 26.5% | 44 | 39.0% |
| | 7 and above | 20 | 10.0% | 14 | 12.0% |
| | Total | 200 | 100.0% | 113 | 100.0% |

### 4.2 Causes of Water Scarcity in Tharaka North and Maara Sub-Counties

The comparison of Tharaka North and Maara sub-counties according to the perceptions on the causes of water scarcity shows that there are some discrepancies in responses to a number of the main statements. In Tharaka North, most respondents strongly believed that climate change plays a role in water scarcity, with the figure standing at 52 individuals (46%), and less than a couple of individuals (2%) strongly opposed. Maara, on the other hand, displayed a more even response with 56 (28%) affirming and 13 (6.5%) strongly disagreeing. The Chi-square tests indicated that there were significant differences in perceptions of climate change and the values of $\chi^2 = 68.99$ ($p < 0.0001$) in Tharaka North and $\chi^2 = 35.23$ ($p < 0.0001$) in Maara. The Spearman correlation analysis also showed a positive but nonsignificant correlation between perceptions of climate change and water scarcity in both sub-counties, with $r = 0.0060$ ($p > 0.05$). Another key cause of water scarcity was found to be deforestation. In Tharaka North, 54 (47.5) out of the respondents strongly supported this statement, and only four (3.5) opposed it. As well, 100 respondents (50%) in Maara strongly agreed with this, and just two (1) disagreed. The Chi-square values showed a significant difference between deforestation, $\chi^2 = 55.38$ ($p < 0.0001$) in Tharaka North and $\chi^2 = 123.16$ ($p < 0.0001$) in Maara. In both sub-counties, the positive, but non-significant correlation between water scarcity and deforestation was $r = 0.0570$ ($p > 0.05$).

Land degradation and soil erosion opinions were also not even in the two sub-counties. In Tharaka North, 40 (35) respondents held the opinion that soil erosion and land degradation contribute to water scarcity, and seven (6) strongly disagreed with the opinion. Maara, however, recorded a higher consensus where 87 respondents (43.5%) agreed and 11 (5.5) strongly disagreed. Significant differences were observed in chi-square values, wherein kh2=27.39 (p= 0.0001) in Tharaka North and kh2=104.5 (p= 0.0001) in Maara. In both sub-counties, the correlation was positive but not significant and had $r = 0.0570$ ($p > 0.05$). The ideology of illiteracy was viewed differently in terms of causing water scarcity. This registered a considerable disputation of 30 respondents (26.5% in Tharaka North and 69 respondents (34.5) in Maara), which is a higher percentage when compared to Maara. The chi-square analysis revealed significant variation with kh2 = 19.56 ($p < 0.0002$) in Tharaka North and kh2 = 0.73 ($p > 0.6942$)

in Maara. Cases of illiteracy and water shortages in the two sub-counties were observed to have a significant correlation, as the correlation was negative, $r = -0.2460$ ($p < 0.05$).

The two sub-counties were concerned about the lack of government support, with different levels of focus. At Tharaka North, 50 respondents (44.24%) held an agreement to the fact that low governmental support is a contributing factor to water scarcity, but in Maara, 107 respondents (53.50%) did not. The Chi-square outcomes showed that there were significant differences, as kh2 = 24.23 ($p < 0.0001$) in Tharaka North and kh2 = 107.28 ($p < 0.0001$) in Maara. Also, the Spearman correlation analysis showed that there was a significant negative correlation between lack of government support and water shortage in the two sub-counties, with $r = -0.2180$ ($p < 0.0001$) recorded. Poverty was also reported as a key factor. In Tharaka North, 63 respondents (55.75%) strongly agreed that poverty is the main cause of water scarcity, while 10 respondents (8.84%) were neutral. In Maara, 94 respondents (47%) agreed, while 21 (10.50%) disagreed. The Chi-square tests showed significant differences, with values of $\chi^2 = 37.50$ ($p < 0.0001$) in Tharaka North and $\chi^2 = 59.48$ ($p < 0.0001$) in Maara. Spearman correlation analysis confirmed a significant negative relationship between poverty and water scarcity in both sub-counties, with $r = -0.3370$ ($p < 0.0001$).

Table 2: Causes of Water Scarcity

| Statement | Sub-County | S.D (F, %) | D (F, %) | N (F, %) | A (F, %) | S.A (F, %) | Chi-Square, p-value |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | ($\chi^{2,\,p}$) |
| Climate change is the cause of water scarcity | Tharaka North | 2, 2.0% | 8, 7.0% | 21, 19.0% | 30, 27.0% | 52, 46.0% | $X^2$=68.99 p< 0.0001 |
| | Maara | 13, 6.5% | 21, 10.5% | 44, 22.0% | 56, 28.0% | 36, 18.0% | $\chi^2$ = 35.23 p < 0.0001 |
| Deforestation has led to water scarcity. | Tharaka North | - | 4, 3.5% | 15, 13.0 | 40, 35.0% | 54, 47.5% | $\chi^2$ = 55.38 p < 0.0001 |
| | Maara | - | 2, 1.0% | 23, 11.50% | 75, 37.5% | 100, 50.0% | $\chi^2$ = 123.16 p < 0.0001 |
| Soil erosion and land degradation cause water scarcity | Tharaka North | 7, 6.0% | 16, 14.0% | 28, 25.0% | 22, 19.0% | 40, 35.0% | $\chi^2$ = 27.39 p < 0.0001 |
| | Maara | 11, 5.5% | 19, 9.5% | 23, 11.5% | 87, 43.5% | 60, 30.0% | $\chi^2$ =104.5 p < 0.0001 |
| Illiteracy is one of the causes of water scarcity | Tharaka North | 30, 26.5% | 45, 39.8% | 26, 23.0% | 12, 10.6% | - | $\chi^2$ = 19.56 p < 0.0002 |
| | Maara | 69, 34.5% | 70, 35.0% | 61, 30.5% | - | - | $\chi^2$ = 0.73 p > 0.6942 |
| Lack of both County and National government support has led to water scarcity | Tharaka North | 18, 15.9% | 50, 44.2% | 27, 23.9% | 18, 15.9% | - | $\chi^2$ = 24.23 p < 0.0001 |
| | Maara | 47, 23.5% | 107, 53.5% | 41, 20.5% | 5, 2.5% | - | $\chi^2$ = 107.28 p < 0.0001 |
| Poverty is the main cause of water scarcity | Tharaka North | - | - | 10, 8.8% | 40, 35.4% | 63, 55.8% | $\chi^2$ = 37.50 p < 0.0001 |
| | Maara | - | 21, 10.5% | 36, 18.0% | 94, 47.0% | 49, 24.5% | $\chi^2$ = 59.48 p < 0.0001 |

Figures in parentheses are in percentages.

Water scarcity remains a pressing challenge in the semi-arid regions of Tharaka North and Maara Sub-counties. The study sought to identify the key drivers of this scarcity by engaging residents through structured questionnaires. (Table 3), outlines the main causes cited by respondents, including drought, low rainfall, declining groundwater levels, global warming, and governance-related issues. While all these factors play a role in exacerbating water scarcity, their intensity and frequency vary across the two sub-counties due to differing geographical, climatic, and infrastructural conditions. The findings below present a detailed analysis of each factor as perceived by the respondents.

### 4.2.1 Drought

Drought was described as the most important reason for water scarcity in Maara and Tharaka North sub-counties. In Maara, over a hundred people (50.5%) pointed out that dried-up water sources, less agricultural productivity, and very little drinking water access were the results of long dry spells. A drought was also mentioned in Tharaka North by 57 out of 113 people (50.4%) as the major reason for the water crisis. This means that drought is not only a seasonal event but a continuous climatic problem that very much hampers the water supplies in both areas.

### 4.2.2 Low Rainfall

Low rainfall was reported to be closely associated with drought and a decisive factor in water scarcity. Rainfall pattern in Maara Sub-County was described by 52 people (26%) as being inconsistent and below average, which was a major barrier to water availability, especially for rainfed agriculture and for household consumption. In Tharaka North, 30 people (26.5%) voiced their concern in the same way, saying that the erratic rainfall usually causes the seasonal rivers and shallow wells to dry up. The findings imply that the reduced rainfall is affecting the recharge of both surface and groundwater, thus worsening the water shortage.

### 4.2.3 Low Groundwater Levels and Few Water Sources

Groundwater depletion and the restricted number of water sources have been less talked about, but they are still vital factors affecting water scarcity. In Maara, 12 people (6%) linked the absence of water with low groundwater reserves, and 15 people (7.5%)

indicated the overall lack of water points like boreholes and wells as the cause. Out of the total respondents in Tharaka North, 7 respondents (6.2%) and 8 respondents (7.1%) mentioned that the main problems were low groundwater and inadequate water infrastructure, respectively. Therefore, it can be concluded that the two sub-counties need to invest more in groundwater exploration and the enlargement of water infrastructure.

### 4.2.4 Global Warming

Global warming was seen as a significant driver of water scarcity, although less than other drivers. In Maara, twenty (10%) of the respondents associated increasing world temperatures with more frequent and severe dry spells that have had an impact on water accessibility. Eleven (9.7%) of the respondents in Tharaka North also made a similar observation that traditional water governance methods are no longer practicable due to changes in climate patterns. While small, these scores serve to highlight the key role of ever-increasing community awareness regarding climate change and its broader environmental implications.

### 4.2.5 Water Governance Issues

The study examined the governance factor among others, such as environmental and infrastructural causes of water scarcity. (Table 3), All respondents,200 (100%) in Maara and 113 (100%) in Tharaka North, agreed that water governance is a major determinant of water service provision. In Maara, conflicts over water were the governance-related challenge most frequently mentioned, and 56 respondents (28%) reported it as a common issue. Preventable health risks and issues of water security also featured prominently. 36 (18%) and 40 (20%) respondents described preventable risks to physical health and access to fresh water, respectively. In Tharaka North, it was observed that 28 (24.8) and 18 (15.9) % indicated water conflicts and health hazards, while 21(18.6) % pointed out water insecurity. Corruption and uneven distribution of water were also identified as continuous problems that were more widespread in Maara compared to Tharaka North. Nevertheless, the extent of reports across the sites indicates systemic governance problems that must be addressed to provide more equitable and sustainable water accessibility.

Table 3: Responses on the Scarcity of Water

| Question | Attribute | Maara sub county | | Tharaka sub-county | |
|---|---|---|---|---|---|
| | | Frequency (n=200) | % | Frequency (n=113) | % |
| Does the governance of water affect the water supply? | Yes | 200 | 100% | 113 | 100% |
| If yes, state how | Unequal distribution of water | 34 | 17% | 17 | 15.0% |
| | Lack of transparency | 10 | 5% | 5 | 4.4% |
| | Preventable health risks | 36 | 18.0% | 18 | 15.9% |
| | Water disputes | 56 | 28.0% | 28 | 24.8% |
| | Water security | 40 | 20.0% | 21 | 18.6% |
| | Corruption | 16 | 8.0% | 16 | 14.2% |
| | Water pollution | 8 | 4.0% | 8 | 7.1% |
| What do you think is the cause of water scarcity in your area? | Low rainfall | 52 | 26.0% | 30 | 26.5% |
| | Low groundwater | 12 | 6.0% | 7 | 6.2% |
| | Drought | 101 | 50.5% | 57 | 50.4% |
| | Global warming | 20 | 10.0% | 11 | 9.7% |
| | Few water sources | 15 | 7.5.0% | 8 | 7.1% |
| State some of the adaptation measures put in place to cope with water scarcity? | Increase storage | 40 | 20.0% | 21 | 18.6% |
| | Groundwater development | 58 | 29.0% | 35 | 31.0% |
| | Water recycling and reuse | 41 | 20.5% | 21 | 18.6% |
| | Drought-resistant crops | 33 | 16.5% | 18 | 15.9% |
| | Drip irrigation | 28 | 14.0% | 18 | 15.9% |
| What measures have you put in place to conserve and preserve available water sources? | Set up rain catchment tanks | 14 | 7.0% | 7 | 6.2% |
| | Rehabilitate old wells and boreholes | 41 | 20.5% | 25 | 22.1% |
| | Protect springs and rivers | 31 | 15.5% | 21 | 18.6% |
| | Sustainable utilization of water sources | 48 | 24.0% | 26 | 23.0% |
| | Enforce water laws and regulations | 36 | 18.0% | 18 | 15.9% |
| | Use of sand storage dams | 10 | 5.0% | 5 | 4.4% |
| | Artificial recharge of aquifers | 6 | 3.0% | 3 | 2.7% |
| | Afforestation and reforestation | 14 | 7.0% | 8 | 7.1% |

### 4.2.6. Ranking of Causes by Severity

To assess the relative importance of each cause, respondents rated severity on a 5-point scale (1 = very low, 5 = very high). The ranking demonstrates that drought, low rainfall, and governance challenges are the most severe constraints. Drought and rainfall variability directly affect agricultural output and water availability, while governance failures exacerbate inequitable distribution and infrastructure breakdowns.

Table 4: Ranking of Causes by Severity

| Cause of Scarcity | Severity Score (1–5) |
|---|---|
| Drought | 4.8 |
| Low Rainfall | 4.5 |
| Governance Issues | 4.2 |
| Few Water Sources | 3.8 |
| Low Groundwater Levels | 3.6 |
| Global Warming | 3.2 |

### 4.2.7 Validation with Environmental Data

To enhance the perceptions of the households, the study verified the responses to secondary environmental statistics, rainfall records (2010-2023): Kenya Meteorological Services data indicate a decreasing rainfall trend in both sub-counties, whereby the mean annual rainfall dropped by about 12 % over ten years. The short rains (October-December) were very erratic in that they coincided with the respondent perceptions of the frequency of drought. The trends in groundwater, reports by the Water Resources Authority (WRA) (2021-2023), affirm the reduction in groundwater tables to semi-arid regions, especially in Tharaka North, where the yield of boreholes has decreased by 15-20 %. Spatial Variability, Maara receives more rainfall as a result of being near the mountain, Kenya, whilst Tharaka North always receives less rainfall, which can be seen to be the reason why there are various access and coping strategies.

### 4.2.8 Sources of Water in the Two Sub-Counties

A review of responses to water sources in Maara and Tharaka North sub-counties indicated that there was a significant variation in the source of water used by the respondents in the two regions. In Maara Sub-County, tap water was the most common source of water, with 169 (85.0) of the respondents using it as the primary source of water. 13 respondents (6.5%), 8 respondents (4%) used river water and boreholes, respectively. Less often used sources included wells and rainwater, with 7 respondents

(3.5) and 3 respondents (1.5), respectively.

On the other hand, Tharaka North Sub-County exhibited a variation in the water sources. Most of the respondents relied on river water, with 60 people (53.1%) relying on the river water. Another important source was boreholes, which were used by 13 respondents (11.5%). The most frequent sources of water were tapping water (11 respondents, 9.7%), wells and rainwater, 15 and 14 respondents respectively. (Figure 3).

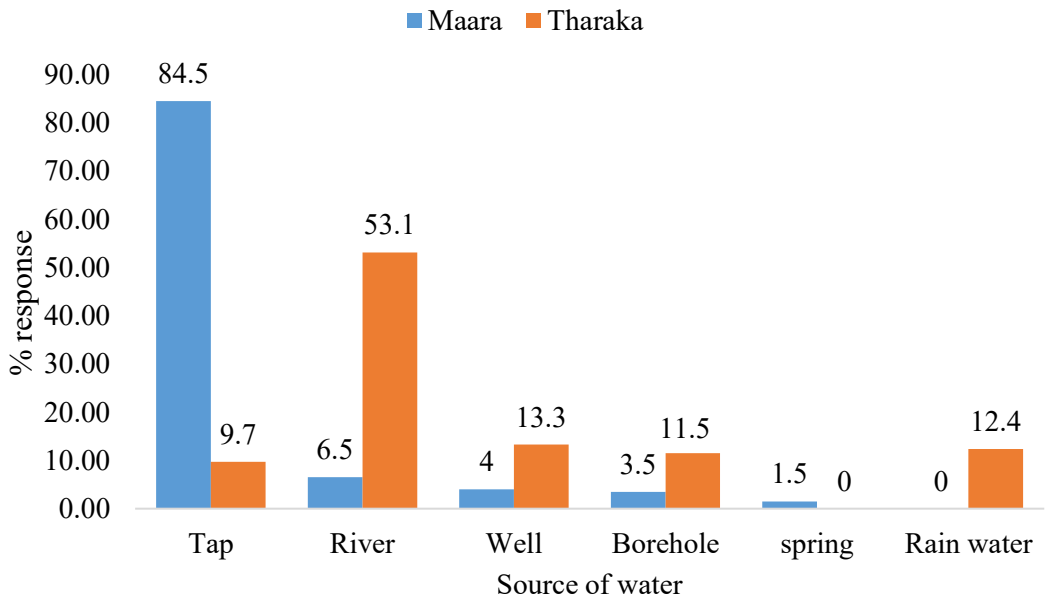


Figure 3: Sources of Water in Maara and Tharaka North Sub-counties

The descriptive statistics were supported by interviews and focus group discussions carried out. “In Maara, tap water is more available, and we rely on piped connections even though there are occasional supply issues,” noted one participant during a focus group discussion (FGD). Meanwhile, a Tharaka North respondent explained, “River water is the easiest to access here, especially during the dry season, as there are few boreholes or piped water connections.” The Chi-Square tests were used in the study to determine that there is a significant difference in water sources at Maara and Tharaka North. The research discovered that there was a huge distinction between forms of water sources between Maara and Tharaka North sub-counties, recorded by ($\chi 2 = 179.57$, $df=5$, $p<0.0001$). Besides, the Spearman correlation was used to determine whether there is a correlation between the water sources used in Maara and Tharaka North. The

study also indicated a strong negative relationship between the use of different water sources, including tap, rivers, wells, boreholes, springs, and rainwater between Maara and Tharaka North, as indicated by ($r = -0.5070$, $p=0.0001$). The results highlight the fact that better water management practices are badly needed.

### 4.2.9 Geospatial Analysis of Water Scarcity

Geospatial analysis indicated that there are significant differences in the distance that women cover to get water sources within the study area. In Tharaka North, the average travel made by households is 4.8 km with a range of 1 km to 12 km. These distances can amount to over an hour walk up and down carrying water, which constitutes a heavy time constraint on the women who will have to carry the water. Conversely, Maara households had a mean distance of 1.5 km, and the majority of the trips took less than half an hour. These results prove the imbalanced geographical allocation of water resources, as women living in Tharaka North have a higher issue in terms of water access than those in Maara.

Additional spatial correlation analysis defined a correlation between closeness to water and the livelihood results of women. The households were grouped into near and far households based on a 2 km buffer analysis of the households in relation to water points. The rank correlation coefficient of Spearman showed there was a positive relationship between proximity to water sources and better livelihood variables. Females in the homes that were in proximity to water bodies noted increased farm output and involvement in trade and market activities. On the other hand, the additional time taken in getting water by those living far away meant that time and energy used on that would have been spent on earning an income and other productive activities.

These findings emphasize the overlap of access to water and socio-economic welfare. The availability of safer piped schemes and boreholes, and a relatively higher amount of rainfall in Maara, makes the collection of water less time-consuming and allows women to expand their economic activity in the region. On the other hand, the high dependency of rivers and seasonal pans in Tharaka North, which is a drier area, creates a cycle in which the lack of access to water limits the economic productivity of women and serves to strengthen the vulnerability of households. These findings underscore the

importance of water access as a matter of convenience and a factor of livelihood, especially to women who must bear the burden of water retrieval. The geospatial analysis will offer some evidence that better water infrastructures, like piped networks, boreholes, and rainwater harvesting systems, have the potential to save time, reduce poverty among women and generate socio-economic development.

Such policy interventions are therefore supposed to focus on gender sensitive water planning, especially in arid and semi-arid areas such as Tharaka North, where women bear the majority of the burden of collecting water that contributes to poverty and erosion of resilience. Strengthening rural water governance, guided by GIS-based identification of scarcity hotspots, can promote equitable resource distribution and enhance women's participation in both agricultural and market economies.

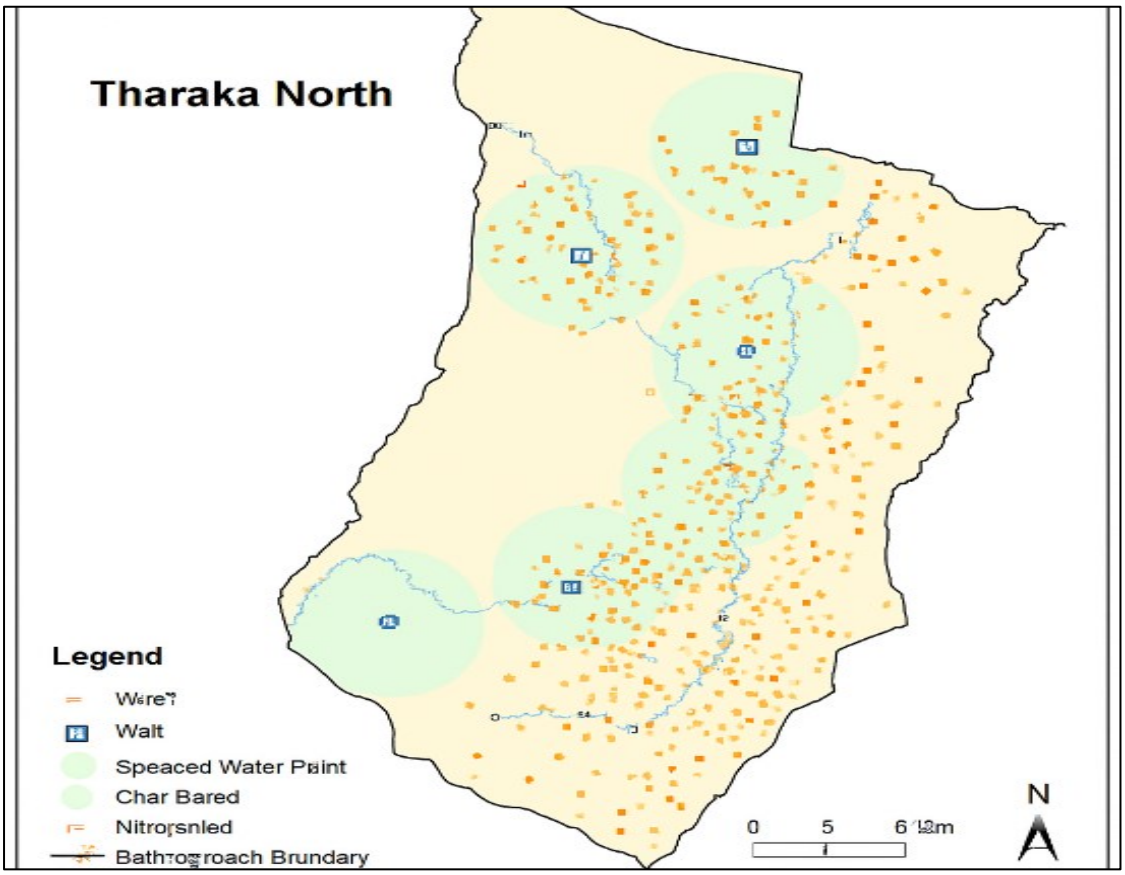


Figure 4: Map of Geospatial Analysis

Source: Author 2024

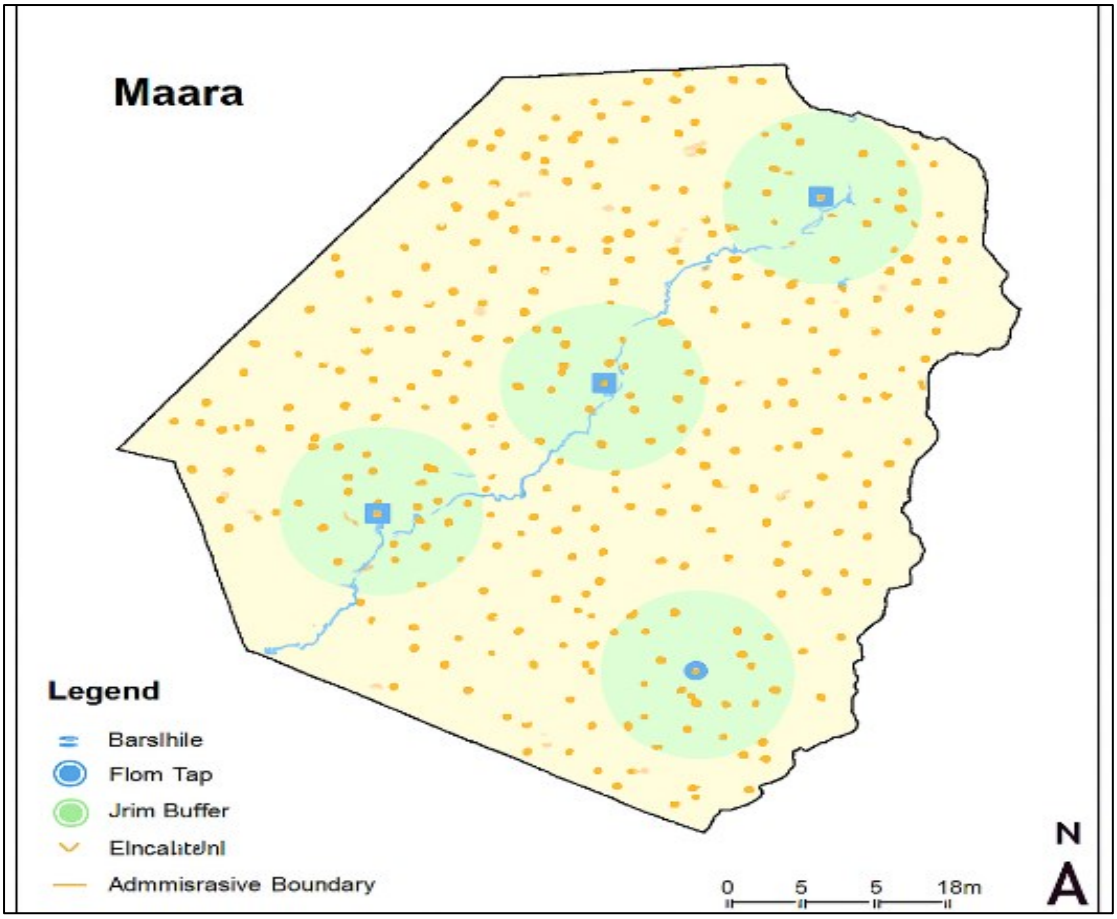


Figure 5: Map of Geospatial Analysis.

Source: Author 2024

### 4.4 Gender Differentiation in Access to the use of Water in the two Sub-Counties

#### 4.4.1 Gender Equality in Water Access

Regarding gender equality in water access, the majority of respondents in both areas believe that women do not have equal access compared to men. In Maara, a significant majority, 125(62.5%), felt that women face inequalities in water access, while a smaller portion, 75(37.5%), thought women have equal access, with a significant difference between Maara and Tharaka North ($\chi 2 = 6.26$, df. =1, $p = 0.0123$). Similarly, in Tharaka, North, the majority 72(63.7%) believed that women do not have equal access to water, with fewer respondents 41(36.3%) feeling that access is equal to water (Figure 6). This was also supported by interviews and focus group discussions carried out.

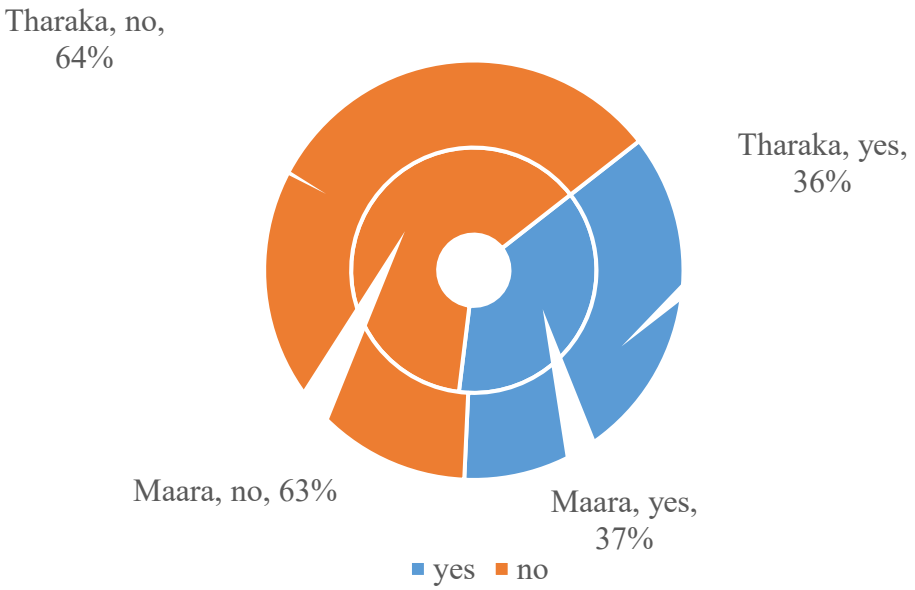


Figure 6 Gender Equality in Water Access

The chi-square test found a significant difference in equal access to water between Maara and Tharaka North ($\chi 2 = 7.84$, df. =1, p=0.0051). In addition, the results revealed a positive correlation in response to gender equality in water access in the two sub-counties (r=1.0000, p<0.0001).

### 4.4.2. Gendered Challenges in Access to Water

The study findings reveal that women in both Maara and Tharaka North sub-counties face substantial challenges in accessing water, which are deeply rooted in cultural, social, and structural barriers. Women remain the primary individuals responsible for fetching water, a task that consumes a considerable portion of their time and reduces opportunities to engage in education, income-generating activities, and other productive roles.

Survey results highlight several critical obstacles affecting women's access to water. Approximately 19.5% of respondents in both sub-counties mentioned competition and water-related conflicts as the tension with scarce resources. The second obstacle was found to be land ownership, with 20.4 per cent of the respondents in Tharaka North and 18.5 per cent in Maara citing land tenure problems. Intimately linked with it, the issue of land rights of women was brought up by the greatest percentage of respondents, 22.0% in Maara and 21.2% in Tharaka North, which highlights the gendered inequities

in the control of resources. Another barrier found was cultural barriers, where 21.0 per cent of respondents in Maara and 20.4 per cent of Tharaka North reported that the traditional norms limit the autonomy of women in the management of water. In addition, 19.0% in Maara and 18.6% in Tharaka North emphasized the issue of social exclusion and inequality as a systemic disadvantage to which women are exposed in terms of accessing and controlling their water resources.

Qualitative evidence from interviews and focus group discussions reinforced these quantitative findings. Women expressed that insecure land tenure constrains their ability to invest in sustainable water infrastructure, while male dominance in local governance structures limits their participation in water-related decision-making. Although regression analysis suggested that gender differentiation was a weaker predictor compared to direct scarcity factors, the lived experiences of women demonstrate that they bear a disproportionate burden of water scarcity, making them more vulnerable to its adverse impacts.

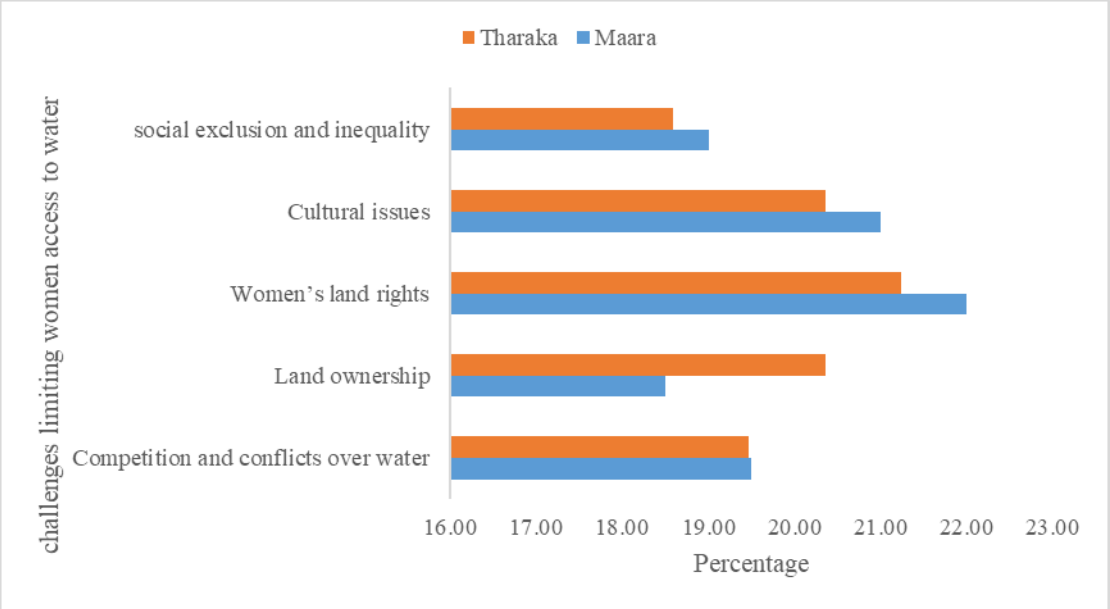


Figure 7: Gendered Challenges in Access to Water.

### 4.5. Effect of Water Scarcity on Women's Social-Economic Activities

In Tharaka North, a large proportion of respondents (57.51%) agree or strongly agree that water scarcity has led to decreased income, compared to a similar proportion (56.5%) in Maara. However, the chi-square test shows a significant difference in decreased income in (Tharaka North: $\chi 2 = 32.35$, $p < 0.0001$; Maara: $\chi 2 = 41.95$, $p <$

0.0001), respectively. The findings indicate that although the overall perception is similar, the distribution of agreement levels varies significantly within each sub-county (Table 5).

A majority of respondents in both Tharaka North (77.86%) and Maara (79%) agree or strongly agree that proximity to water sources has enabled agricultural improvement. The chi-square values (Tharaka North: $\chi2 = 16.79$, $p < 0.0002$; Maara: $\chi2 = 26.92$, $p < 0.0001$) suggest a significant difference within the responses of each county, indicating that the distribution of agreement is significantly varied within each sub-county, as illustrated in Table 5.). In Tharaka North, a majority (59.28%) agrees or strongly agrees that proximity to water sources results in higher income, while a slightly smaller proportion (50%) in Maara holds the same view Table 4.5). The significant chi-square results (Tharaka North: $\chi2 = 45.18$, $p < 0.0001$; Maara: $\chi2 = 36.65$, $p < 0.0001$) indicate significant differences in proximity to the river source and higher income between Maara and Tharaka North sub-counties.

In Tharaka North, a majority (70.78%) agrees or strongly agrees that proximity to water sources enables improved engagement in other economic activities, while in Maara, a larger proportion (71%) holds this view. The chi-square test shows no significant difference in proximity to water sources and improvement in other economic activities in Tharaka North ($\chi2 = 2.77$, $p > 0.2492$), indicating consistent responses. However, in Maara, the significant chi-square result ($\chi2 = 57.20$, $p < 0.0001$) indicates a significant variation in proximity to water sources and improvement in other economic activities in Maara sub-counties (Table 5).

A large proportion of respondents in both Tharaka North (76.98%) and Maara (71.5%) agree or strongly agree that residents living far from water sources face social issues. The chi-square tests (Tharaka North: $\chi2 = 77.92$, $p < 0.0001$; Maara: $\chi2 = 103.55$, $p < 0.0001$) show significant differences in distance from water sources between Maara and Tharaka North. The findings suggest that perceptions vary significantly within each sub-county, as illustrated in Table 5. In Tharaka North, a majority (63.71%) strongly disagree with the statement that water is available in their area, while in Maara, the responses are more varied, with a smaller proportion (25.5%) strongly disagreeing and

others either disagreeing or agreeing to various extents. The significant chi-square results (Tharaka North: $\chi 2 = 8.50$, $p < 0.0035$; Maara: $\chi 2 = 59.95$, $p < 0.0001$) indicate substantial differences in the availability of water in the area, especially in Maara, where opinions on water availability are more diverse, as illustrated in Table 5. This was also supported by interviews and focus group discussions carried out.

Table 5: Effect of Water Scarcity on Women's Social-Economic Activities

| Statement | Sub County | (S.D) | (D) | (N) | (A) | (S.A) | Chi-Square, P-Value |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | ($\chi^{2,p}$) |
| Scarcity of water has led to decreased income | Tharaka. N | 2, 1.8% | 16, 14.2% | 30, 26.5% | 35, 30.97% | 30, 26.54% | $\chi^2 = 32.35$ $p < 0.0001$ |
| | Maara | 11, 5.5% | 28, 14% | 48, 24% | 63, 31.5% | 50, 25% | $\chi^2 = 41.95$ $p < 0.0001$ |
| Proximity to water sources has enabled improvement in agriculture | Tharaka N | - | - | 25, 22.1% | 30, 26.54% | 58, 51.32% | $\chi^2 = 16.79$ $p < 0.0002$ |
| | Maara | - | - | 42, 21.0% | 58, 29% | 100, 50% | $\chi^2 = 26.92$ $p < 0.0001$ |
| Residents living in areas proximal to water sources have more income | Tharaka. N | 3, 53.9% | 9, 7.96% | 34, 30.1% | 40, 35.39% | 27, 23.89% | $\chi^2 = 45.18$ $p < 0.0001$ |
| | Maara | 13, 6.5% | 31, 15.5% | 56, 28.0% | 60, 30% | 40, 20.0% | $\chi^2 = 36.65$ $p < 0.0001$ |
| Proximity to water sources has enabled improved engagement in other economic activities. | Tharaka. N | - | - | 33,29.2% | 34, 30.08% | 46, 40.70% | $\chi^2 = 2.77$ $p > 0.2492$ |
| | Maara | - | 21, 10.5% | 37, 18.5% | 49, 24.50% | 93,46.50% | $\chi^2 = 57.20$ $p < 0.0001$ |
| Residents living far from water sources have social issues | Tharaka. N | 4, 3.5% | 9, 7.96% | 13, 11.5% | 32, 28.3% | 55, 48.7% | $\chi^2 = 77.92$ $p < 0.0001$ |
| | Maara. N | 2, 1.0% | 18, 9.0% | 37, 18.5% | 61, 30.5% | 82, 41.0% | $\chi^2 = 103.55$ $p < 0.0001$ |
| Water is available in our area | Tharaka. N | 72, 63.7% | 41, 36.3% | - | - | - | $\chi^2 = 8.50$ $p < 0.0035$ |
| | Maara | 51, 25.5% | 78, 39.0% | 20, 10.0% | 28 14.0% | 23, 11.5% | $\chi^2 = 59.95$ $p < 0.0001$ |

Figures in parentheses are in percentages

### 4.5.1 Coping with Water Scarcity

In comparing the responses from Maara and Tharaka North regarding how women cope with water scarcity, the data reveal notable differences. In Maara, the largest proportion of women cope by queuing for long hours (28.0%) and walking long distances (20.5%), as illustrated in Figure 4.8. Conversely, in Tharaka North, a larger proportion of women walk long distances (30.1%) and pay for water (21.2%). The chi-square test indicates non-significant variation in coping strategies and women's socio-economic activities within Maara ($\chi^2 = 5.75$, df=4, p= 0.2186; P>.05) but not in Tharaka north ($\chi^2 = 7.45$, p = 0.113; P>.05). A moderate positive non-significant correlation (r = 0.7079, p < 0.1810; P>.05) between Maara and Tharaka North some similarities in coping methods and socio-economics activities in Maara and Tharaka North but also highlights differences. This was also supported by interviews and focus group discussions carried out.

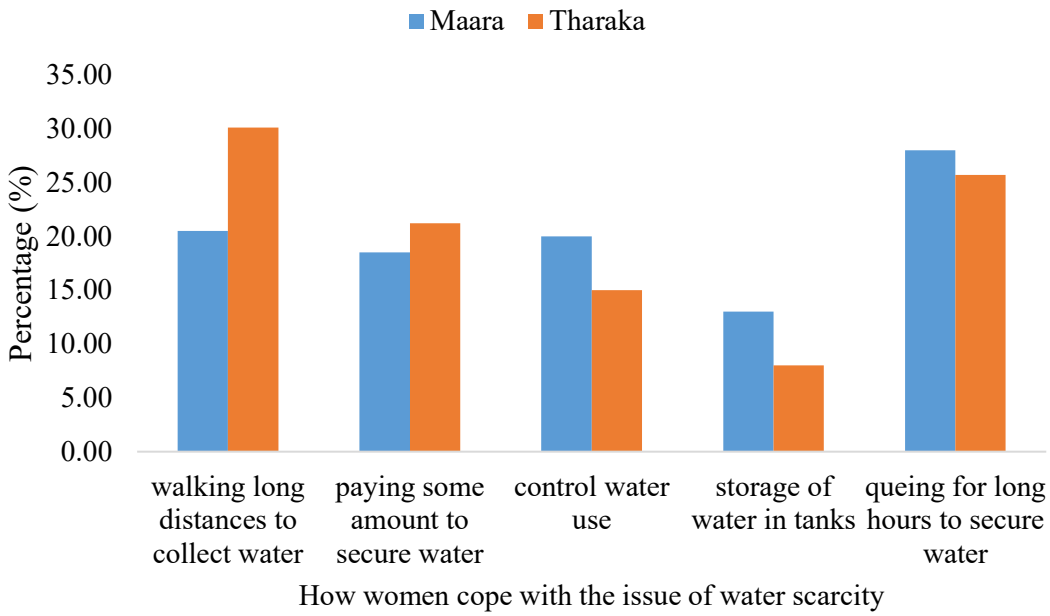


Figure 8: How Women Cope with the Issue of Water Scarcity

### 4.5.2 Socio-Economic Activities of Women

Regarding socio-economic activities, Maara has a large proportion of women engaged in trading (43.0%), while Tharaka North shows more diversity, with notable involvement in livestock production (21.2%) and other activities, as illustrated in (Figure.9) The chi-square test reveals significant differences in socio-economic activities within the Maara sub-county ($\chi^2 = 855.2$, df = 5, p < 0.0001). In contrast, no

significant differences were observed in the Tharaka North sub-county ($\chi^2 = 7.52$, df = 5, p = 0.1843). A positive but not significant correlation (r = 0.3390, p = 0.5110) shows that there is a weak link between socio-economic activities and women varied economic participation in Maara and Tharaka North sub-counties.

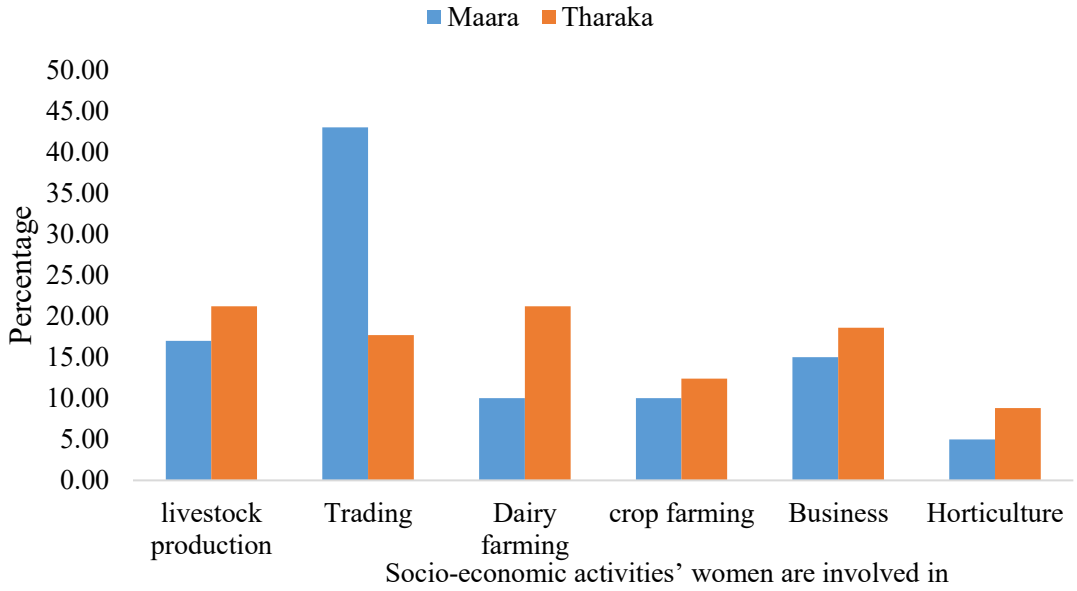


Figure 9: Socio-Economic Activities of Women

### 4.5.3 Reflection of Water Scarcity in Household Procedures

When assessing whether personal household procedures reflect water scarcity, the majority of respondents in both regions do not perceive significant impacts. In Maara, 77% report no impact, while 84.1% of respondents in Tharaka North feel the same, as illustrated in Table 4.6. The chi-square values reveal significant variation in personal households' procedures within Maara ($\chi^2 = 28.37$, p <0.0001) and Tharaka North ($\chi^2 = 46.24$, p <0.0001), respectively. The study found a perfect significant correlation between reflection of water scarcity and household procedures, as illustrated (r = 1.0000, p<0.0001), indicating an agreement between Maara and Tharaka North regarding the effects of water scarcity on household procedures. This was also supported by interviews and focus group discussions carried out.

### 4.5.4 Adjustments to Address Water Scarcity

In terms of adjustments made to address water scarcity, Maara shows a large proportion using grey water (37%), whereas Tharaka North primarily stores water (23%),

(Table.6.) The chi-square test indicates significant variation in adjustments to address water within Maara ($\chi^2 = 51.16$, df=6, $p<0.0001$) and within Tharaka North ($\chi^2 = 13.68$, df=6, $p = 0.0334$), respectively. A moderate positive non-significant correlation ($r = 0.6765, 0.0951$) suggests both Maara and Tharaka North utilize similar coping strategies but differ in their proportions.

Table 6: Reflection of Water Scarcity in Household Procedures, Adjustments, Duration of Coping Measures and Challenges in Coping and Adaptation.

| | | Maara | Tharaka North |
|---|---|---|---|
| | | Frequency, Percentage | |
| Question | Attribute | (F, %) | (F, %) |
| Do your personal household procedures reflect the lack of water? | Yes | 46,23.0% | 18,15.9% |
| | No | 154,76% | 95,84.1% |
| | Total | 200,100.0% | 113,100.0% |
| What adjustments have you made to address water scarcity? | storing water | 40,20.0% | 26,23.0% |
| | use of grey water | 64,37.0% | 23,20.4% |
| | Taking a bath once a day | 38,17.0% | 12,10.6% |
| | use of pit latrines | 18,9.0% | 8,7.1% |
| | rainwater harvesting | 21,11.5% | 18,15.9% |
| | Use of drought-resistant seeds | 11,5.5% | 15,13.3% |
| | Use of drip irrigation | 8,4.0% | 11,9.7% |
| | Total | 200,100.0% | 113,100% |
| For how long have you been using the above measures? | 0-1 years | 43,21.5% | 29,25.7% |
| | 2-3 years | 78,39.0% | 42,37.2% |
| | 4-5 years | 39,19.5% | 23,20.4% |
| | >5 years | 40,20.0% | 19,16.8% |
| | Total | 200,100.0% | 113,100.0% |
| Some of the challenges regarding coping and adaptation strategies | Cost | 43,21.5% | 26,23.0% |
| | Poverty | 78,39.0% | 44,38.9% |
| | competing interest | 39,19.5% | 21,18.6% |
| | Knowledge | 32,16.0% | 17,15.0% |
| | Expertise | 8,4.0% | 5,4.4% |
| | Total | 200,100.0% | 113,100.0% |

Figures in parentheses are in percentage.

### 4.6 Inferential Statistics on Factor Analysis of Effects of Water Scarcity on the Livelihoods of Rural Women in Tharaka North and Maara Sub-counties

#### 4.6.1 Descriptive Statistics for Composite Factor Analysis of Effects of Water Scarcity on the Livelihoods of Rural Women in Tharaka North and Maara Sub-counties

The descriptive statistic showed that respondents slightly agreed on the causes of water scarcity (3.00±0.47) and agreed that water scarcity significantly impacted women's socio-economic activities (3.12±0.39). However, there was general disagreement about gender differentiation in access to water (2.01±0.50). These findings were based on responses from 313 participants. Table7

Table 7: Descriptive Statistics for Composite Factor Analysis

| Factor/ variable | N | Mean ±Std. Deviation |
|---|---|---|
| Causes of water scarcity in Tharaka North and Maara Sub-counties | 313 | 3.00±0.47 |
| Gender differentiation in access to the use of water | 313 | 3.12±0.39 |
| Effect of water scarcity on women's socio-economic activities | 313 | 2.01±0.50 |

### 4.7 Reliability Analysis for the Study Variables

The Cronbach's alpha values for the various categories demonstrated strong internal consistency and reliability for the survey items in the study. For the causes of water scarcity in Tharaka North and Maara Sub-counties, the alpha was 0.7480 with 14 items, while gender differentiation in water access had an alpha of 0.7190 with 4 items. The impact of water scarcity on women's socio-economic activities showed an alpha of 0.7410 with 12 items. The overall composite reliability for all 30 items was 0.7310. Since these values were all above the standard threshold of 0.7, this indicated that the survey effectively measured the relevant constructs, such as water scarcity, gender differences in access, and the socio-economic effects on women, thus ensuring the consistency and reliability of the responses (Table 8).

Table 8: Reliability Analysis of each Variable

| Item | Cronbach's alpha | No. of Items |
|---|---|---|
| Causes of water scarcity in Tharaka North and Maara Sub-counties | 0.7480 | 14 |
| Gender differentiation in access to the use of water | 0.7190 | 4 |
| Effect of water scarcity on women's socio-economic activities | 0.7410 | 12 |
| Composite | 0.7310 | 30 |

Source: Author, 2024

### 4.8 Inferior Statistics

#### 4.8.1 Correlation Analysis

The inferential statistics of the study variables are given and discussed, and the study concentrated on the correlation of the causes of water scarcity, gender differentiation, and the impact of water scarcity on the socio-economic activities of women in Tharaka North and Maara sub-counties. The Spearman correlation coefficient was used to carry out this analysis.

Table 9: Tharaka North Correlation Analysis.

| | | | Effect of water scarcity on women's socio-economic activities | Causes of water scarcity in Tharaka North | Gender differentiation |
|---|---|---|---|---|---|
| Spearman's rho | Effect of water scarcity on women's socio-economic activities | Correlation Coefficient | 1.000 | | |
| | | Sig. (2-tailed) | | | |
| | | N | 113 | | |
| | Causes of water scarcity in Tharaka North | Correlation Coefficient | .923** | 1.000 | |
| | | Sig. (2-tailed) | 0.000 | | |
| | | N | 113 | 113 | |
| | Gender differentiation | Correlation Coefficient | .928** | .981** | 1.000 |
| | | Sig. (2-tailed) | 0.000 | 0.000 | |
| | | N | 113 | 113 | 113 |

Correlation is significant at the 0.01 level (2-tailed).

The correlation matrix indicates that all variables related to water scarcity, gender differentiation, and the subsequent effects on women's socio-economic activities exhibit statistically significant and positive associations with the livelihoods of rural women in Tharaka North. The relationship between the causes of water scarcity and its effects was particularly strong, with a correlation coefficient of 0.923, whereas gender differentiation also displayed a similarly high association with the effects of water scarcity, reflected by a coefficient of 0.928. These observations indicate that the structural causes of water scarcity and the disparity between the genders are the primary factors in increasing its negative effects on the livelihoods of women in rural areas. Gender differentiation was most significantly related to the causes of water scarcity as a relationship, as depicted by the coefficient of 0.981, and this relationship has been underscored by the interdependence between gender roles and resource constraints in determining sensitivity to water scarcity.

Table 10: Maara Correlation Analysis

| | | | Effect of water scarcity on women's socio-economic activities | Causes of water scarcity in Maara | Gender differentiation |
|---|---|---|---|---|---|
| Spearman's rho | Effect of water scarcity on women's socio-economic activities | Correlation Coefficient | 1.000 | | |
| | | Sig. (2-tailed) | | | |
| | | N | 200 | | |
| | Causes of water scarcity in Maara | Correlation Coefficient | .915** | 1.000 | |
| | | Sig. (2-tailed) | 0.000 | | |
| | | N | 200 | 200 | |
| | Gender differentiation | Correlation Coefficient | .921** | .952** | 1.000 |
| | | Sig. (2-tailed) | 0.000 | 0.000 | |
| | | N | 200 | 200 | 200 |

Correlation is significant at the 0.01 level (2-tailed).

The correlation table indicates that there exists a strong positive relationship between water scarcity, its causes, gender differentiation, and socio-economic activities of the women in the Maara Sub-County. Particularly, Causes of Water Scarcity and Gender

Differentiation are both positively related to the Effect of Water Scarcity on Socio-Economic Activities of Women, with their respective correlation coefficients of 0.915 and 0.921, respectively. This implies that these factors have been linked with stronger impacts of water problems on women's livelihoods. Furthermore, "Gender Differentiation" shows the strongest correlation with the "Causes of Water Scarcity," with a coefficient of 0.952, suggesting a robust link between gender-specific factors and the causes of water scarcity.

### 4.8.2 Multiple Regression Analysis

The multiple regression model of this paper was to examine the relationship between several variables, factors causing water scarcity, gender differentiation and effects of water scarcity, to the socio-economic activities of the women in the sub-county of the Tharaka North and the Maara. The statistical results of the model revealed that the predictors and the dependent variable had high and significant correlations. Both of them are noteworthy (positive) relationships between the predictors and the dependent variable, with slightly higher R-values of the Tharaka North (0.877) than of the Maara (0.873). This is an indication of a slightly stronger relationship in Tharaka North, but the distinction is very slight and may not have any meaningful practical consequences. Equally, the values of the R2, which denote the fraction of the variance in the dependent variable that is represented by the predictors, are quite high in the two sub-counties, with Tharaka North accounting for 76.9% of the variance and Maara 76.3%. The fact that this is only different by 0.6 per cent means that the models can be compared to determine how well in the two regions about their explanatory power.

The Standard Error of the Estimate for both regions is 0.641, and this means the same level of accuracy in the predictions given by the models. Such a low standard error implies that the regression models are fairly accurate in predicting the implications of the water crisis on the socio-economic activities of women in the two sub-counties. Moreover, the Significance of F Change (Sig. F Change) of both regions is 0.000, which proves the fact that the models are statistically significant. This means that the predictors are very useful in trying to explain the variation in the dependent variable, and the findings are not likely to be caused by chance.

In general, the values of R and R2 of both sub-counties demonstrate that both models are good fits to the data, and the differences between them are minimal. The same values of the Standard error of the estimate imply the same accuracy of the models and the values of Sig. F Change also prove the statistical significance of the predictors to explain the effects of water scarcity. The marginal variations in both sub-counties, particularly in the values of R and R2, could be a reflection of regional disparities in the intensity or occurrences of water scarcity. Such contextual aspects may play a role in determining the influence of the predictors on the socio-economic activities of women in every region. However, both sub-county models are very valid and sound, and they give a solid assumption of how water scarcity affects the socio-economic life of women. Although the disparities are slight, the models are very effective and statistically robust, thus highlighting the applicability and stability of the results to the two regions.

Table 11: Model Summary

| | | | | Std. Error of the | Change Statistics | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Model | R | R Square | Adjusted R Square | Estimate | R Square Change | F Change | df1 | df2 | Sig. F Change |
| 1. Tharaka | .877[a] | 0.769 | 0.765 | 0.641 | 0.769 | 183.412 | 2 | 110 | 0.000 |
| 1. Maara | .873[a] | 0.763 | 0.760 | 0.596 | 0.763 | 316.873 | 2 | 197 | 0.000 |

Table 12: ANOVA

| Model | | Sum of Squares | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| | | | THARAKA NORTH | | | |
| 1 | Regression | 150.593 | 2 | 75.297 | 183.412 | .000[b] |
| | Residual | 45.159 | 110 | 0.411 | | |
| | Total | 195.752 | 112 | | | |
| | | | MAARA | | | |
| 1 | Regression | 225.258 | 2 | 112.629 | 316.873 | .000[b] |
| | Residual | 70.022 | 197 | 0.355 | | |
| | Total | 295.280 | 199 | | | |

The ANOVA results (Table 12) provide a detailed analysis of the statistical significance and explanatory power of two regression models assessing the effect of water scarcity on women's socio-economic activities in Tharaka North and Maara. Sub Counties, in both models, the p-values are 0.000, indicating that the predictors, gender differentiation and causes of water scarcity are statistically significant and have a meaningful impact on explaining the variance in the dependent variable. This implies

that both models are significant at the level of 0.05, and the predictors play a role in explaining the effects of water scarcity on the socio-economic activities of women. The F-statistic of Tharaka North is 183.412, indicating that this model is representing a large amount of variance in the dependent variable, and the small p-value shows that the outcome is not based on chance. Conversely, the F-statistic value of Maara is much greater at 316.873, which means that the model of Maara explains a greater percentage of variance of the dependent variable and the model fits the data better than the Tharaka North model. This suggests that the Maara model has stronger explanatory power. Although both models are statistically significant, the higher F-statistic for Maara implies that it is the more robust model of the two. To refine the comparison further, it would be useful to examine additional metrics such as $R^2$ and adjusted $R^2$, as well as perform residual analysis, to provide a more comprehensive evaluation of the models' goodness-of-fit and identify any potential issues such as overfitting.

Table 13: Co-Efficient

| Model | | Unstandardized Coefficients | | Standardized Coefficients | | | Correlations | | | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | T | Sig. | Zero-order | Partial | Part | Tolerance | VIF |
| 1. Tharaka | (Constant) | -0.283 | 0.161 | | -1.753 | 0.082 | | | | | |
| | Causes of water scarcity | 0.636 | 0.211 | 0.655 | 3.007 | 0.003 | 0.876 | 0.276 | 0.138 | 0.044 | 22.661 |
| | Gender Differentiation | 0.210 | 0.204 | 0.225 | 1.034 | 0.303 | 0.866 | 0.098 | 0.047 | 0.044 | 22.661 |
| 2. Maara | (Constant) | -0.148 | 0.120 | | -1.232 | 0.219 | | | | | |
| | Causes of water scarcity | 0.629 | 0.098 | 0.708 | 6.399 | 0.000 | 0.872 | 0.415 | 0.222 | 0.098 | 10.163 |
| | Gender Differentiation | 0.158 | 0.101 | 0.173 | 1.561 | 0.120 | 0.845 | 0.111 | 0.054 | 0.098 | 10.163 |

The comparison of the impact of water scarcity on the socio-economic livelihoods of rural women in Tharaka North and Maara sub-counties is based on two predictors, which include causes of water scarcity and gender differentiation. In the Tharaka North model, the baseline effect is less (-0.283), which is worse socio-economic conditions than Maara (-0.148). This is because the causes of water scarcity are stronger in Tharaka North (coefficient = 0.636), i.e. the socio-economic activities of women in this region are more susceptible to water scarcity determinants. Furthermore, the fact that gender

differentiation is more influential (coefficient = 0.210) in the Tharaka North region demonstrates the possible advantages of eliminating gender disparities in the region. Conversely, the Maara model indicates a less significant effect of the causes of water scarcity (coefficient = 0.629), indicating that women in Maara are less influenced by the causes of water scarcity, maybe because there is better infrastructure or coping strategies. The gender difference is not so strong in Maara (coefficient = 0.158), which means that the gender differences are of less importance to intensify the impact of water shortage in this area.

Table 14: Comparison of Key Insights

| Aspect | Tharaka North | Maara | Implications |
|---|---|---|---|
| Baseline Conditions | More adverse (-0.283) | Less adverse (-0.148) | Tharaka North faces more challenging socio-economic conditions overall. |
| Causes of Water Scarcity | Greater impact (0.636) | Slightly lower impact (0.629) | Tharaka North women are more sensitive to water scarcity causes; targeted interventions here may yield higher returns. |
| Gender Differentiation | Greater impact (0.210) | Lower impact (0.158) | Gender inequalities exacerbate impacts more in Tharaka North; addressing these disparities could significantly improve livelihoods in this sub-county. |

The socio-economic conditions and implications of water scarcity in Tharaka North and Maara Sub-Counties present notable differences, particularly in terms of the causes of water scarcity and gender differentiation. Tharaka North has worse adverse baseline socio-economic circumstances, with the score of -0.283, indicating a greater level of hardship compared to Maara, whose score is slightly higher at -0.148. This is to imply that interventions in Tharaka North will have to deal with more serious issues compared to those in Maara. In terms of the causes of water scarcity, Tharaka North has been more affected with a score of 0.636, which shows that the population of the county, particularly the women, are more prone to water scarcity. Conversely, Maara shows a comparatively lower score of 0.629 in the impact, indicating that although water scarcity influences both of the regions, the influence is higher in Tharaka North. In Tharaka North, especially, women are more susceptible to the impact of the water

shortage, and thus the ways to apply the interventions focusing on the causes thereof to the area may have a greater positive impact.

The problem of gender differentiation also has a bigger score in Tharaka North and is 0.210 higher than the score of 0.158 of Maara. It proves that gender inequalities make the impact of water scarcity in Tharaka North more significant. Reducing such gender inequalities may result in a significant change in livelihoods, especially to women and hence, a greater impacting difference in Tharaka North. The overall paradigm of comprehending the relationship between water scarcity, the reasons for this shortage and gender distinction is expressed as a regression equation:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon.$$

Where;

Y-is the effect of water scarcity, which is the dependent variable

β0-The Regression constant term, β1 and β2 represent the Coefficients Independent Variables

$X_1$-causes of water scarcity, $X_2$= gender differentiation, $X_3$=, effect of water scarcity, and ε= Error term

The general model can therefore be written as:

Tharaka North: $Y = -0.283 + 0.636X_1 + 0.210X_2$

Maara: $Y = -0.148 + 0.629X_1 + 0.158X_2$

These equations imply that the effects due to water scarcity in Tharaka North are more significantly caused by the factors of water scarcity and gender differentiation because the coefficients of both are higher (0.636 and 0.210, respectively). The coefficients are somewhat smaller in Maara (0.629 on $X_1$ and 0.158 on $X_2$), which means that although the degree of water shortage also has a significant impact, the socio-economic and gender status is not so high. Thus, targeted interventions addressing both the causes of water scarcity and gender inequalities in Tharaka North may yield more pronounced benefits, improving the overall socio-economic conditions in the region.

Table 15: Collinearity Statistics: Variance Inflation Factor (VIF)

| Coefficients | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Unstandardized Coefficients | | Standardized Coefficients | | | Collinearity Statistics | |
| Model | | B | Std. Error | Beta | T | Sig. | Tolerance | VIF |
| | | | | Maara Sub County | | | | |
| 1 | (Constant) | -0.148 | 0.120 | | -1.232 | 0.219 | | |
| | Causes of water scarcity in Maara | 0.629 | 0.098 | 0.708 | 6.399 | 0.000 | 0.098 | 10.163 |
| | Gender differentiation | 0.158 | 0.101 | 0.173 | 1.561 | 0.120 | 0.098 | 10.163 |
| | | | | Tharaka North Sub-County | | | | |
| 2 | (Constant) | -0.283 | 0.161 | | -1.753 | 0.082 | | |
| | Causes of water scarcity in Tharaka North | 0.636 | 0.211 | 0.655 | 3.007 | 0.003 | 0.044 | 22.661 |
| | Gender differentiation | 0.210 | 0.204 | 0.225 | 1.034 | 0.303 | 0.044 | 22.661 |

The findings in Table 15 give the collinearity values, that is, the Variance Inflation Factor (VIF) used to analyse the impacts of water scarcity on socio-economic activities of the women in Maara and Tharaka North Sub-Counties. In the study, two factors that were taken as primary predictors were the causes of water scarcity and differentiation by gender. The unstandardized coefficient (B) of the water scarcity causes in the Maara Sub-County was 0.629 with a standardized beta coefficient of 0.708. This demonstrates that there is a strong positive correlation between the cause of water scarcity and the impacts on socio-economic activities of women because the t-value of 6.399 and p-value of 0.000 are positive.

Gender differentiation, on the other hand, had a lower unstandardized coefficient (B = 0.158) and a standardized beta of 0.173 with a t-value of 1.561 and a p-value of 0.120, which is insignificant. The values of the predictor tolerance were 0.098 and the VIF of 10.163, which indicated that there might be multicollinearity. At Tharaka North Sub-County, the coefficient of the causes of water scarcity was not standardized (B) = 0.636, and the standardized beta coefficient = 0.655, t-value = 3.007 and the significant p-value = 0.003. The gender differentiation had a coefficient of 0.210 (unstandardized) and a standardized beta of 0.225, but the t-value was 1.034 and the p-value 0.303, which meant that it was an insignificant predictor. The multiple collinearity issues were also

higher in both predictors of this sub-county, with the tolerance value of 0.044 and VIF of 22.661. The findings highlight that the causes of water scarcity have a stronger and more significant impact on women's socio-economic activities compared to gender differentiation in both sub-counties. However, the high VIF values suggest the need to address multicollinearity in the analysis.

# CHAPTER FIVE
# DISCUSSION

## 5.1 Water Sources

The study findings indicate that residents in Tharaka North and Maara sub-counties rely on diverse water sources, including rivers, boreholes, wells, tap water, and rainwater. Nevertheless, the two sub-counties have obvious inequalities brought about by the ecological and infrastructural differences. In Tharaka North, rivers and seasonal streams are the major water sources, but boreholes and traditional river wells are used as supplementary water sources. This reliance can be attributed to a greater amount of vulnerability since rivers and streams are vulnerable to seasonal changes and can frequently dry up in case of long droughts. Conversely, Maara households rely more on piped water systems, which provide more consistent access, although still experiencing periodical shortages during the peak demand seasons, which proves that both absolute and temporal scarcity coexist in the two regions (Bukachi et al., 2021).

Such findings are consistent with the NEMA (2023) report, which established that rivers are the main source of water in Tharaka North, with 38% of the population having piped water as the main source and 24% and 19 percent having boreholes and traditional wells, respectively. These findings are consistent with other studies in the region, hence making them credible. In the example given, Nthenge (2016) noted that the rivers, roof catchments, shallow wells, boreholes, and sand dams were the primary source of water in Makueni County, another semi-arid area with similar climatic pressures. These similarities suggest that households in arid and semi-arid regions (ASALs) in Kenya experience similar problems of water shortage, variability and reliability.

The results indicate that there is an urgent need to have strong water governance measures. FAO (2023) advises that good governance of water management must focus on equity, sustainability and participation so that water is fairly distributed, especially in agricultural-based territories where competition over water becomes more pronounced in times of drought. Enforced government structures would ease scarcity, eliminate conflict, and improve community safety. Other parts of the world have also reported similar issues; in one example, Anderson (2016) reported the disproportionately discriminating effects of seasonal water scarcity on women in

Carhuaz and Shilla, Peru, and the effects of scarcity are gendered in Tharaka Nithi County. These comparisons across regions indicate that although the ecological settings vary, the governance imperative is global. Inclusion and effective management of Tharaka North and Maara are thus key towards enhancing water security and resistance to frequent climatic shocks.

### 5.2 Causes of Water Scarcity

The causes of the water deficit in the area of study were also made out to be natural as well as manmade causes, but the most significant causes, as indicated by the respondents, were frequent droughts and erratic rain patterns. These climatic conditions that have been amalgamated with the higher impacts of climate change have intervened with the patterns of the rainfall in the seasons and have caused more durations of dry periods, that has caused drying of rivers, wells and boreholes that eventually creating less supply of water. These findings can be both associated with the world and region-wide studies that trace the rising climate variability as the source of water insecurity in the arid and semi-arid areas (Ungureanu et al., 2020; Niang et al., 2014). Another thing that the respondents noticed is the fact that unpredictable rainfall will affect the traditional rainwater harvesting practices, whereby the households will not be able to gather and store adequate water to use in their domestic and agricultural practices. Other works in Sub-Saharan Africa have reported the same thing, with the studies showing that the dependence on rain-based systems by communities was directly related to the change in the rain seasonality (Adusei-Asante and Hancock, 2014).

In addition to the natural causes, human-induced causes were also found to play a very significant role in the scarcity. One of the biggest problems was weak water governance, where policies, lack of coordination of the county institutions, and engagement of the community in water management structures led to inequitable access. Njuki et al. (2016) estimate that the problem of water insecurity cannot be solved without governance failure, particularly the absence of women and the marginalized groups of people in the decision-making committees, since this will narrow the scope of perspectives that may be incorporated to solve the issue. Another aspect that was emphasized by the respondents in Tharaka Nithi is that no investment in sustainable infrastructure, such as large storage tanks, pipelines and treatment plants,

restrains the capacity of the community to store water during wet seasons to take in case of long droughts. This is similar to the study in rural Tanzania and Ethiopia, where poor infrastructure was one of the biggest challenges to water security (Nganyanyuka et al., 2014; Tadesse et al., 2019).

Anthropogenic drivers were also discovered as a serious environmental degradation. The upstream areas were found to experience land-use and deforestation that enhanced soil erosion and siltation, hence reducing the capacity of rivers and dams to hold water. The findings are consistent with the work of Nde & Moyo (2022)., who demonstrated that unsustainable land-use practices impair the integrity of the watersheds and slow down the quantity of surface water recharge. Besides, the population growth has put pressure on the already-strained water supply. The population increase can create disequilibrium in the availability and demand of the local, agricultural and livestock water, thus leading to competition and in some cases, war. According to (Nkiaka et al., 2024), the population explosion recorded in the ASAL areas in Africa has caused low per capita water, and this is not only an environmental issue, but also a socio-economic and a political one.

This study confirms the fact that the scarcity of water in the Tharaka Nithi County is not a wholly natural one but rather a socio-political fabrication that has been devised due to government failure, inadequate infrastructure, and other unbalanced power relationships. Climate change and deforestation, an increase in population and institutions that are not functioning well create a complex web of vulnerabilities. This is aligned to wider literature, which considers water scarcity to be a multidimensional issue that needs to be approached using integrated strategies which focus on both ecological and socio-political aspects (Allan, 2011; Biswas, 2011).

### 5.3 Gender Differentiation in Access to and Use of Water

Findings of the research suggest that there is acute gendering of water access and use, and women have unequal opportunities as opposed to men due to the cultural practices, land tenure activities, and restrictions on women's ownership of land. These disproportions do not allow the women to make their own choices on water resources, particularly in the rural settings where land ownership is one of the most critical issues

that determine the extent of water accessibility (Odeny, 2013). In cases where the land resources, such as the water resources, are owned by men, women are normally deprived of access to the basic resources, and instead, women must have to resort to other unorthodox means of sourcing water to use in the home and as an input in the field. The cultural activities, including the establishment of authority based on male dominance over household resources, are also seen as the reasons behind this difference, and this aspect was identified by Nthenge (2016), who mentioned that in the region under study, males are the most probable decision-makers related to water use. Still on the same note, Aravindakshan et al. (2020) also observe that land ownership and the right to make decisions are hindered by cultural norms and practices, which continue to entrench the inequalities.

The other significant conclusion of the study is that, other than being structural, the unequal weight that the women bear is encountered in their day-to-day living. The Feminist Political Ecology theory shows how the institutions of patriarchy maintain the state of powerlessness of women facing the scarcity of resources Harcourt (2023) In Tharaka North and Maara sub-counties, the females asserted that they wasted a lot of time and effort to walk long distances to acquire water, which is weighty in some instances, to have fewer opportunities to attend schools, work to earn money, and take up governmental services. Insecure land tenure also worsened the situation of women so much that they could not commit to long-term investments in water infrastructure, and men-controlled structures disenfranchised women from key decisions in water management (Tsekleves et al., 2022).

Women's stories reflected the high human price of water scarcity, which includes physical exhaustion, vulnerability to water-borne diseases, and mental tension because of the uncertainty of water supply. These challenges were further worsened by poverty, as the women in the low-income families were not able to afford proper storage facilities or water to buy daily and had to find unsafe and distant sources (Senna, 2021). These situations enhanced water wars, heightened vulnerability during drought and the low capacity of women to respond to the crisis events. Overall, the findings demonstrate that the concept of gender inequality is not a peripheral matter but central to the problem of water scarcity. The intersectionality exists between the development of water

insecurity and power relations among women's voices and realities, and those of cultural norms and poverty, to generate compounded disadvantages. To resolve these inequalities, one should not only be satisfied with increasing water availability, as well as simply solving structural inequality in land tenure, resource management, and gender division of labour to have equal access and sustainable exploitation of water resources.

### 5.4 Effect of Water Scarcity on Women's Socio-Economic Activities

Most women are endangered by water scarcity since it impacts their capacity to participate in productive and social practices (Miletto, Caretta, Burchi & Zanlucchi, 2017). Ling (2022) underscores the fact that water scarcity negatively affects social and economic development and the well-being of ordinary citizens in different areas. Women tend to walk longer distances and take much time in the queue to get water. These results are in line with (Tsekleves et al., 2022). who posted that long distances to acquire water waste the time that would be spent in income-generating activities or agriculture. Bisung and Elliott (2017) suggest that the poor usually spend more time gathering water than working or spending time in other recreational activities. Similarly, Abubakar (2018) observes that households sometimes sacrifice basic needs to purchase water or invest in products to improve water quality. Since women and girls are primarily tasked with water collection, the time burden reduces girls' educational opportunities (Thomas & Sedikides, 2016). During interviews and focus group discussions, many women reported developing back problems due to carrying heavy loads of water over long distances.

For instance, Zuin et al. (2011) found that households in Maputo spend an average of 35 minutes fetching water and 72 minutes waiting in line. Such time poverty is evident in Tharaka Nithi County, where women's reduced productivity limits their engagement in other socio-economic activities. Poverty and water insecurity create a reinforcing cycle: households lacking reliable water access struggle to adopt coping mechanisms such as rainwater harvesting or water storage infrastructure (Collins et al., 2018). The families also source water through the informal vendors, who, in some cases, carry water to unsafe locations. Poor washing of storage containers also increases the chances of contamination (Von Nguyen et al., 2014; Praveena et al., 2018). Otherwise, the sewage and animal waste expose water kept long or extracted through open water

bodies like rivers and wells to pollution (Sarkar et al., 2015). Such activities lead to increased cases of water-borne diseases, which makes the problem of health challenges among women and children even harder.

Besides the physical load and exposure to diseases, water scarcity has a dramatic mental effect. Research indicates that people can spend late nights or queue long to access water when there is a drought, and this contributes to heightened stress and anxiety (Bisung & Elliott, 2016). According to Wutich et al. (2020), mental health issue is complicated by material insecurity, social expectations and perceived injustice, whereas Brewis et al. (2021) show that perceived injustice and household water insecurity are interconnected and add to depression and anxiety. This fact indicates that water scarcity not only impacts women physically, but it also affects their mental health.

Socio-economic impacts are also very strong. Small-scale trade became the alternative source of livelihood among a large number of women in the Maara Sub-County, whereas in Tharaka North, livestock rearing was the main source of fallback. Nevertheless, such plans were limited due to workload, capital, and access to the market, which could not allow women to diversify their livelihoods (UN Women, 2014; Sorenson et al., 2011). The phenomenon of time poverty due to the fact of water collection also reduced the chances of women to get an education, skills training and paid employment (Pickering and Davis, 2012). In addition, low water usage in agriculture and animal husbandry undermined the household food security, compelling women to put domestic demand on water over economic pursuits (FAO, 2016). As a result, poverty continued in cycles, whereby women were the biggest victims. In general, the interplay of water scarcity, gender roles, and socio-economic status is a multidimensional problem, which not only prevents the empowerment of women but also jeopardizes the health and well-being of whole communities. These challenges need to be addressed through gender responsive water governance, better infrastructure and policies that will minimize the burden of water collection and increase the social and economic strength of women.

### 5.5 Coping and Adaptation Strategies

Residents in Tharaka North and Maara Sub-Counties have come up with various coping and adaptation mechanisms to work against the effects of the chronic water scarcity. The most identified strategy was the implementation of sound water storage methods, such as rainwater harvesting and using greywater to irrigate crops. These measures allow households to use the scarce water resources to the maximum and provide a buffer supply during times of acute scarcity. Nthenge (2016) emphasizes that the communities that put water harvesting constructions, soil protection measures, water reuse, and crop differentiation were significantly more effective in their water scarcity coping strategies. On the same note, Senna (2021) confirms that water storage was the main coping strategy between people living in Madina, which highlights the need to be proactive in implementing sustainable water storage as an element of resiliency to uncertain water supply. These results directly help in answering the first research question that aimed at measuring the strategies embraced by households in managing water scarcity.

Along with such community-level interventions, there were certain coping mechanisms practiced by women, which were dictated by their primary role in the supply of water within the household. These were rationing of available water, reusing water in several domestic uses, buying water in the informal markets, and seasonal migration of livestock. The success of these plans was, however, in most cases constrained by poverty and lack of institutional support. As an example, the harvesting of rainwater was recognized as a possible solution to adaptation, although only more affluent households were able to install storage tanks, and the majority of women in low-income or female-headed households could not leverage this solution (Masenya, 2015). This observation confirms the second research hypothesis, which expected that the socio-economic status would play a significant role in the adoption of water coping and adaptation strategies.

The seasonal variability was also a very important determinant affecting the coping mechanisms. In extended dry periods, women said that they were walking further and taking more time to gather water, hence working more and less time to earn a living or socialize. Such results are consistent with Cosgrove and Loucks (2015), who note that

cost-effective interventions at the community level, like sand dams, collective water pans, and household storage tanks, are important in enhancing community resistance to water scarcity. This is directly connected to the third research objective, which was to study gender disparity in access and reactions to water scarcity, and it was found that women are disproportionately affected by the issue in times of peak scarcity.

In general, the outcomes reveal that coping/adaptation strategies are socio-economic and gendered, in addition to being technical. Water storage and reuse practices are more practical and immediate responses, but structural obstacles like poverty, insecure land tenure, and gender inequality curtail their operation. Consequently, gender-sensitive, cost-effective, and seasonally specific adaptation interventions are necessary to address the issue of adapting successfully. These strategies would mitigate the overburden of women at work, ensure food production, and protect the lives of the people amid chronic and escalating water scarcity. These results can be used to support the ultimate research questions, which were that gender inequalities and socio-economic differences influence the efficacy of coping and adaptation mechanisms in rural households.

# CHAPTER SIX
# SUMMARY, CONCLUSION AND RECOMMENDATIONS

## 6.1 Summary of the Findings

This research examined the reasons behind water scarcity, gender-based disparities in water, and their effects on the livelihoods of rural women in Tharaka North and Maara sub-counties. It was found that the residents used a range of water sources, which included rivers, boreholes, wells, tap water and rainwater. In Tharaka North, rivers were the most widely spread, and tap water was more common in Maara. The common types of boreholes and traditional wells in both regions bore some similar patterns with those documented in other arid land areas like Makueni County (NEMA, 2023). This supported the reliability and soundness of the trends in water sourcing and use. The research found that drought was the main cause of water scarcity that resulted in the drying up of rivers, a decline in groundwater recharge, and the drying of springs and boreholes. Unpredictable rainfall also made the problem even more difficult as it hindered the chances to collect rainwater. The scarcity was worsened by human activities, such as poor governance, water infrastructure, forest depletion, and population increase (Lam et al., 2023).” These results are in agreement with other dry and semi-arid areas where the two stressors of climatic and anthropogenic origin interact in increasing water insecurity.

The residents embraced various coping and adaptation mechanisms to reduce scarcity. These involved the excavation of shallow wells, boreholes, water storage, and the reuse and buying of water from the private vendors. Nonetheless, low drilling rates and economic limitations made boreholes unaffordable to several households, and they had to rely on hand-dug wells or water rationing to perform the basic household tasks like taking a shower, cooking, and sanitation. These tactics were in line with coping behaviours recorded in drought-affected areas around the world (Murti et al., 2016; Abubakar, 2018; Nastiti et al., 2017). However, adaptation activities continued to be mostly reactive and limited by poverty, lack of access to technology, and marginalization of governance systems (Njuki et al., 2016). The crisis was exacerbated by seasonal variability, as the workloads of women increased during extended dry periods (Mohamed, 2022).

The aspect of gender in relation to water access became a burning problem. Women and girls were the most affected by scarcity because they had the duty of collecting water and sometimes had to walk long distances and stand in queues at the communal water points. This not only added to the physical and emotional pressure, but also less time was available to them to study and earn income, and engage in local politics (Mwinzi, 2014; Ling, 2022). The women were also limited by patriarchal norms and insecure land tenure. Women had limited rights, which meant that they could not invest in water infrastructure or contribute substantially to the decision-making process because land ownership is a powerful factor affecting access to water (Hillesland, 2023). Other rural African societies have reported similar gendered inequalities, as women in African cultures rely on the resources that are controlled by males, and this reliance contributes to inequality (Aravindakshan et al., 2020).

The water scarcity also had far-reaching consequences on food security, agricultural yield, and family well-being. Limited availability of credible water resources limited crop production and animal husbandry, hence compromising nutritional security and livelihood. Women were also forced to make unsafe choices in their livelihood, like rationing water to use back home or purchasing expensive water from the vendors. This is consistent with (Njoroge et al., 2024). who emphasizes that there is a cyclic pattern of poverty, water insecurity and vulnerability among the marginalized population. In conclusion, it has been revealed in the research that the issue of water scarcity in Tharaka North and Maara is an environmental as well as a socio-political issue. It is caused by drought and unpredictable rainfall, but caused by poverty, bad governance, gender differences, and ownership of land. The impacts are more on the women who are disproportionately affected, thus limiting their access to education, their economic worth, and their health in general. To address such challenges, there is an immediate need to have improved water governance, invest in sustainable infrastructure, promote gender-sensitive policies, and engage communities in water management. These would help to increase resilience, equity, and sustainable development in arid regions.

### 6.2 Conclusion

The research results prove the fact that the supply of water in Tharaka North and Maara sub-counties is highly dynamic and is based on the combination of geographic, climatic,

socio-economic, and cultural factors. In Tharaka North and Maara, rivers and tap water are the most popular sources of water, respectively, and boreholes, wells and rainwater harvesting are the secondary sources. These findings are in line with the past literature, which proves the reliance of this region on the traditional and enhanced water systems (NEMA, 2023; Ling, 2022). The main natural factors of water deficit turned out to be drought and disrupted rainfall that influenced domestic and agricultural water supply greatly (Nthenge, 2016; FAO, 2021). Nevertheless, it is not only an environmental crisis. The challenge is compounded by human-induced factors, which include, among others, weak governance structures, poor infrastructure, and cultural barriers. Specifically, women are not empowered to make decisions concerning land and water resources due to patriarchal norms and unequal power relations, which can make them more vulnerable and limit their ability to change (Odeny, 2013; Miletto et al., 2017).

The gender difference was also very intense, as women were the most affected by the collection of water owing to rooted cultural orientations. This financial imbalance impairs the health of women, their time to generate income, education of girls, and leaves the household at risk of unsafe water sources (Miletto et al., 2017; Ling, 2022). This means that water scarcity is not just an environmental problem but a socio-cultural and governance problem that compromises the social-economic welfare of women.

Despite those adversities, the resilience of residents has been impressive. Some of the coping and adaptation methods comprise water storage, greywater reuse, rainwater collection, use of vendors at a personal level, and wells and boreholes (Nthenge, 2016). The communities have also resorted to indigenous knowledge systems and diversified livelihood practices to address the effects of scarcity. The problem is, however, that the economic constraints of using these strategies prevent poor households, which highlights the disparity in adaptive capacity. To sum up, the interaction of environmental variability, poverty, governance, and gender relations determines water scarcity in Tharaka Nithi County. Although there are coping mechanisms that have been developed by communities, the solution to this is sustainably done through systematic interventions. They are the enhancement of water infrastructure, capacity building of governance and resource distribution, mainstreaming gender-sensitive water policies, and community-based conservation and poverty reduction initiatives (UN-Water, 2023;

FAO, 2021). A comprehensive and holistic model that incorporates indigenous knowledge and contemporary climate-smart practices is thus needed to attain water security and water resilience in the area in the long term.

### 6.3 Recommendations

The recommendations are designed based on the cost, feasibility and impact to make it relevant to the policy and to make sure the water resources management is sustainable.

#### 6.3.1 Short-Term, Low-Cost, High-Feasibility Measures

The immediate solution to water scarcity can be achieved through the encouragement of home-based rainwater collection and grey water reuse structures in arid areas. The availability of water can be increased at the household level through the use of simple water catchment methods like roof catchment, storage tanks and household grey water reuse to boost water supply through irrigation (Khanal et al., 2023). The most appropriate government subsidies and the support of NGOs should focus on women-led homes that are the most vulnerable to the issue of water scarcity and commonly handle domestic water management (Miletto et al., 2017). Moreover, cultural norms that may limit the involvement of women in the management of water are also hard to break, and the awareness campaign addressing the issues of water conservation, hygiene, and the rights of women towards accessing water is essential in promoting behavioural change (Odeny, 2013).

#### 6.3.2 Medium-Term, Moderate-Cost Measures

Sand dams, shallow wells, and water pans are community-based approaches which are cost-effective methods to establish resilience to seasonal variability. These strategies advance water storage during rainy seasons and effective water supply during droughts, in line with sustainable adaptation strategies of arid and semi-arid lands (ASALS) (Nthenge, 2016). Ensuring that women are mainstreamed into water governance committees through affirmative action and leadership training will enhance gender equity in decision-making and improve the effectiveness of water management interventions (UN-Water, 2019). Supporting women's cooperatives with access to microfinance for technologies such as water tanks and drip irrigation systems will further strengthen household-level resilience and empower women economically (Ling, 2022).

### 6.3.3 Long-Term, High-Cost but High-Impact Measures

Water security requires substantial investments. Looking forward, there will need to be a significant investment to achieve sustainable water security. Aquifer recharge projects through artificial means and large-scale irrigation schemes designed to take into account climate variability can improve groundwater supply, reduce reliance on erratic rainfall (FAO, 2011). Also, holistic climate-smart agriculture initiatives incorporating modern technologies and traditional knowledge can improve productivity, food security and resilience in ASAL areas (Kihila 2018). At the institutional development level, developing early warning systems and resilient planning frameworks at the county level will enable communities to be prepared for drought shocks, hence minimise vulnerability with long-term protection of livelihoods (IPCC, 2022).

## 6.4 Suggestions for Further Study

Future research could also build on the findings of this study, considering how climate variability has gendered livelihood implications in the long run. To get to the bottom of the water governance policies that have been executed in Tharaka Nithi County and other ASAL regions over the years, their sustainability and flexibility in time should be researched through a longitudinal study (UNDP, 2020). Besides, the new water technologies such as solar-powered boreholes, intelligent irrigation, and low-cost water purification in remote areas (where infrastructure is limited) should be included in future research (NEMA, 2023). Weighing the impacts of patriarchal norms will be crucial in determining the outcomes of adaptation, since even though these norms have been recognised as barriers for women who have no say in the decision-making process and have limited access to resources, they are still prevailing (Odeny, 2013; Caretta, 2015). The knowledge of how water access will impact women's economic empowerment and the overall resilience of the community will be an invaluable input to gender-responsive water governance (Miletto et al., 2017). Furthermore, the water quality of the various sources must be assessed in detail to ensure that access is not only measured in terms of availability but also with safety and other public health standards, especially with the current situation of climate change and its accompanying risk of contamination (WHO, 2017).

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## APPENDICES

### Appendix I: Questionnaire for the Local Community

**INTRODUCTION**

The purpose of this research is to carry out a research thesis on "Effect of Water Scarcity on the Livelihoods of Rural Women in Tharaka North and Maara Sub-Counties, Tharaka Nithi County, Kenya" You have been selected to assist in providing the required information, as your views and ideas are considered important to this study. This questionnaire is therefore specifically for academic research only, and the information collected will be treated with utmost confidentiality.

Please answer all the questions provided as honestly as possible, to the best of your knowledge

Sub-County.....

**SECTION A: Socio-demographic characteristics of the respondents**

1. Gender Male [] Female []
2. Age group [1] 20-29 years [2] 30-39 years [3] 40-49years [4] 50-59 years [5] 60 years and above
3. Education level. [1] Never attended school [2] Primary [3] Secondary level [4] Tertiary level
4. Occupation [1] Crop Farmer [2] mixed farming [3] salaried employment [4] unemployed [5] Business
5. Who is responsible for the income generation in the household?

[1] Mother [2] Father [3] others ……..……

6. Average monthly income of the household……
7. Size of the household 3 [] 4 [] 5 [] 6 [] 7 [] Above 8 []

**SECTION B: Causes of water scarcity**

8. What do households in this area use the most common source of water?
9. Tap [] River [] Well [] Borehole [] spring [] Tank [] Dam []
10. Does the governance of water affect the water supply?

Yes [] No []

If yes, state how

11. What do you think is the cause of water scarcity in your area?
12. State some of the adaptation measures put in place to cope with water scarcity?
13. What measures have you put in place to conserve and preserve available water sources?
14. Tick the level of agreement with the statement below

| Response | SD | D | N | A | SA |
|---|---|---|---|---|---|
| Climate change is the cause of water scarcity. | | | | | |
| Deforestation has led to water scarcity. | | | | | |
| Soil erosion and land degradation cause water scarcity | | | | | |
| Illiteracy is one of the causes of water scarcity. | | | | | |
| Lack of both County and National government support has led to water scarcity. | | | | | |
| Poverty is the main cause of water scarcity. | | | | | |

Key: Strongly Disagree (SD), Disagree (D), Neutral (N), Agree (A), Strongly Agree (SA)

**SECTION C: Access to the use of water**

15. Is water accessible in this area?

Yes [] No [] a) If no, what causes inaccessibility

16. Do women have equal access to water like men? a) Yes () b). No ()

If no, please state reasons as to why

17. State the major challenges limiting access to water in your area

**SECTION D: Effect of water scarcity on women's social-economic activities**

18. Tick the level of agreement with the statement below

| Response | SD | D | N | A | SA |
|---|---|---|---|---|---|
| The scarcity of water has led to decreased income. | | | | | |
| Proximity to water sources has enabled improvement in agriculture. | | | | | |
| Residents living in areas proximal to water sources have more income. | | | | | |
| Proximity to water sources has enabled improved engagement in other economic activities. | | | | | |
| Residents living far from water sources have social issues. | | | | | |
| Water is available in our area. | | | | | |

Key: Strongly Disagree (SD), Disagree (D), Neutral (N), Agree (A), Strongly Agree (SA)

19. How do women cope with the issue of water scarcity?

20. State some of the socio-economic activities in which women are involved.

**SECTION E: Coping and adaptation Strategies**

21. Do your personal household procedures reflect the lack of water?

    Yes [] No []

22. What adjustments have you made to address this water scarcity?

23. For how long have you been using the above measures?

    0-1years [] 2-3 years [] 4-5 [] more than 5 years []

24. Some of the challenges regarding coping and adaptation strategies

**Thank you for your response**

**Appendix I1: Guide Questions for Key Informants**

**INTRODUCTION**

The purpose of this research is to carry out a research thesis on "Effect of Water Scarcity on the Livelihoods of Rural Women in Tharaka North and Maara Sub-Counties, Tharaka Nithi County, Kenya". You have been selected to assist in providing the required information, as your views and ideas are considered important to this study. This questionnaire is therefore specifically for academic research only, and the information collected will be treated with utmost confidentiality.

Please answer all the questions provided as honestly as possible, to the best of your knowledge.

To be completed by the interviewer

1. Name of the interviewee .....

2. Occupation.....

3. Position held in government and/or community----------4. Gender: Male () Female

1) What is the cause of water scarcity in the area?

2) Do you help residents with access to water?

3) What have you done to reduce the issue of water scarcity?

4) How do you ensure women have an equal opportunity when it comes to water accessibility?

5) Which diseases are commonly associated with a lack of access to clean water?

6) Does this area experience any water-related conflict?

7) How do you solve such conflicts?

8) What are the strategies put in place to cope with water scarcity?

9) What are some of the socio-economic activities' women are involved in?

10) How do you support such activities?

11) What are some of the adaptation measures used in managing water scarcity?

12) Are these adaptation measures useful?

13) Challenges associated with adaptation measures

**Thank you for your response**

**Appendix III: Focused Group Discussion Guide Questions**

**INTRODUCTION**

The purpose of this Research is to carry out a research thesis on "Effect of Water Scarcity on the Livelihoods of Rural Women in Tharaka North and Maara Sub-Counties, Tharaka Nithi County, Kenya" The questions in this guide are therefore specifically for the academic research only, and the information collected will be treated with utmost confidentiality.

Please answer all the questions provided as honestly as possible, to the best of your knowledge.

To be completed by the interviewer

1. Number of members in the group.....
2. ii. Area where the FGD was held.....

1) Does the community understand the cause of water scarcity?
2) When did you start experiencing water scarcity?
3) Do water scarcity cause diseases to spread in the area?
4) Do we have a related conflict in this area?
5) Do women have equal access to water sources in this area?
6) What is the reason for the unequal accessibility of water sources by women?
7) How have you adapted to the issue of water scarcity?
8) How do you conserve available water sources?
9) Do you get any help from the County, National government or NGO concerning water scarcity?
10) What are some of the socio-economic activities' women are involved in?
11) What are some of the adaptation measures used in managing water scarcity?
12) Are these adaptation measures useful?
13) Challenges associated with adaptation measures.

**Thank you for your response.**

**Appendix IV: Observation Sheet**

Observation of the available water point in use

_____
_____
_____
_____
_____

Observation of socio-economic activities being carried out

_____
_____
_____
_____
_____

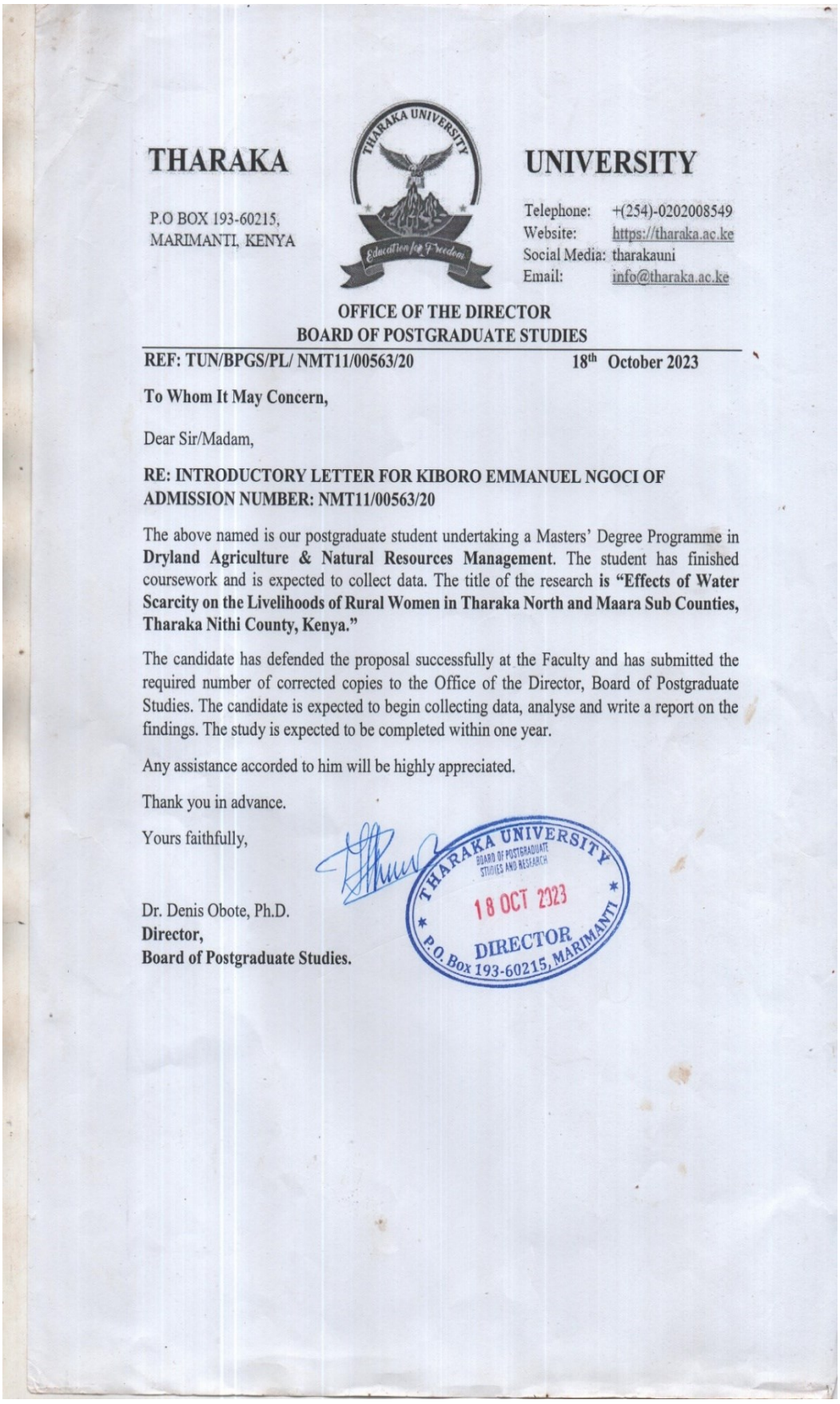
Observation of the equipment used in fetching and carrying water

_____
_____
_____
_____

Observation of the distances travelled in looking for a water point

_____
_____
_____Observation of water storage facilities

## Appendix V: Tharaka University Institutional Introductory Letter



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**OFFICE OF THE DIRECTOR**
**BOARD OF POSTGRADUATE STUDIES**

**REF: TUN/BPGS/PL/ NMT11/00563/20** **18th October 2023**

**To Whom It May Concern,**

Dear Sir/Madam,

**RE: INTRODUCTORY LETTER FOR KIBORO EMMANUEL NGOCI OF ADMISSION NUMBER: NMT11/00563/20**

The above named is our postgraduate student undertaking a Masters' Degree Programme in **Dryland Agriculture & Natural Resources Management**. The student has finished coursework and is expected to collect data. The title of the research **is "Effects of Water Scarcity on the Livelihoods of Rural Women in Tharaka North and Maara Sub Counties, Tharaka Nithi County, Kenya."**

The candidate has defended the proposal successfully at the Faculty and has submitted the required number of corrected copies to the Office of the Director, Board of Postgraduate Studies. The candidate is expected to begin collecting data, analyse and write a report on the findings. The study is expected to be completed within one year.

Any assistance accorded to him will be highly appreciated.

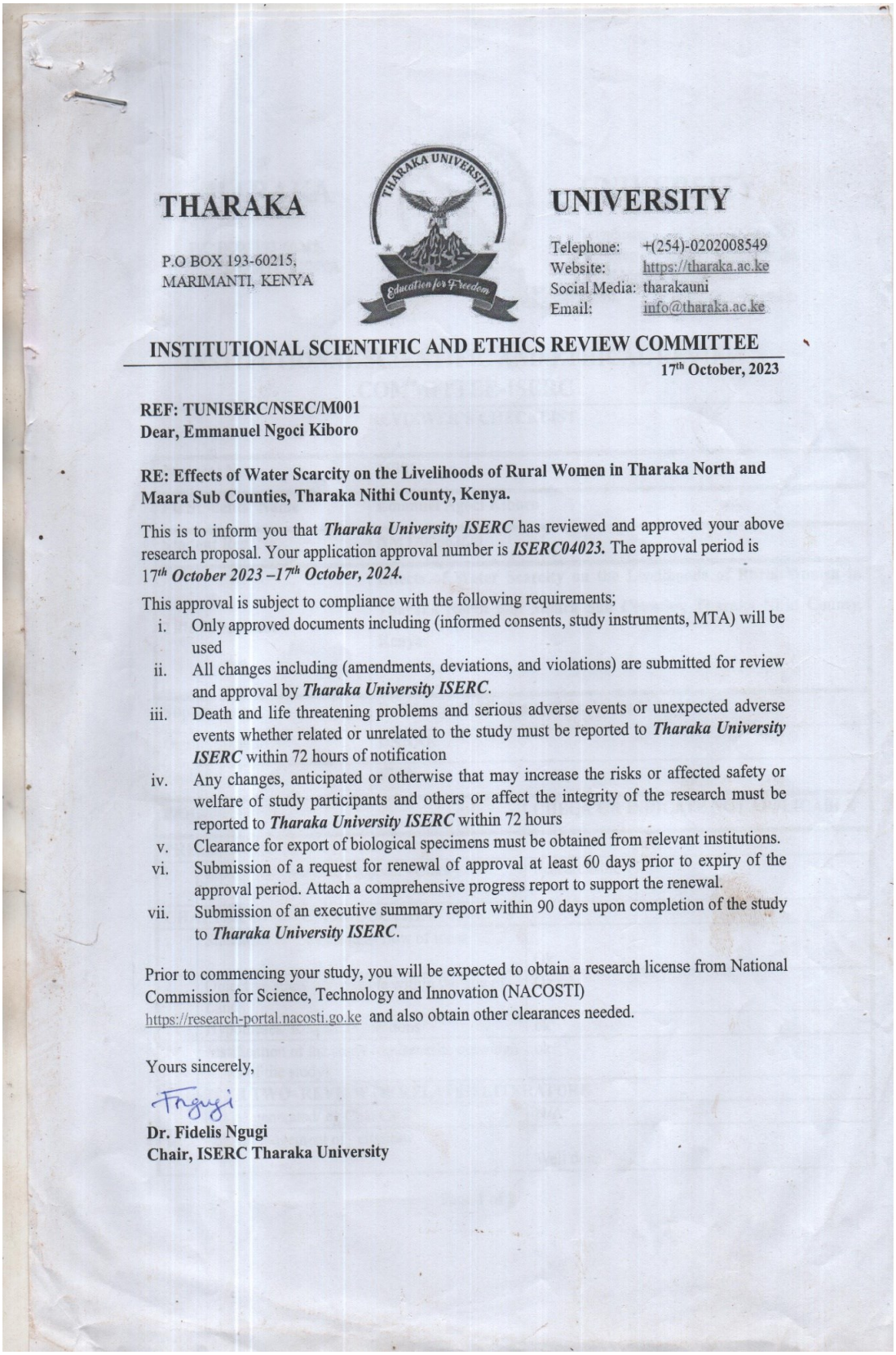
Thank you in advance.

Yours faithfully,

THARAKA UNIVERSITY BOARD OF POSTGRADUATE STUDIES AND RESEARCH 18 OCT 2023 DIRECTOR P.O. Box 193-60215, MARIMANTI

Dr. Denis Obote, Ph.D.
**Director,**
**Board of Postgraduate Studies.**

## Appendix VI: Tharaka University Institutional Scientific and Ethics Review Committee Letter



**THARAKA UNIVERSITY**

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**INSTITUTIONAL SCIENTIFIC AND ETHICS REVIEW COMMITTEE**

**17th October, 2023**

**REF: TUNISERC/NSEC/M001**
**Dear, Emmanuel Ngoci Kiboro**

**RE: Effects of Water Scarcity on the Livelihoods of Rural Women in Tharaka North and Maara Sub Counties, Tharaka Nithi County, Kenya.**

This is to inform you that ***Tharaka University ISERC*** has reviewed and approved your above research proposal. Your application approval number is ***ISERC04023.*** The approval period is ***17th October 2023 –17th October, 2024.***

This approval is subject to compliance with the following requirements;

i. Only approved documents including (informed consents, study instruments, MTA) will be used
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by ***Tharaka University ISERC***.
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to ***Tharaka University ISERC*** within 72 hours of notification
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to ***Tharaka University ISERC*** within 72 hours
v. Clearance for export of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days upon completion of the study to ***Tharaka University ISERC***.

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://research-portal.nacosti.go.ke and also obtain other clearances needed.

Yours sincerely,

Fngugi

**Dr. Fidelis Ngugi**
**Chair, ISERC Tharaka University**

## Appendix VII: National Commission for Science, Technology and Innovation (NACOSTI) Research Permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **836551**

Date of Issue: **12/January/2024**

**RESEARCH LICENSE**

**This is to Certify that Mr.. Emmanuel Ngoci Kiboro of Tharaka University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Tharaka-Nithi on the topic: EFFECTS OF WATER SCARCITY ON THE LIVELIHOODS OF RURAL WOMEN IN THARAKA NORTH AND MAARA SUB-COUNTIES, THARAKA NITHI COUNTY, KENYA for the period ending : 12/January/2025.**

License No: **NACOSTI/P/24/32389**

**836551**

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

**See overleaf for conditions**