Climate Change and Water Scarcity Coping Strategies in Arid and Semi-Arid Lands in Kenya

Philip K. Mwendwa

Department of Geography, Egerton University, Kenya

**Corresponding author: philkimms@gmail.com*

https://doi.org/10.62049/jkncu.v6i2.592

Abstract

Arid and semi-arid regions face significant challenges in managing water resources due to climate change, population growth, and economic development. This study focuses on Kitui County, where climate change has intensified water scarcity, impacting communities' socio-economic well-being. Despite these challenges, there's limited research on community coping strategies. The study area was chosen for its representation of arid and semi-arid conditions. A sample of 100 households was surveyed across three constituencies using proportional population sampling. Questionnaires were administered to collect data on demographic information and coping strategies. To test the association between households' perception of climate change and the adoption of specific coping strategies, a chi-square test of independence was used. Results indicate that the majority of respondents were male (62%), reflecting cultural norms where men engage in water infrastructure development. Walking long distances to fetch water from seasonal rivers emerged as the primary coping strategy, followed by rainwater harvesting and purchasing water from vendors. Higher education and income levels were associated with more sophisticated coping strategies like rainwater harvesting and private boreholes. Water rationing and government interventions also played significant roles in coping. Government interventions, although present, were not always significant in mitigating water scarcity. Overall, this study underscores the urgency of implementing sustainable water management strategies and fostering community resilience in arid and semi-arid regions.

Keywords: Arid And Semi-Arid Areas (Asals), Water Resources, Coping, Climate Change, Management Strategies

Introduction

Arid and semi-arid regions face great challenges in managing and conserving scarce water resources under pressures of climate change, population, over-abstraction, and economic development (Wheater *et al.,* 2010). Despite global progress in access to clean water, many countries in Africa still face challenges in accessing this resource (Sustainable Development Goals Report, 2022). Climate change poses a great challenge in the management of freshwater resources, especially in arid and semi-arid areas (Mohammed and Scholz, 2017). The challenge is even greater in Africa because erratic rainfall and high population growth pose a great strain on water resources (Kalele et al., 2021). In East Africa, climate change is causing a great impact on water resources, and there is a need to establish new and effective mitigation and adaptation measures (Opere *et al,* 2019). The prediction by the Intergovernmental Panel on Climate Change (IPCC) points to a decrease in rainfall in the arid areas, thus increasing freshwater scarcity (IPCC, 2007). Any slight change in the precipitation pattern in arid and semi-arid regions can result in undesirable changes in surface water runoff, consequently affecting surface water availability (Fekete *et al*., 2004). The impacts of climate change on water resources can be characterized by shifts in water quantity, water quality, and water timing (Mathew and Quene, 2009). Vulnerability to these impacts is exacerbated by the inadequate coping strategies of communities (Kangalawe *et al.,* 2011). Access to clean water for all people remains a major challenge in many developing countries. This is partly because of the sustainability rate of the water projects in the developing countries, which remains low due to poor management of water infrastructure and inadequate resources (Hazelton, 2015). It is a common phenomenon to come across non-functioning water supply projects in the arid areas in Kenya (Ministry of Water and Irrigation, 2011). The changes to water supply critically impact water security, accessibility, and the socio-economic well-being of societies (Bradley *et al*., 2006; Bigas *et al*., 2012). Even with these changes, very few studies have focused on how communities cope with limited access to freshwater resources (See also Pearson *et al.,* 2015). Many areas of South Eastern Kenya lie in the Arid and Semi-Arid Climatic region in Kenya, making the region to be water scarce. Households with water in their premises account for 6.8% against the national average of 24% (Kitui County Integrated Development Plan, 2018). The focus of this study was to determine the strategies adopted by communities to cope with the limited water resources in arid and semi-arid areas occasioned by climate change.

Methods and Materials

Study Area

This study was carried out in Kitui county, which lies between latitudes 0^0 10' and 3^0 0' South and longitude 37^0 50' and 39^0 0' East. It is approximately 160 Kilometers East of Nairobi and covers a total area of 30,496.4 Km^2 (KCIDP, 2018). The study area experiences two rainy seasons: between October and December (Short rains), and between March and May (Long rains). However, the rainfall distribution is erratic and unreliable. With regards to topography, the county has a low altitude ranging between 400 m above sea level and 1800 m above sea level. The highest mean annual temperature is 32^0 C while the lowest annual mean temperature is 14^0 C. Most of the rivers in the county are seasonal and drain their waters to either of the two perennial rivers, the Tana and Athi Rivers.

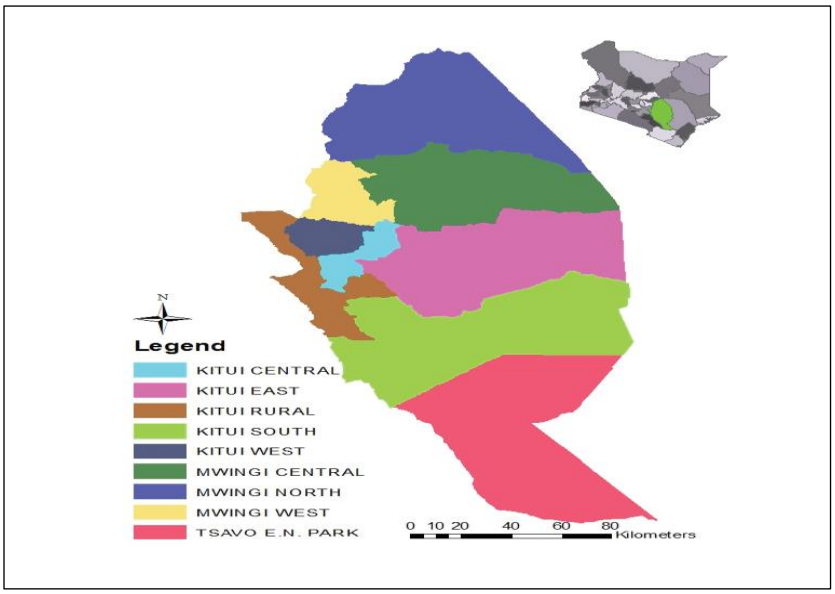

Figure 1: Location of the study area

Study Sample Selection

From the eight (8) constituencies in the county, three (3) were selected using simple random sampling (Mwingi North, Mwingi Central, and Mwingi West). Proportional population sampling was then used to randomly select survey participants in the three constituencies. With a sample size of one hundred (100) households, thirty-seven (37) households in Mwingi Central, thirty-five (35) households in Mwingi North, and twenty-eight (28) households in Mwingi West were selected.

Questionnaire Survey

Household data were obtained through the administration of questionnaires by trained field assistants. Data on coping strategies, type of water source for the household, ownership of the water source, distance to the water source, estimated time spent to and from the water source, seasonality of the water source, and waiting time at the source were collected.

Data Analysis

In this study, data analysis involved both descriptive and inferential statistics. Descriptive statistics such as frequencies and percentages were used in the analysis of respondents' demographic characteristics and the coping strategies adopted by households to deal with water scarcity. To test the association between households' perception of climate change and the adoption of specific coping strategies, a chi-square test of independence was used. Each coping strategy was coded as a binary variable (1 = adopted; 0 = not adopted), while climate change perception was measured as a dichotomous variable (1 = perceived changes in climate; 0 = otherwise) (Table 1). This analysis was based on equation 1.

$$\chi^2=\sum E_i(O_i-E_i)^2 \text{.....Equation 1}$$

Where (O_i) represents the observed frequency and (E_i) represents the expected frequency under the null hypothesis of no association. Statistical significance was assessed at the 5% level.

Table 1: Description of Predictor Variables

Variable	Description	Measurement
Climate change*	Households perceive climate change impacts	1 = Yes, 0 = No
Harvesting rainwater	Household harvests rainwater	1 = Yes, 0 = No
Digging wells	The household has dug a well	1 = Yes, 0 = No
Drilling boreholes	The household has drilled a borehole	1 = Yes, 0 = No
Fetching water from seasonal rivers	Households fetch water from seasonal rivers	1 = Yes, 0 = No
Purchasing water from vendors	Household purchases water from vendors	1 = Yes, 0 = No
Water rationing	Household practices water rationing	1 = Yes, 0 = No
County government intervention	Household gets/got water from the county government support/Project	1 = Yes, 0 = No
Constructing water pans	The household gets water from water pans	1 = Yes, 0 = No

**Independent variable*

Results of the Study

Out of the 100 questionnaires that were administered, 100 questionnaires were collected back from the three constituencies. This represents a 100% success rate.

Demographic Information

Demographic information reveals data related to age, education, gender, marital status, employment, and income level (Table 2)

Table 2: Demographic information of respondents

Variable	Percentage (%)
Gender	
Male	62
Female	38
Age	
18-30	34
31-50	47
51-70	17
>70	2
Marital Status	
Single	15
Married	55
Separated	10
Divorced	6
Widowed	14
Education Status	
Not attended school	11
Primary School	43
Secondary School	42
College/University	4
Employment Status	

Formal employment	21
Informal employment	70
Retired	9
Income level (Kshs per month)	
<3000	15
3000-4999	27
5000-9999	32
10000-19999	16
>20000	10
Total	100

It was established that the majority of the respondents (62%) were male, while women constituted 38%. This high number of men could be attributed to the cultural orientation of the community in the study area, where men take up the roles of digging wells, drilling boreholes, and constructing water pans. On the other hand, women are tasked with fetching water from the rivers or wells. With regards to age, the study found that the majority of the respondents (47%) were between 35 and 51 years. Respondents aged between 18 and 30 years also constituted a significant percentage (34%). The youthful nature of the respondents makes them active participants in coping with water scarcity challenges since they have families that need a supply of drinking water. Additionally, respondents in these age brackets participate in small-scale irrigation farming, especially near the wells dug near seasonal rivers. For those above 70 years, their participation is limited by their inability to dig or drill boreholes and their reduced strength to walk distances looking for water.

Married respondents (55%) were more likely to develop coping strategies since they need more water for domestic usage. The coping strategies developed by respondents who were single, widowed, separated, and divorced accounted for 15%, 14%, 10% and 6%, respectively. The study established that 43% of the respondents had attained primary school education, while 42% were secondary school leavers. Only 4% of the respondents had attained a college or university education, while 11% did not have any formal education. The educational level of the respondents had a significant influence on the coping strategy. Respondents with higher education qualifications had invested in rainwater harvesting structures. This was also linked to the income levels of the respondents as well as their employment status. It was established that the income levels were directly related to the educational level and the type of employment. Most respondents with formal employment (21%) had water tanks in their homes, while others had drilled boreholes in their farms. The low-income levels of most of the respondents (<Kshs 10,000) meant that they could only resort to coping strategies that are less expensive, like walking for distances to fetch water from seasonal rivers or water pans constructed by the county government and non-state actors. The few boreholes in the study area were either drilled privately by the respondents earning >Kshs 20,000, the County government, or non-governmental organizations.

Water Scarcity Coping Strategies

Several coping strategies have been developed by the residents of the study area to deal with water scarcity occasioned by climate change. It was established that rain fails at least every two years. In the recent past, the rain patterns have changed, with the short rains only occurring between November and early December, while the long rains only occur in April. The main coping strategy adopted by most of the respondents was

walking distances to fetch water from seasonal rivers (83%). The popularity of this coping strategy could be attributed to the fact that there are many households in the study area without piped water, as noted by Mwendwa (2021). The strategy is also cheap since the water in those seasonal rivers is obtained free of charge. Harvesting rainwater was also reported by 63% of the respondents. Most of the respondents store this water harvested from iron sheet-roofed houses in tanks. However, the cost of these tanks was reported to be too high, which limits many of the respondents' ability to afford the high-capacity tanks. Many have been forced to install water tanks that can only hold an average of 5000 liters of water. Consequently, the water is normally consumed within a month, and the household has to resort to other coping strategies to get water before the next rainy season.

It was also established that 52% of the respondents rely on water rationing to cope with water scarcity. The water rationing strategies employed include re-using waste water for purposes such as watering fruit trees, using less water when washing, not using water showers, and using pit latrines rather than flushing toilets. The results also indicated that 11% of the respondents had drilled boreholes to help them cope with climate-induced water scarcity. This small percentage can be attributed to the high cost associated with drilling boreholes in the study area. Further, 20% of the respondents indicated that they had dug wells to cope with water scarcity. It was established that owning a well or living closer to one increased the chances of coping with water scarcity since this increased water availability for the households. Many of these wells were dug near the seasonal rivers because the water table was relatively high. Only 8% of the respondents reported that County government interventions had enabled them to cope with water scarcity. Some of the interventions included drilling boreholes and the construction of earth dams. This low number of respondents could be attributed to the low number of such projects in the study area. Many of these boreholes drilled by the county governments were poorly maintained, and some had even dried up. Moreover, the construction of water pans by some of the respondents (13%) enabled them to cope with water scarcity. The results indicated that rainwater harvesting, digging of wells, drilling boreholes, fetching water from seasonal rivers, water rationing, and purchasing water were the main water scarcity coping strategies in Kitui County.

Table 3: Water Scarcity Coping Strategies

Coping Strategy	Percentage of Respondents (%)
Harvesting rainwater	63
Digging wells	20
Drilling boreholes	11
Fetching water from seasonal rivers	83
Purchasing water from vendors	24
Water rationing	52
County government intervention	8
Constructing water pans	13

To test the association of households' perception of climate change and adoption of climate change coping strategies, chi-square tests of independence were conducted. The results (Table 4) indicated significant association between climate change and rainwater harvesting ($X^2 = 31.04$, df=1, $p = 0.01$), digging wells ($X^2 = 4.21$, df=1, $p = 0.02$), fetching water from seasonal rivers ($X^2 = 69.61$, df=1, $p = 0.01$), purchasing water from vendors ($X^2 = 5.47$, df=1, $p = 0.01$) and water rationing ($X^2 = 3.06$, df=1, $p = 0.04$). This is because all of these strategies had p-values less than 0.05. Drilling boreholes ($X^2 = 2.42$, df=1, $p = 0.17$),

County government interventions ($X^2 = 1.68$, df=1, $p = 0.16$), and constructing water pans ($X^2 = 2.04$, df=1, $p = 0.08$) did not have a statistically significant association with climate change.

Table 4: Chi-Square Test Results

Water Coping Strategy	X^2	df	p-value
Harvesting rainwater	31.04	1	0.01*
Digging wells	4.21	1	0.02*
Drilling boreholes	2.42	1	0.17
Fetching water from seasonal rivers	69.61	1	0.01*
Purchasing water from vendors	5.47	1	0.03*
Water rationing	3.06	1	0.04*
County government intervention	1.68	1	0.18
Constructing water pans	2.04	1	0.08

*Note: *indicates significance at 5%*

Discussions

The results of the study indicated that male respondents (62%) were more involved in drilling of boreholes, digging wells, constructing water pans, and harvesting rainwater, while women mostly walked for distances to fetch water. This was linked to the societal norms and cultural orientation of the community, where men are expected to perform most of the masculine duties, while women are the ones expected to walk for distances to fetch water. In a similar study, the National Population Council (2014) established that more female adults (26%) were involved in fetching water for the household as compared to male adults (21%).

Fetching water from seasonal rivers ranked highest among the coping strategies. This involves trekking for long distances with donkeys to fetch water. Most residents who walk for distances to fetch water are the low-income earners since they are not able to afford high-capacity water tanks to store rainwater for use in the dry season. This concurs with Okpoko et al. (2013), who noted that distances of up to 2 Kilometres could be covered to access water. Similar findings were reported by Ezeudu et al. (2022), who observed that 48% of the households were fetching their water from streams/rivers. Respondents with boreholes in their farms or those living near them were more likely to cope with water scarcity than those living far away. This is similar to Abubakar (2019), who found that private boreholes were a major source of drinking water in Nigeria. Additionally, Abungu (2025) established that boreholes were the most utilized water source in Turkana, supporting almost 94.1% of households.

Purchase of water from water vendors was a common practice among respondents who live in urban areas. Water vendors use bicycles, donkeys, and tuk-tuks to ferry the water from the sources to the markets where they sell a 20-litre jerrycan for Kshs 20. Rural households occasionally purchase water from water vendors when they have social functions such as weddings, funerals, and circumcision ceremonies. This concurs with the findings of Ezeudu et al (2022), who noted that vended water in Nigeria was a community water coping strategy mostly during events that require huge volumes of water, such as burials, Christmas, and weddings (See also Pattanayak et al., 2005).

Conclusions

In conclusion, this study sheds light on the coping strategies employed by communities in Kitui County, an arid and semi-arid region facing significant challenges in water resource management due to climate change. The findings reveal that walking long distances to fetch water from seasonal rivers is the primary coping strategy, highlighting the substantial burden placed on residents, particularly women, due to water scarcity. Additionally, rainwater harvesting and purchasing water from vendors emerged as significant strategies, reflecting both traditional and innovative approaches to address water scarcity. Furthermore, the study underscores the influence of demographic factors such as gender, age, education, employment, and income level on the choice of coping strategies. Cultural norms and societal roles play a pivotal role in shaping these dynamics, with men predominantly involved in infrastructure development, while women are more engaged in water-fetching activities.

The significance of education and income levels is evident in the adoption of more sophisticated coping strategies like rainwater harvesting and private boreholes. However, it is essential to note that higher education and income are not universally accessible, highlighting the need for targeted interventions to ensure equitable access to water resources. Government interventions, although present, were not consistently effective in mitigating water scarcity, indicating the necessity for improved governance and resource allocation strategies. Nonetheless, initiatives such as water rationing and county government interventions like borehole drilling and water pan construction demonstrate efforts to address the challenges posed by climate change and water scarcity.

Overall, this study underscores the urgency of implementing sustainable water management strategies and fostering community resilience in arid and semi-arid regions. Future research should delve deeper into the socio-economic impacts of water scarcity and evaluate the effectiveness of various coping mechanisms in enhancing water security and socio-economic well-being.

References

Abubakar, I. R. (2019). Factors influencing household access to drinking water in Nigeria. *Utilities Policy, 58*, 40–51.

Abungu, V., Adanu, K., Firouzjaei, M. D., Wasonga, B., & Elliot, M. A. (2025). Multiple household water sources and uses in rural ASALs: Evidence and proposed solutions from Turkana, Kenya. *Groundwater for Sustainable Development*. https://doi.org/10.1016/j.gsd.2025.101531

Ezeudu, O. B., Ezeudu, T. S., Ugochukwu, U. C., Okolo, O. J., Ani, C. D., Ajogu, A. P., Ajaero, C. C., Mbakwe, U. I., & Nduji, N. N. (2022). Coping strategies, cultural practices and policy implications on domestic water supply in an erosion susceptible rural community, Nigeria. *Resources, 11*, 77. https://doi.org/10.3390/resources11080077

Fekete, B., Vörösmarty, J., & Willmott, C. (2004). Uncertainties in precipitation and their impacts on runoff estimates. *Journal of Climate, 17*, 294–304. https://doi.org/10.1175/1520-0442

Hazelton, D. (2015). *The development of community water supply systems using deep and shallow well hand pumps* (WRC Report No. TT132/00). Water Research Centre.

Kangalawe, R., Mwakalila, S., & Masolwa, P. (2011). *Climate change impacts, local knowledge and coping strategies in the Great Ruaha River Catchment Area, Tanzania*. *Natural Resources*.

Kelele, D. N., et al. (2021). Climate change impacts and relevance of smallholder farmers' response in arid and semi-arid lands in Kenya. *Scientific African, 12*, e00814.

Kitui County. (2018). *County integrated development plan 2018–2022*. Government Printer.

Mathew, J. W., & Quene, T. L. (2009). *Adapting water management: A primer on coping with climate change*. World Wildlife Fund.

Ministry of Water and Irrigation. (2011). *Water and environment sector performance report*. Ministry of Water and Irrigation.

Mohammed, R., & Scholz, M. (2017). Adaptation strategy to mitigate the impact of climate change on water resources in arid and semi-arid regions: A case study. *Water Resources Management, 31*, 3557–3573.

Mwendwa, P. K. (2021). Performance of non-state actors in provision of water services in arid and semi-arid areas: A case of Kyuso Sub-County, Kenya. *Journal of Environment and Earth Science, 11*, 29–36.

National Population Commission, & ICF International. (2014). *Nigeria demographic and health survey*. National Population Commission & ICF International.

Okpoko, E., Egboka, B., Anike, L., & Okoro, E. (2013). Rainfall harvesting as an alternative water supply in water-stressed communities in Aguata-Awka Area of Southeastern Nigeria. *Environmental Engineering Research, 18*, 95–101.

Opere, A., Omwoyo, A., Mueni, P., & Orango, M. (2019). Impact of climate change on water resources in Eastern Africa. In C. Ondieki & J. Kitheka (Eds.), *Hydrology and water resources management in arid, semi-arid, and tropical regions* (pp. 199–227). IGI Global. https://doi.org/10.4018/978-1-7998-0163-4.ch010

Pattanayak, S. K., Yang, J. C., Whittington, D., & Bal Kumar, K. C. (2005). Coping with unreliable public water supplies: Averting expenditure by households in Kathmandu, Nepal. *Water Resources Research, 41*, W02012.

Pearson, A., Mayer, J., & Bradley, D. (2015). Coping with household water scarcity in the Savannah today: Implications for health and climate change into the future. *Earth Interactions, 19*.

The Sustainable Development Goals Report. (2022). *Department of Economic and Social Affairs, United Nations*.

Wheater, H. S., Mathias, S. A., & Li, X. (2010). *Groundwater modeling in arid and semi-arid areas*. Cambridge University Press.