

East African Journal of Environment and Natural Resources

eajenr.eanso.org

Volume 8, Issue 3, 2025

Print ISSN: 2707-4234 | Online ISSN: 2707-4242

Title DOI: <https://doi.org/10.37284/2707-4242>



EAST AFRICAN
NATURE &
SCIENCE
ORGANIZATION

Original Article

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

Emmanuel Ngoci Kiboro^{1*}, Dr. Marciano Mutiga, PhD¹ & Dr. James Muchoka, PhD²

¹ Tharaka University, P. O. Box 193-60215, Marimanti, Kenya.

² County Government of Embu, P. O. Box 36, Embu, Kenya.

* Correspondence Email: emmanuelngoci@gmail.com

Article DOI: <https://doi.org/10.37284/eajenr.8.3.3892>

Date Published: ABSTRACT

30 October 2025

Keywords:

Water Scarcity,
Agricultural
Productivity,
Livelihoods,
Gender Inequality,
Poverty Reduction,
Climate Change,
Sustainable Water
Access.

Water is critical for rural development, poverty alleviation, and agricultural productivity. However, its availability in some regions is limited, threatening the livelihoods of millions of rural households. In Tharaka Nithi County, water scarcity undermines household welfare and perpetuates poverty by constraining agricultural production, increasing women's workloads and reducing their economic opportunities, and eroding community resilience. This study investigated the impacts of water scarcity on women's livelihoods in Tharaka North and Maara Sub-Counties, Tharaka Nithi County, Kenya. Data were collected between May and August 2023, during the long dry season when water shortages are most acute. A total of 313 respondents were surveyed, 113 from Tharaka North Sub-County and 200 from Maara Sub-County. Focus group discussions, key informant interviews, direct field observations, and GIS mapping of water sources were also carried out. Quantitative data were analysed using SPSS 26, while qualitative data were subjected to thematic analysis. It was established that water scarcity led to decreased income (Tharaka North: $\chi^2 = 32.35$, $p < 0.05$; Maara: $\chi^2 = 41.95$, $p < 0.05$) and reduced agricultural productivity and income opportunities (Tharaka North: $\chi^2 = 32.35$, $p < 0.05$; Maara: $\chi^2 = 41.95$, $p < 0.05$). Women face 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 both an environmental challenge and a driver of entrenched poverty and gender inequality. 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, could help fix the issue. Strengthening women's participation in water governance and promoting affordable technologies like sand dams, aquifer recharge, and household water storage systems are essential steps toward equitable and sustainable water access.

APA CITATION

Kiboro, E. N., Mutiga, M. & Muchoka, J. (2025) Effects of Water Scarcity on the Livelihoods of Rural Women in Tharaka North and Maara Sub-Counties, Tharaka Nithi County, Kenya. *East African Journal of Environment and Natural Resources*, 8(3), 298-312. <https://doi.org/10.37284/eajenr.8.3.3892>.

CHICAGO CITATION

Kiboro, Emmanuel Ngoci, Marciano Mutiga and James Muchoka 2025. "Effects of Water Scarcity on the Livelihoods of Rural Women in Tharaka North and Maara Sub-Counties, Tharaka Nithi County, Kenya". *East African Journal of Environment and Natural Resources* 8 (3), 298-312. <https://doi.org/10.37284/eajenr.8.3.3892>

HARVARD CITATION

Kiboro, E. N., Mutiga, M. & Muchoka, J. (2025) "Effects of Water Scarcity on the Livelihoods of Rural Women in Tharaka North and Maara Sub-Counties, Tharaka Nithi County, Kenya", *East African Journal of Environment and Natural Resources*, 8 (3), pp. 298-312. doi: 10.37284/eajenr.8.3.3892.

IEEE CITATION

E. N., Kiboro, M., Mutiga & J., Muchoka "Effects of Water Scarcity on the Livelihoods of Rural Women in Tharaka North and Maara Sub-Counties, Tharaka Nithi County, Kenya", *EAJENR*, vol. 8, no. 3, pp. 298-312, Oct. 2025.

MLA CITATION

Kiboro, Emmanuel Ngoci, Marciano Mutiga & James Muchoka. "Effects of Water Scarcity on the Livelihoods of Rural Women in Tharaka North and Maara Sub-Counties, Tharaka Nithi County, Kenya". *East African Journal of Environment and Natural Resources*, Vol. 8, no. 3, Oct 2025, pp. 298-312, doi:10.37284/eajenr.8.3.3892

INTRODUCTION

Water scarcity is among the most pressing development challenges of the twenty-first century, posing profound implications for global sustainability, human health, and economic stability. The United Nations estimates that over two billion people live in regions facing high water stress. At the same time, nearly half of the world's population still lacks reliable access to safe and clean drinking water. The crisis is compounded by rapid population growth, accelerating urbanisation, industrial expansion, and climate change, all of which exert unsustainable pressure on limited freshwater resources (Boretti & Rosa, 2019). Water scarcity is no longer a distant prospect; it is a contemporary global reality undermining socio-economic progress, environmental integrity, and public health (Jian, 2025). Countries such as China and India exemplify the crisis, where economic expansion, industrialisation, and urban demand have outstripped available water supplies, triggering both ecological degradation and social distress (Rosińska et al., 2024). Without immediate and coordinated interventions, the problem will intensify, threatening food security, industrial growth, and even human survival in many regions of the world.

Across Africa, Sub-Saharan Africa (SSA) remains one of the most water-insecure regions globally. Over 300 million people lack access to safe drinking water, while millions more rely on unreliable and unsafe sources. Women and children bear the greatest burden of this crisis (Omer, 2025). Because the majority of livelihoods in SSA depend on rain-fed agriculture, recurrent droughts and erratic rainfall directly translate into food shortages, declining agricultural productivity, and an increased prevalence of waterborne diseases (Lombe et al., 2024). As De Guzman et al. (2023) note, women and girls are disproportionately affected, often walking long distances to fetch water, a task that consumes valuable time and limits opportunities for education, income generation, and civic participation. In many arid and semi-arid areas, dwindling water resources have also sparked competition and conflict, further deepening the vulnerability of marginalised populations.

In Kenya, water scarcity persists as a major environmental and development concern, particularly in the Arid and Semi-Arid Lands (ASALs), which constitute more than 80% of the country's total landmass (Nkonya et al., 2018). Only about 41% of Kenyans have consistent access to safe drinking water, while the rest rely on rivers,

shallow wells, boreholes, and seasonal streams, many of which are susceptible to contamination and overuse (Bukachi et al., 2021a; 2021b; 2021c). The government has made efforts to address these challenges through policy frameworks such as the Water Act (2016), the Climate Change Act (2016), and Vision 2030. However, poor policy implementation, inadequate infrastructure, limited financing, and increasing climatic variability continue to undermine progress toward water security.

In rural Kenya, particularly in Tharaka-Nithi County covering areas such as Tharaka North and Maara Sub-Counties, women are primarily responsible for ensuring household water supply for drinking, cooking, sanitation, and small-scale farming (Were et al., 2006). During periods of scarcity, they travel long distances to find water, exposing themselves to fatigue, health risks, and even gender-based violence (Geere & Cortobius, 2017). Beyond domestic needs, women use water for subsistence farming, livestock rearing, and small-scale trading activities central to household survival. Yet, their contributions and experiences remain underrepresented in water governance and policy planning (Amusan & Olutola, 2017a; 2017b). Reliable access to water for women has the potential to enhance household welfare, promote food security, and foster economic empowerment.

Tharaka-Nithi County's Integrated Development Plans (CIDPs) acknowledge the centrality of water to livelihoods and prioritise the expansion of water infrastructure, rainwater harvesting, and catchment restoration (Tharaka-Nithi County Government, 2023). These plans also call for the inclusion of women in water governance. Nonetheless, gender mainstreaming in the county's water sector remains inconsistently applied, limiting the translation of policy commitments into tangible outcomes. In rural areas, the disparity between constitutional guarantees and actual access to safe water underscores the need to view water scarcity not merely as a development issue, but as a fundamental

human rights concern, one that disproportionately affects women as the primary water collectors and managers at the household level.

Environmental degradation has further intensified Kenya's water crisis. Deforestation, overgrazing, and unsustainable agricultural practices have degraded key catchments such as Mt. Kenya, which supplies water to Tharaka-Nithi and surrounding regions (Mwirigi et al., 2024). Pollution from agricultural runoff, industrial effluents, and poor sanitation further reduces the availability of clean water (Lin et al., 2022). Meanwhile, rapid urbanisation and population growth have outpaced infrastructural development, creating additional stress on already limited resources (KNBS, 2019). Weak institutional coordination and poor enforcement of environmental regulations continue to constrain effective water governance (Otieno, 2024). These combined human and natural stressors exacerbate the vulnerability of rural households, particularly women and girls, who bear the daily responsibility of fetching water (Amusan & Olutola, 2017a; 2017b). The long hours spent collecting water reduce time available for education, childcare, and economic pursuits, perpetuating cycles of poverty and gender inequality (WHO & UNICEF, 2019). Studies further reveal that limited water access intensifies health problems for women and children and exacerbates social inequities, as wealthier or politically connected households often secure preferential access to scarce resources (Bisung & Elliott, 2016).

Feminist theory critiques the patriarchal structures that restrict women's access to resources and decision-making power (Sultana, 2012). Building upon this, the Feminist Political Ecology (FPE) framework explores the intersections of gender, environment, and power in shaping access to and control over natural resources (Truelove, 2011). Despite these insights, gendered dimensions remain insufficiently integrated into water management strategies. Water scarcity diminishes women's productivity and health, as they devote substantial

time and energy to obtaining water. In addition, the use of unsafe water sources exposes them to diseases such as diarrhoea, hepatitis, and eye and skin infections, while contributing to stillbirths and miscarriages (Baumgartner & Pahl-Wostl, 2013). Heavy workloads and limited access to sanitation facilities further compromise their well-being, illustrating how structural inequalities and environmental stress intersect to disadvantage women.

The implications of water scarcity extend beyond health to food security, where women play a pivotal role. Water availability is fundamental to meeting global food demands and managing the interlinkages between agriculture, energy, climate, and human development (Cosgrove & Loucks, 2015; Bhat et al., 2025). Women contribute significantly to agricultural production through home gardening, crop cultivation, livestock rearing, and post-harvest activities (Rana & Chopra, 2013). Declining water availability thus directly reduces agricultural output, household nutrition, and income, reinforcing gendered poverty traps.

Within Tharaka-Nithi County, Tharaka North and Maara Sub-Counties offer contrasting ecological settings for examining the impacts of water scarcity. Tharaka North, located in a semi-arid zone, experiences low and erratic rainfall, frequent droughts, and limited agricultural productivity. Most households depend on shallow wells and seasonal rivers that often dry up during prolonged dry spells. In contrast, Maara Sub-County lies in the highlands and receives relatively higher rainfall,

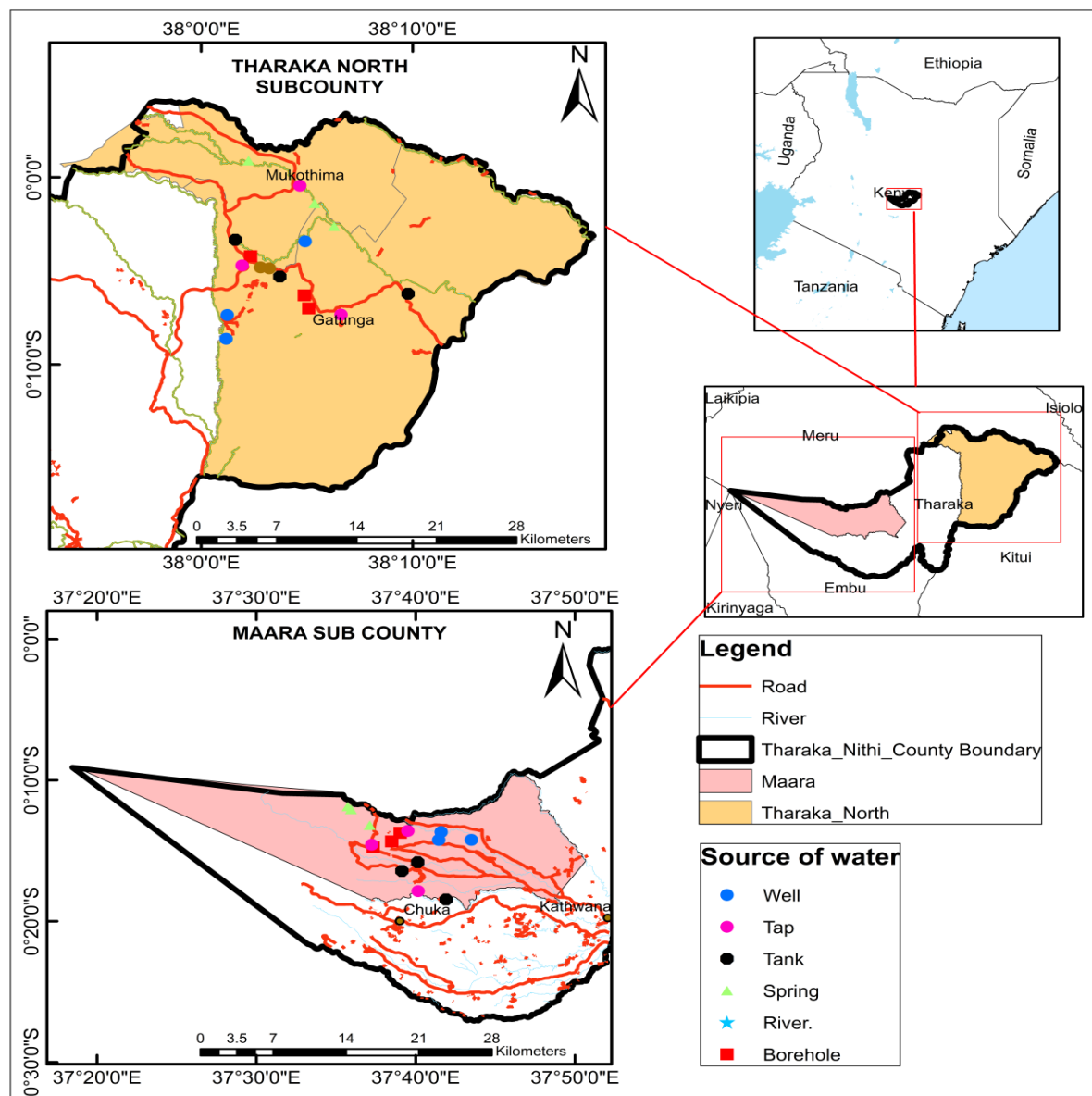
enabling more intensive farming. Despite these ecological differences, both sub-counties face water scarcity. Tharaka North experiences absolute scarcity due to persistent droughts, while Maara faces temporal scarcity driven by population growth and rising agricultural demand. These ecological contrasts provide an ideal comparative framework for exploring how water scarcity shapes rural livelihoods and gender roles in differing climatic contexts.

Although the impacts of water scarcity are widespread, they are not gender-neutral. Yet, existing studies tend to focus either on arid or humid environments, leaving a limited understanding of how water scarcity affects women's livelihoods across diverse ecological zones. This study, therefore, seeks to address this gap by examining the effects of water scarcity on rural women's livelihoods and socio-economic activities in Tharaka North and Maara Sub-Counties of Tharaka-Nithi County, Kenya.

MATERIALS AND METHODS

Study Area

The study's data collection location was Tharaka-Nithi County, Kenya. Particularly, Maara sub-county, a highland that receives enough rainfall yearly and Tharaka North sub-county, a semi-arid lowland with erratic annual rainfall, were the study areas (Ngetich et al., 2022). By selecting the two ecologically diverse sub-counties, a comparative analysis of water scarcity impacts was carried out.

Figure 1: Map of the Study Area

Research Design

This study employed a mixed-methods approach, integrating both quantitative and qualitative techniques to comprehensively explore the research objectives. Quantitative data were obtained through household surveys, while qualitative insights were collected via focus group discussions (FGDs), key informant interviews (KIIs), and direct observations in the field. Combining these methods strengthened

the validity of the study through triangulation and provided a more nuanced understanding of the gendered dimensions of water scarcity across the study sites.

Population and Sampling

The study targeted rural women, recognising their central responsibility in water collection, household management, and livelihood sustenance. A multi-

stage sampling strategy was applied. Initially, Tharaka North and Maara sub-counties were purposively selected because of their recurring water scarcity and contrasting ecological characteristics. In the next stage, villages and households were randomly sampled from official household registers using Qualtrics XM software, ensuring fair representation and minimising sampling bias.

The sample size was established using Fisher's formula as adapted from Haque and Ishtiaque (2020):

$$n = (Z^2 \times p(1-p)) / d^2$$

Where:

n - required sample size

Z - standard normal deviate at 95% confidence level (1.96)

p - estimated population proportion (0.5 when unknown)

d - desired precision level (0.05)

Substituting these values gives:

$$n = ((1.96)^2 \times 0.5(1-0.5)) / ((0.05)^2) = 384$$

Because the population of rural households in both sub-counties was below 10,000, a finite population correction (FPC) was applied as follows:

$$n_f = n / (1 + (n/N))$$

Where N is the total number of households (approximately 2,000).

$$n_f = 384 / (1 + (384/2000)) = 322$$

After accounting for possible non-responses and logistical adjustments, the final effective sample size was 313 households, comprising 113 in Tharaka North and 200 in Maara Sub-County.

In addition, 12 key informants were purposively selected, representing local administrators, water officers, community elders, women's group leaders,

and non-governmental organization (NGO) representatives working on water and livelihood projects in the region. Their inclusion provided expert and administrative perspectives on water scarcity and its socio-economic implications.

Data Collection

Data were collected between May and August 2023, coinciding with the dry season when water scarcity is most severe. This timing enabled the study to capture authentic experiences of scarcity among households. Quantitative data were gathered using structured questionnaires that recorded socio-demographic characteristics, water access patterns, time spent collecting water, and related livelihood effects. The qualitative component employed focus group discussions (FGDs), key informant interviews (KIIs), field observations, and geospatial mapping to complement and contextualise the survey findings. FGDs explored collective perceptions, coping strategies, and gendered impacts of water scarcity, while KIIs provided institutional perspectives on policy, infrastructure, and water management. Field observations documented collection practices, queuing times, and the physical burden on women, whereas GPS-enabled mapping captured the spatial distribution of water sources for subsequent geospatial analysis. Ethical approval was obtained from the National Commission for Science, Technology, and Innovation (NACOSTI) and the University Research Ethics Committee. All participants provided informed consent, and confidentiality was maintained in accordance with established research ethics.

Pilot Study

Before the commencement of the main study, a pilot study was undertaken in a neighbouring area exhibiting similar environmental and socio-economic characteristics. The objective of the pilot was to evaluate the clarity, coherence, and reliability of the research instruments. Content validity was assessed by academic and professional

experts to ensure that all relevant dimensions of the study were adequately represented (Almanasreh et al., 2019). Construct validity was established through Principal Component Analysis (PCA), where factor loadings exceeding 0.5 confirmed the structural adequacy of the instruments (Hair et al., 2019). Reliability testing using Cronbach's alpha produced a coefficient of 0.89, surpassing the recommended benchmark of 0.80 for internal consistency (Bujang et al., 2018). The findings from the pilot study affirmed that the instruments were valid, reliable, and appropriately structured for implementation in the main field survey.

Data Analysis

Data analysis involved both quantitative and qualitative techniques. Quantitative data were coded and analysed using SPSS version 26, where descriptive statistics summarised household characteristics, and chi-square tests assessed the association between water scarcity and women's livelihood outcomes across the two sub-counties. Spatial analysis using ArcGIS mapped the geographic distribution of water sources and evaluated access patterns relative to distance and livelihood impacts.

Qualitative data obtained from FGDs, KIIs, and field observations were transcribed, coded, and analysed thematically following the framework proposed by Braun and Clarke (2006). The themes that emerged highlighted gender roles, coping strategies, and socio-economic challenges linked to water scarcity.

Through this multi-layered analysis, the study established a comprehensive understanding of how water scarcity influences women's livelihoods, health, and socio-economic participation in both Tharaka North and Maara sub-counties.

RESULTS AND DISCUSSIONS

Results

The study revealed distinct patterns of how water scarcity affects women's livelihoods across Tharaka

North and Maara sub-counties. Quantitative results indicated that in Tharaka North, 57.5% of respondents agreed or strongly agreed that water scarcity had led to decreased income, while in Maara, a comparable proportion (56.5%) reported similar effects. However, chi-square tests showed significant intra-subcounty variation in responses (Tharaka North: $\chi^2 = 32.35$, $p < 0.0001$; Maara: $\chi^2 = 41.95$, $p < 0.0001$), suggesting that although perceptions were broadly similar, the degree of agreement varied significantly within each subcounty. Focus group discussions supported these findings, with women in Tharaka North reporting reduced farm productivity and limited time for income-generating work due to long hours spent fetching water. In Maara, participants attributed income reduction to frequent water rationing and declining yields of irrigated crops such as vegetables and bananas.

Regarding agricultural improvement, most respondents in Tharaka North (77.9%) and Maara (79%) agreed or strongly agreed that proximity to water sources enhanced farming activities. The chi-square results (Tharaka North: $\chi^2 = 16.79$, $p < 0.0002$; Maara: $\chi^2 = 26.92$, $p < 0.0001$) confirmed significant internal variation in these views. Interviews with local agricultural officers in both sub-counties affirmed that households near permanent rivers or boreholes had diversified into horticulture and small-scale irrigation, while distant households relied primarily on rain-fed agriculture.

A comparison of income levels relative to proximity to water sources showed that 59.3% of respondents in Tharaka North and 50% in Maara agreed or strongly agreed that nearness to water sources resulted in higher income. These differences were statistically significant (Tharaka North: $\chi^2 = 45.18$, $p < 0.0001$; Maara: $\chi^2 = 36.65$, $p < 0.0001$). Focus group discussions emphasised that women living near rivers could irrigate kitchen gardens and rear livestock, while those in drier zones depended on erratic rainfall. Observations further revealed that women in Tharaka North often walked longer

distances to fetch water compared to their counterparts in Maara, reflecting the uneven distribution of reliable water points.

In relation to engagement in other economic activities, 70.8% of respondents in Tharaka North and 71% in Maara agreed that proximity to water sources created opportunities for livelihood diversification. The chi-square analysis showed no significant difference in Tharaka North ($\chi^2 = 2.77$, $p > 0.2492$), but a significant variation in Maara ($\chi^2 = 57.20$, $p < 0.0001$). Qualitative findings corroborated these results: women closer to water sources reported being able to engage in small enterprises such as brewing, basket weaving, and poultry keeping, while those farther away cited fatigue and time constraints as barriers.

Most respondents in both sub-counties recognised the social implications of water scarcity. In Tharaka North, 77% and in Maara, 71.5% agreed or strongly agreed that residents living far from water sources experienced more social challenges, such as conflicts over water use and domestic tension. The chi-square tests (Tharaka North: $\chi^2 = 77.92$, $p < 0.0001$; Maara: $\chi^2 = 103.55$, $p < 0.0001$) revealed

significant differences in responses within both areas. Observational data supported these findings, showing long queues and disputes at communal water points, particularly in Maara, where water demand exceeded supply during peak hours.

Lastly, perceptions of water availability varied sharply between the two regions. In Tharaka North, 63.7% of respondents strongly disagreed that water was readily available, whereas only 25.5% in Maara expressed the same sentiment. The differences were statistically significant (Tharaka North: $\chi^2 = 8.50$, $p < 0.0035$; Maara: $\chi^2 = 59.95$, $p < 0.0001$). Interviews with local leaders attributed this disparity to better-developed water infrastructure in Maara, including community boreholes and piped water projects, compared to Tharaka North, where most residents relied on seasonal rivers and hand-dug wells. Overall, both quantitative and qualitative data underscore that while water scarcity affects women in both sub-counties, its intensity and social consequences are more pronounced in Tharaka North due to limited infrastructure and greater distances to water sources.

Table 1: Effect of Water Scarcity on Women's Socio-economic Activities

Statement	Sub County	(S.D)	(D)	(N)	(A)	(S.A)	Chi-Square, P-Value (χ^2, p)
		1	2	3	4	5	
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	Tharaka. N	-	-	33, 29.2%	34, 30.08%	46, 40.70%	$\chi^2 = 2.77$ $p > 0.2492$

Statement	Sub County	(S.D)	(D)	(N)	(A)	(S.A)	Chi-Square, P-Value
enabled improved engagement in other economic activities.	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%	$\chi^2 = 59.95$ $p < 0.0001$

Discussion

Water scarcity places a disproportionate burden on women, limiting their participation in productive and social activities. The findings of this study are consistent with previous work by Goswami and Bishit (2017), who emphasised that inadequate water availability undermines both social and economic development, affecting the daily lives of communities across various regions. Similar to Ngigi's (2009) observations, the results reveal that women in Tharaka Nithi County spend considerable time walking long distances and queuing for water, time that could otherwise be allocated to income-generating ventures or subsistence farming. Bisung and Elliott (2017) also observed that water collection often consumes more time than formal employment or recreation, reinforcing economic inequality. In line with Abubakar (2018), the study found that households sometimes sacrifice other essential needs to purchase water or invest in basic purification methods. Likewise, as Bimla et al. (2013) observed, women and girls remain the primary collectors of water, a responsibility that directly affects girls' school attendance and educational outcomes.

Qualitative evidence from interviews and focus group discussions revealed that many women experience chronic back and neck pain as a result of

carrying heavy containers over long distances. These findings parallel those of Zuin et al. (2013), who documented that households in Maputo spend over an hour daily fetching and waiting for water. Similar "time poverty" was observed in Tharaka Nithi County, where the energy and time invested in water collection diminish women's productivity in other economic activities. This cycle of poverty and water insecurity echoes the observations of Collins et al. (2018), who noted that limited access to reliable water sources hinders the adoption of sustainable coping mechanisms such as rainwater harvesting or household storage systems. Moreover, many families depend on informal water vendors, whose sources are often unregulated. As highlighted by Praveena et al. (2018), the use of unclean containers and storage practices increases contamination risks, while Balaram et al. (2023) reported that stagnant or open water sources are prone to pollution from animal waste and sewage. These findings suggest that unsafe water practices further compound health risks, particularly among women and children, who are most exposed to waterborne diseases.

Beyond the physical strain, water scarcity was also found to have psychological implications. In line with Bisung and Elliott (2016), many respondents reported heightened anxiety and stress due to irregular water availability, late-night collection

routines, and long queues. Brewis et al. (2021) further observed that water insecurity contributes to feelings of powerlessness and social injustice, often leading to depression and emotional exhaustion. The current study supports these assertions, demonstrating that persistent scarcity not only affects women's physical health but also their emotional and mental well-being.

The findings also highlight significant socio-economic impacts. In Maara Sub-County, women frequently turned to petty trade as a coping strategy to offset reduced agricultural yields, while in Tharaka North, livestock rearing emerged as a common fallback activity. However, both strategies were constrained by limited access to credit, markets, and time due to competing domestic responsibilities. These results align with UN Women's (2014) observation that water scarcity limits women's ability to diversify livelihoods. Time poverty, a recurring theme in this study, reduces women's access to education, vocational training, and formal employment, a trend similarly identified by De Guzman et al. (2023). Furthermore, reduced water availability for agriculture and livestock directly affects food production and household nutrition, echoing the FAO (2016) conclusion that water insecurity perpetuates poverty and food deficits. The intersection of gender roles, resource scarcity, and socio-economic vulnerability thus forms a complex web that undermines women's empowerment and community resilience.

Addressing these challenges calls for a multi-pronged approach involving gender-responsive water governance, equitable infrastructure investment, and the promotion of technologies that ease water collection. Targeted interventions such as community-managed water systems, improved storage facilities, and participatory decision-making can enhance women's adaptive capacity and reduce the socio-economic burden of water scarcity.

Limitations of the Study

While the study provides valuable insights into the gendered dimensions of water scarcity, several limitations should be acknowledged. First, the research relied partly on self-reported data, which may be influenced by recall bias or social desirability. Second, the study was conducted during one dry season (May–August 2023); therefore, the results may not fully capture seasonal variations in water availability and livelihood dynamics. Additionally, logistical and budgetary constraints limited the spatial scope and number of focus group discussions conducted. Despite these limitations, the triangulation of quantitative and qualitative methods strengthened the validity and reliability of the findings, providing a comprehensive understanding of how water scarcity affects women's socio-economic and psychological well-being in Tharaka North and Maara sub-counties.

CONCLUSIONS, RECOMMENDATIONS, AND FUTURE STUDIES

Conclusions

Gender disparities are pronounced in how water scarcity affects people in Tharaka North and Maara sub-counties. As per the results, women bear the greatest burden of water collection due to entrenched cultural expectations. This unequal burden compromises women's health, reduces their time for income-generating activities, interrupts girls' education, and exposes households to health risks from unsafe water sources. Consequently, water scarcity is not merely an environmental concern, but also a socio-cultural and governance issue that undermines women's social and economic well-being. Although the women have adopted coping and adaptation strategies such as water storage, reuse of greywater, rainwater harvesting, reliance on private vendors, and the construction of wells and boreholes, they are still affected negatively by the water scarcity issue. The reason is that, as much as communities have also

drawn on indigenous knowledge systems and diversified livelihood practices to mitigate the impacts of scarcity, the adoption of these strategies is constrained by economic limitations, particularly among poor households, which underscores the inequality in adaptive capacity. Water scarcity in Tharaka Nithi County is shaped by the intersection of environmental variability, poverty, governance, and gender relations. Sustainable solutions would entail systemic interventions such as the improvement of water infrastructure, strengthening of governance and resource allocation, mainstreaming of gender-sensitive water policies, and promotion of community-based conservation and poverty reduction programs. Therefore, a holistic and inclusive framework that integrates both indigenous knowledge and modern climate-smart strategies is essential to achieving long-term water security and resilience in the region.

Recommendations

Based on the findings, it is recommended that households should promote rainwater harvesting and greywater reuse systems as these strategies can provide immediate relief. Simple techniques such as roof catchment, storage tanks, and the reuse of household greywater for irrigation can enhance water availability at the household level. Additionally, government subsidies and NGO support should prioritise women-headed households, who are disproportionately affected by water scarcity and often responsible for domestic water management. There is a need for public awareness campaigns focusing on water conservation, hygiene, and women's rights to water access to foster behavioural change and dismantle cultural barriers that restrict women's participation in water management. Community-based investments such as sand dams, shallow wells, and water pans are necessary because they are cost-effective strategies that build resilience to seasonal variability by enhancing water storage during rainy seasons and providing reliable supplies during droughts. 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. It is essential to support women's cooperatives with access to microfinance for technologies such as water tanks and drip irrigation systems to further strengthen household-level resilience and empower women economically. The adoption of artificial aquifer recharge projects and large-scale irrigation schemes adapted to climate variability can increase groundwater availability and reduce dependency on unreliable rainfall. Similarly, integrated climate-smart agriculture programs that combine modern technologies with indigenous knowledge can enhance productivity, food security, and resilience. At the institutional level, establishing early warning systems and resilience planning frameworks at the county level will prepare communities for drought shocks, and this would reduce vulnerability and safeguard livelihoods in the long run.

Recommendations for Future Studies

Future research should build on the findings of this study by exploring the long-term impacts of climate variability on gendered livelihoods. Specifically, a longitudinal study is needed to evaluate the effectiveness of implemented water governance policies in Tharaka Nithi County and other ASAL regions to determine their sustainability and adaptability over time. In addition, further investigations should examine the effectiveness of emerging water technologies such as solar-powered boreholes, smart irrigation systems, and low-cost water purification in rural contexts where infrastructure is limited. Particular attention should also be paid to the role of patriarchal norms in shaping adaptation outcomes, since cultural constraints continue to hinder women's participation in decision-making and limit their access to resources.

Acknowledgment

I would like to express my gratitude to my supervisors, Dr Marciano Mutiga of Tharaka University and Dr James Muchoka, Deputy Director of Environment, Natural Resources, and Climate Change at the County Government of Embu. I am deeply appreciative of the invaluable guidance, support, and mentorship you have provided throughout the process of writing my thesis. Your expert knowledge, insights, and patience have been essential in shaping my research and contributing to my growth as a scholar. I am truly grateful for your unwavering dedication and commitment to my academic success.

I would also like to extend my heartfelt appreciation to Tharaka University, particularly the Faculty of Life Science and Natural Resources Management, for offering me the opportunity to study at such a prestigious institution. The support and encouragement I have received from the faculty members and staff have been vital to my journey.

Additionally, I would like to express my gratitude to the International Aid Service (IAS) for awarding me the scholarship that enabled me to undertake my research. This financial assistance has made a significant difference in my ability to focus on my studies without the added burden of financial stress. My appreciation also goes to Tharaka University's Vice Chancellor for granting me the Internal Research Fund scholarship (IRF). This support has allowed me to further explore and expand my research, ultimately enriching the quality of my thesis. I would also like to acknowledge the significant contributions made by my peers during this research process. Their diverse perspectives, constructive feedback, and collaborative spirit have enriched my understanding and enhanced the quality of my work.

Lastly, I cannot express enough gratitude to my wife, Millicent Kagendo, for her unwavering support and encouragement throughout this journey. Her love, understanding, and patience have

been a constant source of strength, allowing me to persevere and achieve my academic goals. In conclusion, I am indebted to everyone who has played a role in my academic journey, and I am grateful for the support, guidance, and inspiration I have received along the way. This thesis is a testament to the collective effort and dedication of all those who have supported me, and I am honoured to have had the opportunity to learn and grow under such exceptional mentorship.

REFERENCES

- Abubakar, I. R. (2018). Strategies for coping with inadequate domestic water supply in Abuja, Nigeria. *Water International*, 43(5), 570–590. <https://doi.org/10.1080/02508060.2018.1490862>
- Almanasreh, E., Moles, R., & Chen, T. F. (2019). Evaluation of methods used for estimating content validity. *Research in Social and Administrative Pharmacy*, 15(2), 214–221. <https://doi.org/10.1016/j.sapharm.2018.03.066>
- Amusan, L., & Olutola, O. (2017a). Climate change, water crisis, and women's rights in Africa: The case of South Africa. *Journal of African Union Studies*, 6(1), 73–93.
- Amusan, L., & Olutola, O. (2017b). Women and water management in rural Africa: Policy implications. *Gender and Development Journal*, 25(3), 389–402.
- Balaram, V., Copia, L., Kumar, U. S., Miller, J., & Chidambaram, S. (2023). Pollution of water resources and application of ICP-MS techniques for monitoring and management – A comprehensive review. *Geosystems and Geoenvironmental*, 2(4), 1–17. <https://doi.org/10.1016/j.geogeo.2023.100210>
- Baumgartner, T., & Pahl-Wostl, C. (2013). UN-Water and its role in global water governance. *Ecology and Society*, 18(3), 1-13.

- Bhat, M. A., Dar, T., Ahmed, R., Khurshid, Z., & Nisa, F. U. (2025). Water footprint for sustainable practices. *Water Footprints*, 33–63. <https://doi.org/10.1016/b978-0-443-30054-7.00013-6>
- Bimla, A., Gandhi, S., Dilbaghi, M., & Raina, K. (2013). Rural women carry the load of fetching water. *The Indian Journal of Social Work*, 64(1), 65–75. https://www.researchgate.net/publication/292230792_Rural_women_carry_the_load_of_fetching_water
- Bisung, E., & Elliott, S. J. (2016). “Everyone is exhausted and frustrated”: exploring psychosocial impacts of the lack of access to safe water and adequate sanitation in Usoma, Kenya. *Journal of Water, Sanitation and Hygiene for Development*, 6(2), 205–214. <https://doi.org/10.2166/washdev.2016.122>
- Bisung, E., & Elliott, S. J. (2016). Psychosocial impacts of the lack of access to water and sanitation in low- and middle-income countries: A scoping review. *Journal of Water and Health*, 15(1), 17–30.
- Bisung, E., & Elliott, S. J. (2017). “Everyone is exhausted and frustrated”: Exploring psychosocial impacts of water insecurity on women in rural Kenya. *Journal of Rural Studies*, 58, 52–62.
- Boretti, A., & Rosa, L. (2019). Reassessing the projections of the World Water Development Report. *Nature Partner Journals Clean Water*, 2(15), 1–6.
- Brewis, A., Workman, C., Wutich, A., Jepson, W., Young, S., & Staddon, C. (2021). Household water insecurity is strongly associated with food insecurity: Evidence from 27 sites in low- and middle-income countries. *American Journal of Human Biology*, 33(3), e23505.
- Bujang, M. A., Omar, E. D., & Baharum, N. A. (2018). A review on sample size determination for Cronbach’s alpha test: A simple guide for researchers. *Malaysian Journal of Medical Sciences*, 25(6), 85–99. <https://doi.org/10.21315/mjms2018.25.6.9>
- Bukachi, S. A., Omuto, C., & Njue, E. (2021a). Water security in Kenya: Addressing challenges and opportunities. *Kenya Water Institute Journal*, 6(1), 25–39.
- Bukachi, S. A., Onyango, L., & Omolo, N. A. (2021b). Gendered access to water and adaptation to climate change in Kenya. *Climate and Development*, 13(8), 664–673.
- Bukachi, S. A., Wambua, P. K., & Mwangi, M. (2021c). Water governance and household water security in arid and semi-arid regions of Kenya. *Water Policy*, 23(6), 1465–1482.
- Collins, S. M., Boateng, G. O., & Young, S. L. (2018). Progress in household water insecurity metrics: A cross-disciplinary approach. *WIREs Water*, 4(3), e1214. <https://doi.org/10.1002/wat.2.1214>
- Cosgrove, W. J., & Loucks, D. P. (2015). Water management: Current and future challenges and research directions. *Water Resources Research*, 51(6), 4823–4839. <https://doi.org/10.1002/2014wr016869>
- De Guzman, K., Stone, G., Yang, A. R., Schaffer, K. E., Lo, S., Kojok, R., Kirkpatrick, C. R., Del Pozo, A. G., Le, T. T., DePledge, L., Frost, E. L., & Kayser, G. L. (2023). Drinking water and the implications for gender equity and empowerment: A systematic review of qualitative and quantitative evidence. *International Journal of Hygiene and Environmental Health*, 247(1), 1–19. <https://doi.org/10.1016/j.ijheh.2022.114044>
- Food and Agriculture Organisation of the United Nations (FAO). (2016). *Women, agriculture and rural development: A synthesis report*. FAO.

- Geere, J. L., & Cortobius, M. (2017). Who carries the weight of water? Fetching water in rural and urban areas and the implications for water security. *Water Alternatives*, 10(2), 513–540.
- Goswami, K. B., & Bishit, P. S. (2017). The role of water resources in socio-economic development. *International Journal for Research in Applied Science & Engineering Technology (IJRASET)*, 5(12), 1669–1674. <https://www.researchgate.net/publication/379002667> The Role of Water Resources in Socio-Economic Development.
- Haque, A., & Ishtiaque, A. (2020). *Water, flood management and water security under a changing climate*. Springer Nature.
- Jian, F. (2025). The global water crisis: Challenges and solutions for a sustainable future. *Hydrology: Current Research*, 16(1), 562–563.
- KNBS. (2019). *Analytical report on urbanization in Kenya*. <https://www.knbs.or.ke/wp-content/uploads/2023/09/2019-Kenya-population-and-Housing-Census-Analytical-Report-on-Urbanization.pdf>
- Lin, L., Yang, H., & Xu, X. (2022). Effects of water pollution on human health and disease heterogeneity: A review. *Frontiers in Environmental Science*, 10(1), 1–16. <https://www.frontiersin.org/journals/environmental-science/articles/10.3389/fenvs.2022.880246/full>
- Lombe, P., Carvalho, E., & Rosa-Santos, P. (2024). Drought dynamics in Sub-Saharan Africa: Impacts and adaptation strategies. *Sustainability*, 16(22), 1–16. <https://doi.org/10.3390/su16229902>
- Mwirigi, P., Jane, K., & Karieny, D. (2024). The impact of water abstraction on River Mutonga discharge over the last 30 years. *Asian Journal of Geographical Research*, 7(1), 58–68. <https://doi.org/10.9734/ajgr/2024/v7i1214>
- Ngetich, F. K., Mairura, F. S., Musafiri, C. M., Kiboi, M. N., & Shisanya, C. A. (2022). Smallholders' coping strategies in response to climate variability in semi-arid agro-ecozones of Upper Eastern Kenya. *Social Sciences & Humanities Open*, 6(1), 100319. <https://doi.org/10.1016/j.ssaho.2022.100319>
- Ngigi, S. N. (2003). Rain water harvesting for improved food security. Promoting technologies in the Greater Horn of Africa. *Greater Horn of Africa Rainwater Partnership (GHARP)*. Kenya Rainwater Association (KRA).
- Nkonya, E., Minnick, A., Ng'ang'a, E., & Woelcke, J. (2018). *Land and natural resources degradation in the arid and semi-arid lands in Kenya*. World Bank. <https://documents1.worldbank.org/curated/en/461701571216895387/pdf/Land-and-Natural-Resource-Degradation-in-Arid-and-Semi-Arid-Lands-in-Kenya.pdf>
- Omer, S. (2025, March 6). *Global water crisis: Facts, FAQs, and how to help*. World Vision. <https://www.worldvision.org/clean-water-news-stories/global-water-crisis-facts>
- Otieno, J. O. (2024). The contribution of institutional governance to water services. In the *University of Nairobi*. https://erepository.uonbi.ac.ke/bitstream/handle/11295/166734/Otieno%20J_The%20Contribution%20of%20Institutional%20Governance%20to%20Water%20Services%20Delivery%20in%20Kenya.pdf?sequence=1
- Park, H. S., Dailey, R., & Lemus, D. (2002). The use of exploratory factor analysis and principal components analysis in communication research. *Human Communication Research*, 28(4), 562–577. <https://doi.org/10.1111/j.1468-2958.2002.tb00824.x>
- Praveena, S. M., Shaifuddin, S. N. M., & Akizuki, S. (2018). Exploration of microplastics from personal care and cosmetic products and their estimated emissions to the marine environment:

- Evidence from Malaysia. *Marine Pollution Bulletin*, 136(1), 135–140. <https://doi.org/10.1016/j.marpolbul.2018.09.012>
- Rana, S. S., & Chopra, P. (2013). Integrated farming system. *Department of Agronomy*. <https://doi.org/10.13140/rg.2.2.32107.75047>
- Rosińska, W., Jurasz, J., Przestrzelska, K., Wartalska, K., & Kaźmierczak, B. (2024). Climate change's ripple effect on water supply systems and the water-energy nexus – A review. *Water Resources and Industry*, 32, 100266. <https://doi.org/10.1016/j.wri.2024.100266>
- Sultana, A. (2012). Patriarchy and women's subordination: A theoretical analysis. *Arts Faculty Journal*, 4(4), 1–18. <https://banglajol.info/index.php/AFJ/article/view/12929>
- Tharaka Nithi County Government. (2023). *Tharaka Nithi County Integrated Development Plan 2023-2027*. Kippra. or. Ke, County Government of Tharaka Nithi. <https://repository.kippra.or.ke/items/c543240b-e3df-4e4d-ae59-48e0aa6ad659>
- Truelove, Y. (2011). (Re-) Conceptualizing water inequality in Delhi, India through a feminist political ecology framework. *Geoforum*, 42(2), 143–152.
- United Nations Women (UN Women). (2014). *World survey on the role of women in development: Gender equality and sustainable development*. UN Women.
- Were, E., Swallow, B., & Roy, J. (2006). *Water, women, and local social organisation in the Western Kenya highlands*. International Research Workshop on Gender and Collective Action. https://www.researchgate.net/publication/5057185_Water_women_and_local_social_organization_in_the_Western_Kenya_highlands
- World Health Organisation (WHO) & UNICEF. (2019). *Progress on household drinking water, sanitation and hygiene 2000–2017: Special focus on inequalities*. WHO/UNICEF Joint Monitoring Programme.
- Zuin, V., Ortolano, L., & Davis, J. (2013). The entrepreneurship myth in small-scale service provision: Water resale in Maputo, Mozambique. *Journal of Water, Sanitation and Hygiene for Development*, 4(2), 281–292. <https://doi.org/10.2166/washdev.2013.065>