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Original Article

Awareness and Perceptions of Climate Variability Adaptation among Forest-adjacent Communities in Mau Forest, Kenya

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ABSTRACT

Adequate knowledge of climate variability is essential for the success of any adaptation or mitigation efforts. Thus, a study was conducted to investigate the levels of awareness and perceptions on the adaptation of climate variability among forest-adjacent communities (FACs) in Mau Forest, Kenya**.** Data for the investigation was generated through the administration of 313 questionnaires across randomly selected forest-adjacent households. Of the entire questionnaire, 311 were analysed, while two were returned uncompleted and therefore discarded. Descriptive and inferential statistical analyses were conducted. Descriptive analysis showed that 96% of the respondents had knowledge of climate variability, while 4% claimed no knowledge of it. Nearly two-thirds of respondents (65%) reported that they receive weather information, with media (electronic and print) cited as the most common (63%) source of this information. As regards frequency of information, those respondents who get information about climate variability occasionally constituted 60%, while 29% of respondents received information frequently. However, 14% of respondents rarely received any climate-related information. Respondents who received climate-related information occasionally (sometimes) constituted 56%. Alternatively, respondents reported that they obtained weather information from agricultural extension officers (17.6%) and Kenya Forestry Service (KFS) officials (15.3%). The perceptions of the farmers that they had observed erratic weather patterns with a general decline in rainfall and an increase in temperatures were corroborated by scientific data as a trend analysis on rainfall and temperature data over a 20-year period mirrored the farmer's perceptions. A logistic regression model was fitted to determine the socioeconomic factors that influence farmers' choice of adaptation to climate variability. The ANOVA test results (F-test) show that overall, the

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logistic regression model was significant (df = 310, p = 0.002). Results of the model revealed that household head age (df = 310, p = 0.015), household head years of residency (df = 310, p = 0.034), and farming experience (df = 310, p = 0.024) were all significant factors that influence FACs' decision to adopt to climate variability either positively or negatively. This study therefore recommends for more awareness creation and training of FACs of East Mau on how to identify and deal with changing climatic conditions.

APA CITATION

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INTRODUCTION

Climate change and variability pose a major threat to sustainable livelihoods and economic development, particularly in developing countries like Kenya (Kogo *et al*., 2021). The impacts of extreme variability in weather patterns and climate characteristics, including increased temperature, erratic rainfall, frequent floods, and prolonged droughts, are more likely to be pronounced in the sub-Saharan Africa (SSA) region, where over 95% of arable land is rain-fed and supports approximately 80% of the population through subsistence agricultural systems (Serdeczny *et al*., 2017; Abrams, 2018; Mairura *et al*., 2021). The report by the IPCC (2014) indicates that there will be an increase in global temperature by an additional 1.4 to 5.8 ^{o}C by 2100 and rainfall will continue to increase but vary by region, with some regions showing decreasing rainfall. The change in temperature coupled with erratic rains is expected to reduce agricultural productivity by approximately 50%. In Kenya, a warming trend has been observed with the country recording an increase of 1.0 °C since 1960, at an average rate of 0.21 °C each decade (World Bank, 2021). According to the climate risk profile report by the World Bank, the change in temperature and precipitation patterns have led to increased risk of recurrent droughts and devastating floods, threats to biodiversity, an expansion of plant and animal diseases and a number of potential

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challenges for public health (World Bank, 2021).

Forest-adjacent Communities (FACs) in Kenya just like in many parts of the world are highly dependent on climate-sensitive natural resources for livelihoods and economic sustainability (Davidson *et al.*, 2003; Langat *et al.*, 2016). These communities have over time experienced rapid population growths as a result putting more pressure on already depleted natural resources (Davidson *et al.*, 2003). The population of forest-adjacent communities is expected to further increase drastically in the coming decade (Myers, 1990; Habiyaremye *et al.*, 2011; Ouko *et al.*, 2018) exerting more pressure on the already vulnerable forest ecosystem and resources such as water, health facilities, schools, roads, houses, and energy (Somorin, 2010). This makes it urgent for climate change adaptation and mitigation studies to be conducted so as to reduce the dangerous impacts of climate change. Forest-adjacent communities like those living around Mau Forest face unprecedented climate change threats as the forests they have relied on for livelihoods for many years continue to be degraded (Baldyga *et al.*, 2008). The increased frequency and intensity of extreme climatic events such as the prolonged drought coupled with the increased land fragmentation and reduced soil fertility in the agricultural zones that largely provided community livelihoods have exacerbated the problem (Brown *et al.*, 2012).

Perception is important in climate change because it is one of the elements that influence the adaptation process. Climate variability perception and awareness are important precursors to any meaningful ameliorative measures (Kibue *et al.*, 2016; Asifat, 2019). Adaptation to climate change requires that forest-adjacent communities first notice that the climate has changed and then identify useful adaptations and implement them (Maddison, 2007). A better understanding of forest-adjacent communities' perceptions of climate change, ongoing adaptation measures, and the decision-making process is important to inform policies aimed at promoting sustainable adaptation strategies for all sectors of the economy. Despite its relevance, the level of awareness of the scenario of climate change, the proportion of those that understood the challenges posed by climate change is still low, especially in developing nations, Kenya inclusive (Ochieng & Koske, 2013; Lee *et al.*, 2015). This work investigated the level of awareness of climate variability and perceptions of adaptation among FACs in Eastern Mau Forest, Kenya. The study also looked at some of the socioeconomic factors that influence adaptation to climate variability among the FACs as well as some of the strategies they are using to mitigate or adapt to climate variability.

MATERIALS AND METHOD

Description of the Study Area

This study was conducted in three selected villages of Nessuit, Likia, and Mariashoni in Nakuru County (*Figure 1*). The choice of the study area was based on the proximity of the villages to the Mau Forest complex, which is an important source of livelihood for the forest-adjacent communities (FACs). Forest resources are also a crucial means for enhancing the resilience of FACs against the adverse effects of climate change and variability (Balama *et al.*, 2016; Negi *et al.*, 2017).

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The climate is characterised by a trimodal rainfall pattern with long rains from April to June; short rains in August; and shorter, less intense rains from November to December. Generally, the complex receives an average annual rainfall of about 1200 – 1400 mm in normal years devoid of climatic extremes such as the El Niño Southern Oscillation (ENSO). Mean monthly rainfall events in the range of 30 mm to over 120 mm are common (Kundu, 2007). The mean annual temperatures are in the range of 12 to 16 °C, with the greatest diurnal variation during the dry season (Kundu, 2007). The local topography is predominantly rolling land with slopes ranging from 2% in the plains to more than 30% in the foothills. Geological studies have shown that the area is mainly composed of quaternary and tertiary volcanic deposits (Sombroek *et al*., 1980). These deposits have influenced the soil type; for example, the mollic andosols soil type found in the study area was developed from pyroclastic rocks and volcanic ashes. The soils are well-drained, deep, dark brown to grey-brown, friable, and smeary clay loam with thick humic topsoil. These soil types support the intensive agricultural activities around the forest and as a result the region has high human population densities (Olang & Kundu, 2011).

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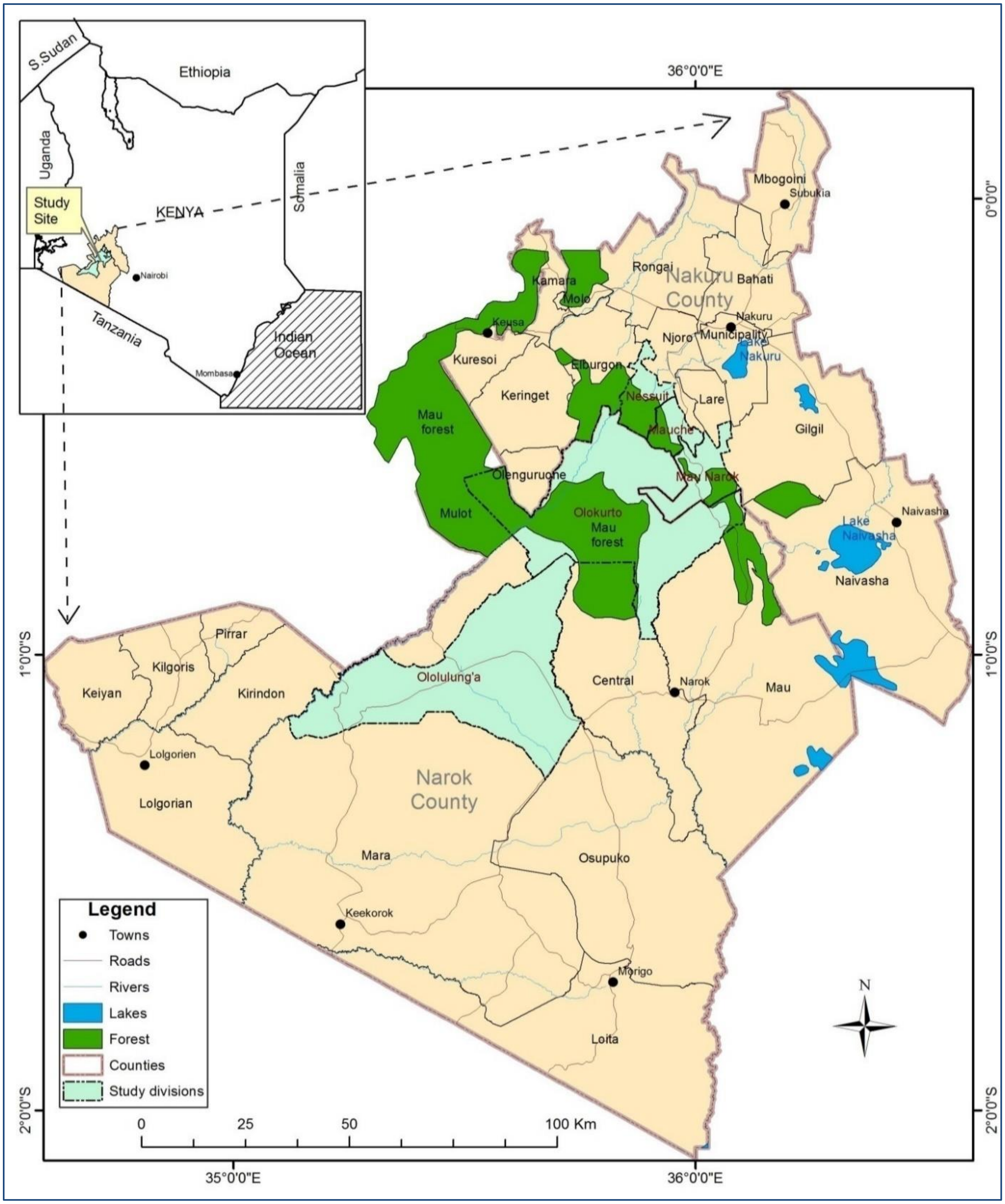
Figure 1: Map of the study area



Data Collection Methods

Different methods and techniques were used to gather qualitative and qualitative data from both primary and secondary sources. Household interviews were conducted using a structured questionnaire to collect data related to;

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demography, forest-adjacent communities' perceptions, and responses to the adverse climate change effects as well as the socioeconomic factors influencing climate change adaptation in the study area. The questionnaire was uploaded into CSPro Software version 6.

The study targeted 1700 households drawn from forest-adjacent communities (FACs) located within 5 Km from the boundary of Mau Forest. The study targeted a population of FACs in three administrative units (villages), namely, Nessuit, Mariashoni, and Likia in Nakuru County. Households lying out of the 5 Km belt were excluded from this study. Krajcie and Morgan's (1970) table for determining the sample size that was used to get a sample from the total population and this sample was proportionately apportioned to the three different study locations (*Table 1*).

Table 1: Population of the study areas and samples size computation

Location	Population size	Sample size	Sampling intensity (%)
Nessuit	720 household	133 person/household	18.47
Likia	860 households	158 person/household	18.37
Mariashoni	120 households	22 person/household	18.33
Total	1700 households	313 person/ household	

Secondary data from both published and unpublished literature from various sources were used to supplement primary data. Climatic data, mainly rainfall and temperature spanning 20 years (1997–2017) was collected from the Kenya Forest Service (KFS) and Egerton University's Civil Engineering Department.

Data Analysis

Quantitative data mainly demographic characteristics, communities' perceptions of climate change effects, and adaptation measures, were coded, processed, and analysed using Statistical Package for Social Science (SPSS) software version 25. Descriptive and inferential statistics involve the use of frequency distribution and logistic regression. Stacked bar graphs and frequency tables were used to compare different variables across study villages. The logistic regression analysis was used to analyse the socioeconomic factors influencing the decision of FACs to adapt to climate variability or not.

RESULTS AND DISCUSSION

Awareness Levels of Climate Variability

The majority of respondents (96%) reported that they are aware of climate change and variability. Nearly two-thirds of respondents (65%) reported that they receive weather information, with media (electronic and print) cited as the most common (63%) source of this information. As regards frequency of information, those respondents who get information about climate variability always constituted 26%, those who received information occasionally constituted 56%, while 3% of respondents received information frequently. However, 14% of respondents rarely received any climate-related information, and 1% never received any climate-related information. Respondents who received

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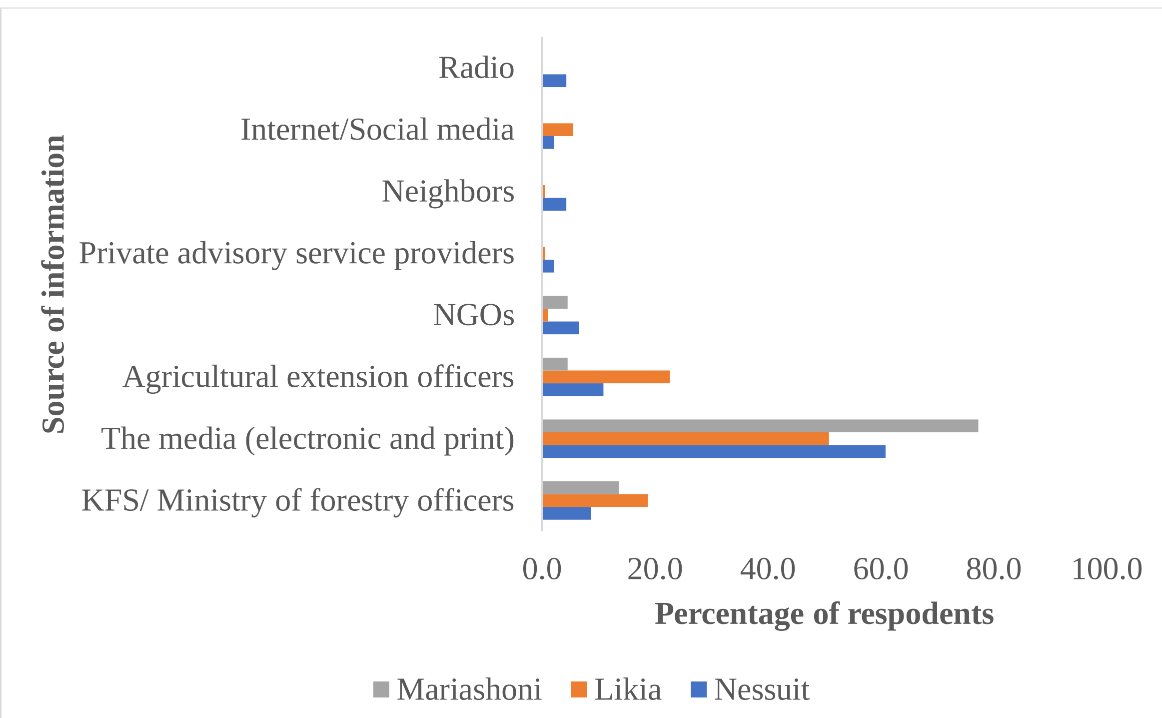
climate-related information occasionally (sometimes) constituted 56%. Alternatively, respondents reported that they obtained weather information from agricultural extension officers (17.6%) and KFS and ministry of forestry officials (15.3%).

Table 2: Awareness levels of climate variability among the respondents

	Nessuit (n=133)		Likia (n=155)		Mariashoni (n=23)		Total (N=311)	
	Yes	No	Yes	No	Yes	No	Yes	No
Aware of climate change?	92%	8%	99%	1%	100%	0%	96%	4%
Obtained any Cc information in the last one year?	48%	52%	77%	23%	74%	26%	65%	35%

Figure 2 shows sources of climate information across the three sampled areas. Media (Electronic and print) appears to be the most common means of disseminating climate information across the three study sites with the highest use being of the medium being in Mariashoni.

Figure 2: Sources of climate information



The majority of people (96%) said that they were aware of climate variability. Mariashoni had the highest number of people (100%) who said they were aware of climate variability (see *Figure 3*).

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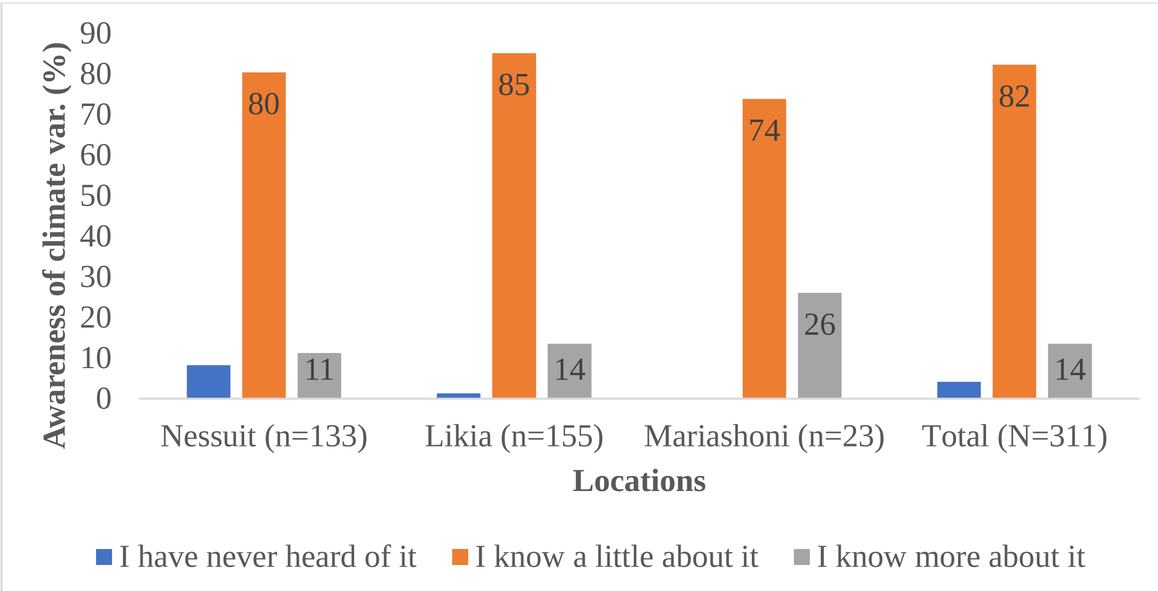
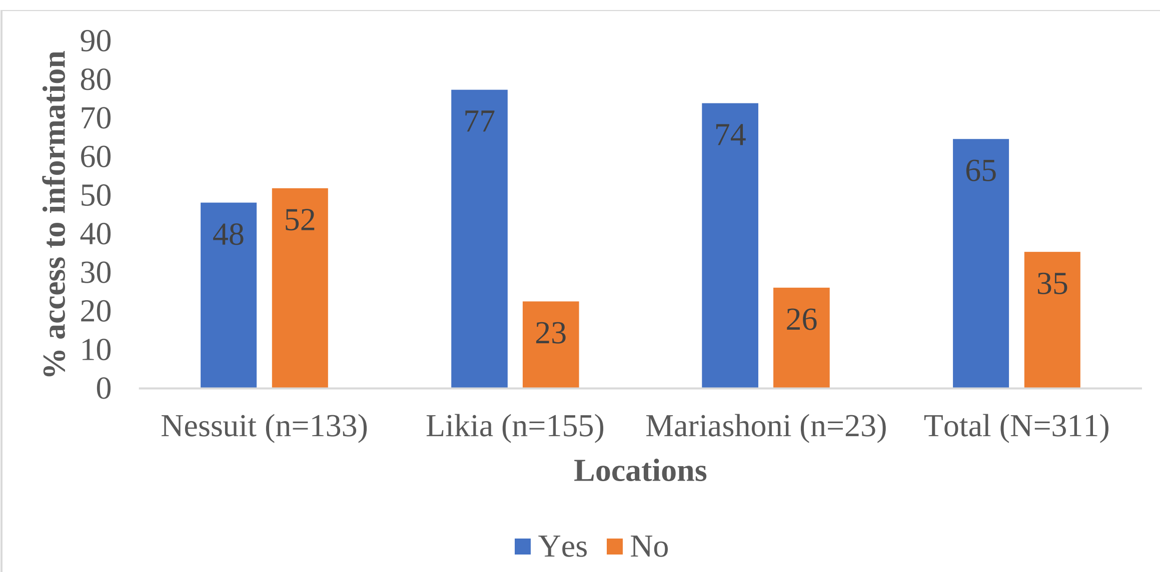
Figure 3: Awareness of climate variability by location in East Mau Forest



Access to climate-related information was highest in Likia (77%) followed by Mariashoni (74%), and finally, Nessuit (48%). In Nessuit, unlike the other two localities, the majority of respondents (52%) said that they do not have any access to climate-related information. Overall, 65% of respondents said that they have access to climate-related information (see *Figure 4*).

Figure 4: Access to climate variability information



As regards to frequency of access to climate-related information, very few people (Likia, 5% and Nessuit, 3%) reported that they always receive this information. For those who said

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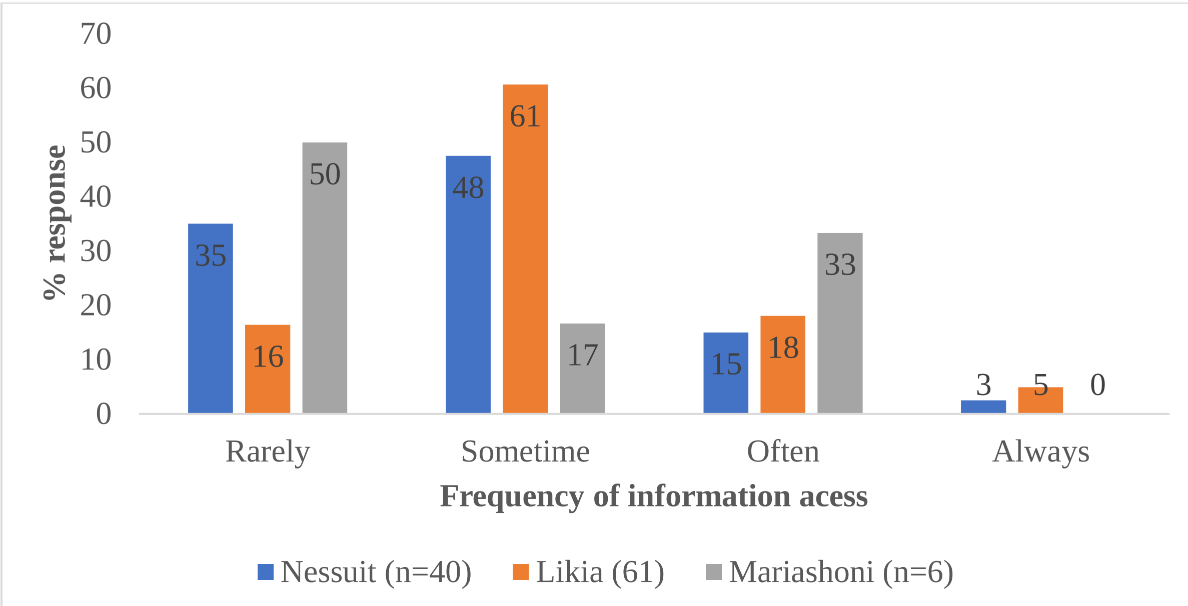
they often receive climate information, Mariashoni reported the highest (33%). However, 50% of people who responded to this question in Mariashoni reported that they rarely get any climate-related information.

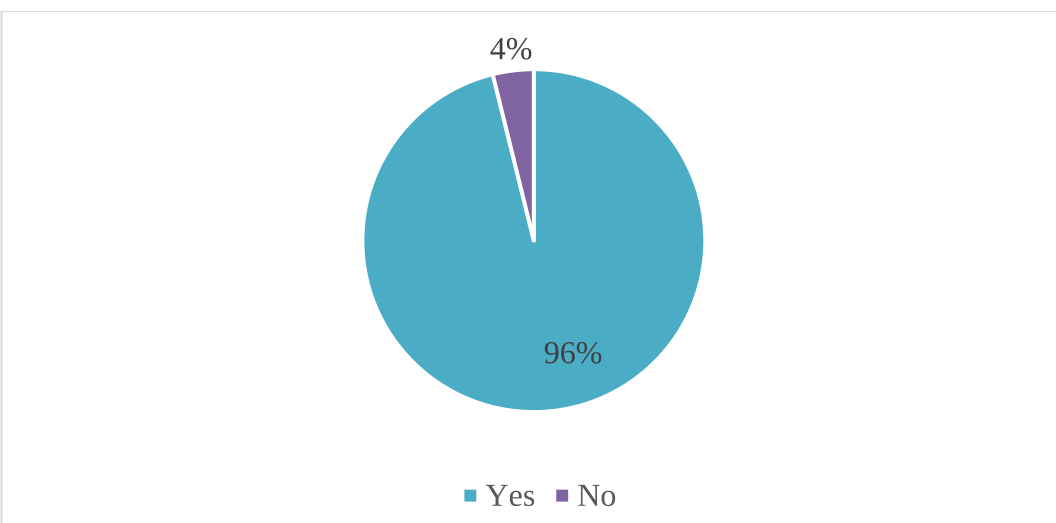
Figure 5: Frequency of access to climate-related information



Forest-adjacent Communities' Perception of Climate Change

Most of the household heads (96.1%) reported that they had observed climate variability. Rainfall variability was the most observed phenomenon, with 94.4% of respondents reporting having observed changes in the amount of rainfall.

Figure 6: Observation of climate variability consequences



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A large proportion of household heads (93.1%) reported noticing changes in annual temperature and another 90.5% reported noticing changes in the onset of rains. Those respondents that reported noticing a change in cessation of rainfall accounted for 85.9% (*Table 3*).

Table 3: Respondents' observations on climate variability in the past 20 years

Climate variability aspects	Percentage (N=311)		
	Yes	No	Do not know
Noticed/perceived changes in temperature over the last 20 years?	93.1	5.9	1.0
Noticed/perceived changes in annual rainfall over the last 20 years?	94.4	5.3	0.3
Noticed/perceived changes in the onset of rains in the last 20 years?	90.5	8.8	0.7
Noticed/perceived changes in the cessation of rains in the last 20 years?	85.9	10.5	3.6

Notwithstanding this general agreement among the respondents that they had perceived changes in key climatic parameters over the last 20 years, there were some differences in the direction of those changes (*Table 4*). Most respondents (73.1%) reported having noticed an increase in mean temperature and the number of hot days. Another majority of respondents (67.2%) also reported that they perceived a decline in rainfall, indicating the weather had become drier over the last 20 years, with those who reported a decline in the number of rainy days (rainfall length) being 72.5%. There was, however, a group of respondents who observed the opposite trend, with 20% observing a decline in mean temperatures and a decline in the number of hot days, and a further 27. 2% reported the weather to have become wetter.

Table 4: Summary of how farmers perceive the change in key climatic parameters

Climatic Parameter	Observation	Percentage (N=311)
Change in mean temperature and number of hot days	Increased	73.1
	Decreased	20.0
	No change	5.9
	Don't know	1.0
Changes in the amount of rainfall	Increased	27.2
	Decreased	67.2
	No change	5.3
	Don't know	0.3
Changes in the rainfall length (number of rainy days)	Increased	22.3
	Decreased	72.5
	No change	4.9
	Don't know	0.3

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Respondents had also experienced several extreme weather events over the last 20 years. As shown in *Table 5*, nearly half (47.4%) of interviewed respondents had experienced drought, followed by 41.7% of respondents who had experienced very hot seasons. Approximately half of the respondents reported having experienced very wet seasons characterised by floods over the last 20 years.

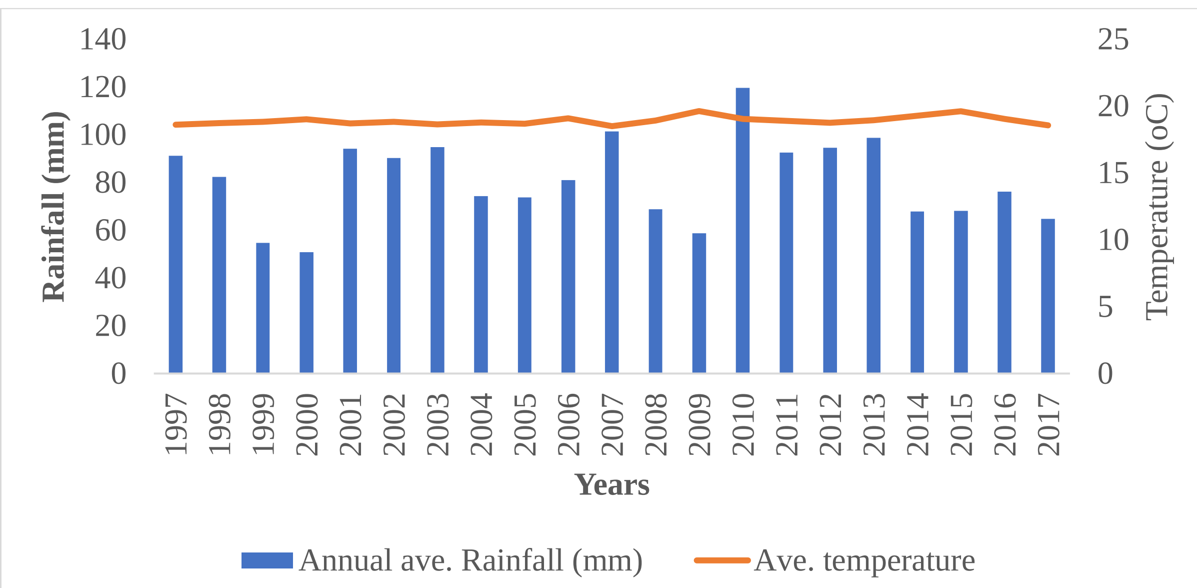
Table 5: Extreme weather events experienced by farmers

Extreme weather events experienced	Percentage (N=311)	
	Yes	**No**
Prolonged drought/ dry spells	47.4	53.6
Very hot seasons	41.7	58.3
Very wet seasons	38.4	61.6

According to the respondents, the main factors to blame for the changes in climatic patterns and the occurrence of extreme weather events are; excessive cutting down of trees (100% of respondents), overgrazing (19.3%), burning of farm wastes (11.2%) and emissions from factories (7.6%).

The perceptions of the FACs seem to align with scientific evidence. To validate these perceptions, rainfall and temperature data for the study area was obtained from the Kenya Forest Service, Nakuru County office a regression fitted on the average mean annual temperature (MAT) and mean annual precipitation (MAP) for a 20-year period (1997 to 2017). The results are shown in *Figure 7* below: -

Figure 7: Climate graph by year for East Mau Forest (1997-2017),



Data **source** (Kenya Forest Service, 2018)

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Results of the MAT analysis shows that there has been an upward trend (increase) in the mean temperature in the last two decades. However, the regression model is a poor fit (p = 0.6). R squared indicates that the regression equation fitted can only predict 1.2% of the results (see appendix 3 for regression output). Similarly, the total annual rainfall for the study area was subjected to regression analysis. Results from the analysis show a general rainfall decline trend. This confirms the perceptions of the FACs, where the majority (67.2%) perceived a general decline in the amount of rainfall over the two decades under study (i.e., 1997-2017).

Impacts/Consequences of Climate Variability on Forest-adjacent Communities

The majority of respondents (83.6%) reported that the quality of drinking water had deteriorated over the last 20 years. Only 1.3% of respondents reported observing an improvement in water quality with 15.1% of respondents reporting that they did not observe any change in water quality over the same duration. In terms of the quantity of drinking water, 75.4% of respondents reported that they observed a decrease with only 12.8% of respondents reporting an increase in the quantity of drinking water in nearby rivers. However, 11.8% of respondents said that they did not observe any changes in the quantity of drinking water in the last 20 decades. Respondents also reported a change in forest vegetation near them over the last 20 years and this could be attributed to the changing climate. A large proportion of respondents (93.8%) reported that they observed the disappearance of some species with only less than 1% (0.98%) of respondents reporting that they observed the emergence of new species. Nonetheless, a few respondents reported that they did not observe any changes (3.9%) in forest vegetation, while 1.3% of respondents were not aware of any changes in forest vegetation over the last 20 years. A segment of other consequences of climate variability as reported by respondents are tabulated in *Table 6*. The consequences are also represented in a stacked bar graph in *Figure 8*.

Table 6: Consequences of climate variability in Mau East Forest

Consequences of climate variability	Level of agreement	F (N=311)	%
Crop failure	Strongly disagree	5	1.61
	Disagree	15	4.82
	Not sure	13	4.18
	Agree	212	68.17
	Strongly agree	66	21.22
Crop diversity changed	Strongly disagree	7	2.25
	Disagree	17	5.47
	Not sure	24	7.72
	Agree	225	72.35
	Strongly agree	38	12.22
Flooding	Strongly disagree	22	7.07
	Disagree	36	11.58
	Not sure	26	8.36
	Agree	209	67.20

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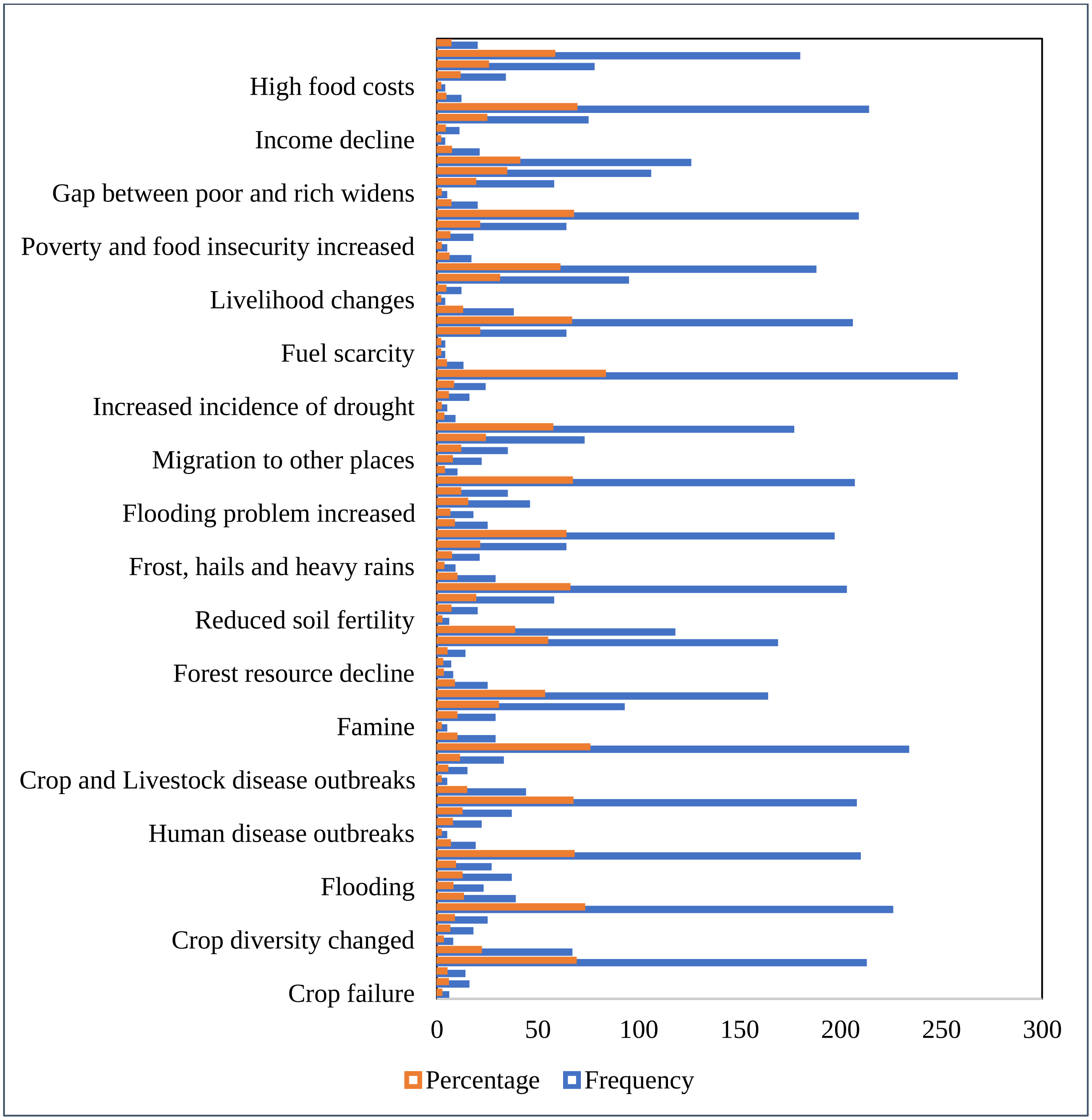
Consequences of climate variability	Level of agreement	F (N=311)	%
	Strongly agree	18	5.79

Figure 8 provides a graphical representation of the consequences of climate variability in the Mau East Forest. Increased cases of drought were sighted by the majority of people (82.6%) as what they perceive to be a serious consequence of climate variability in East Mau Forest.

Figure 8: Consequences of climate variability in Mau East Forest



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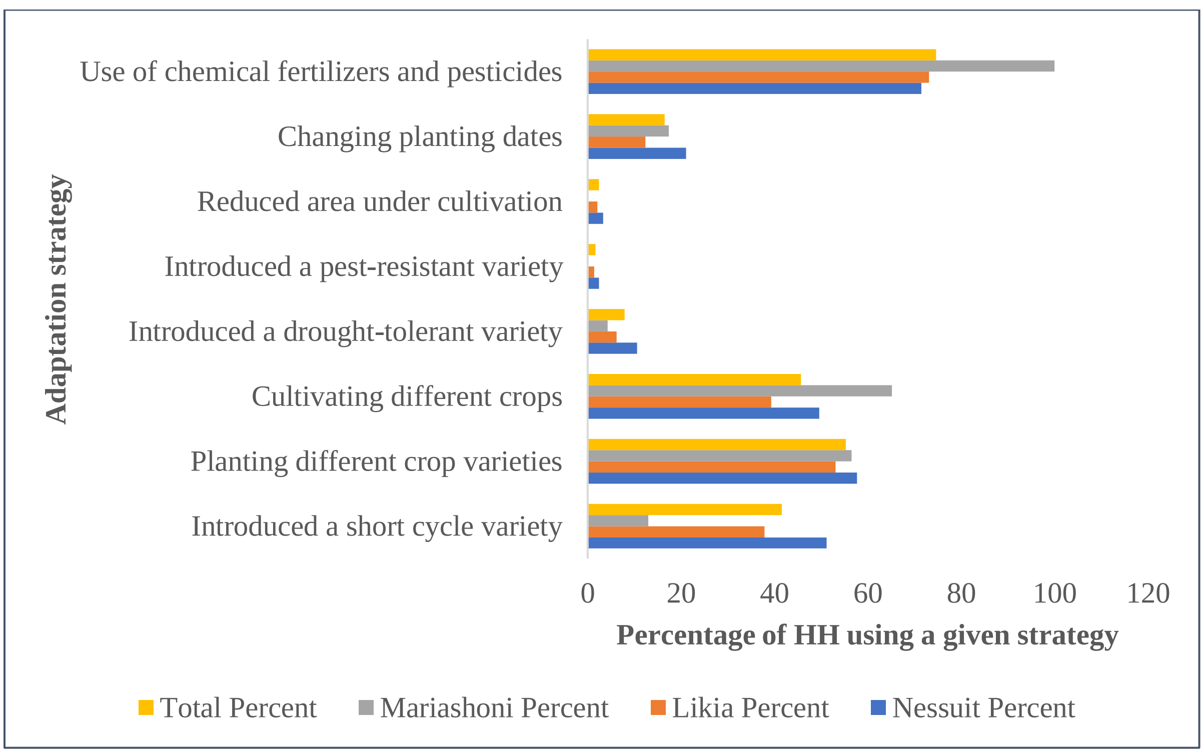
Forest-adjacent Communities' Responses to Climate Change Effects

All the coping and adaptation strategies being used by farmers of Nessuit, Likia, and Mariashoni were documented. For better analysis and interpretation of results, the adaptation strategies were categorised into three broad categories. The first category included all strategies meant to improve crop production or shield against poor crop yields and were named 'crop production strategies. The second category included all response strategies meant to maintain or improve soil nutrients and water or protect against loss and was named 'soil and water conservation strategies. Descriptive statistics were then used to determine which of those strategies are the most widely adopted and charts were used to represent the findings.

A total of 8 crop production response strategies were identified, including; the introduction of short-cycle crop varieties, planting different crop varieties, cultivating different crops, increased use of fertilisers and pesticides, planting drought-tolerant crops, planting pest-resistant varieties, reduction of area under cultivation, and changing (staggering) planting dates. Four of the crop production response strategies were found to be used by more than 40% of the respondents. These were, in ascending order; the introduction of short-cycle variety, cultivating different crops, planting different varieties of the crop and increased use of chemical fertilisers and pesticides. The least adopted crop production strategies were found to be; the introduction of pest-resistant variety, reduction of area under cultivation and introduction of drought-tolerant variety in that order (*Figure 9*).

Figure 9: Crop production adaptation strategies among FACs in the three study locations (N=311)



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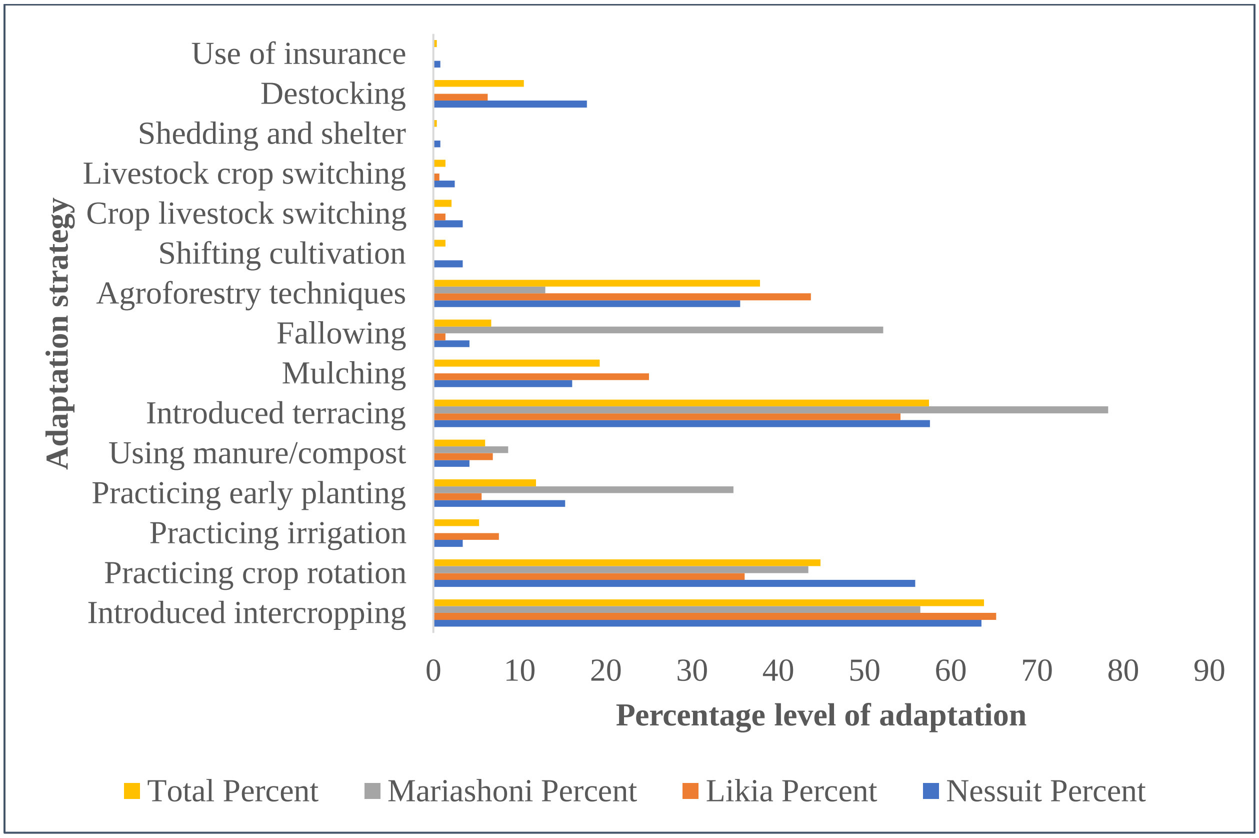
The FACs also employ various soil and water conservation strategies to mitigate climate variability as shown in *Figure 10*. On average, in ascending order, agroforestry techniques (37.9%), introduced terracing (57.5%) and introduced intercropping (63.9%) appear to be the three most common adaptation strategies across the sampled localities. Finally, the household heads in the sampled FACs reported that they use other strategies (see *Figure 10*) to mitigate on vagaries of climate variability. The three most common methods of adaptation, among other strategies are (on average, in ascending order) the use of indigenous leafy vegetation (13.2%), beekeeping (23.1%) and tree planting (94.1%).

Figure 10: The rate of adoption of various soils and water adaptation strategies among the sampled localities



There were other climate variability adaptation strategies adopted by FACs including tree planting (94.1%) and the adoption of nature-based enterprises like beekeeping (23.1%). Other adaptation strategies used by FACs in the study area including the use of indigenous leafy vegetables (13.2%) and indigenous wild fruits (6.2%), among others, are summarised in *Figure 11*.

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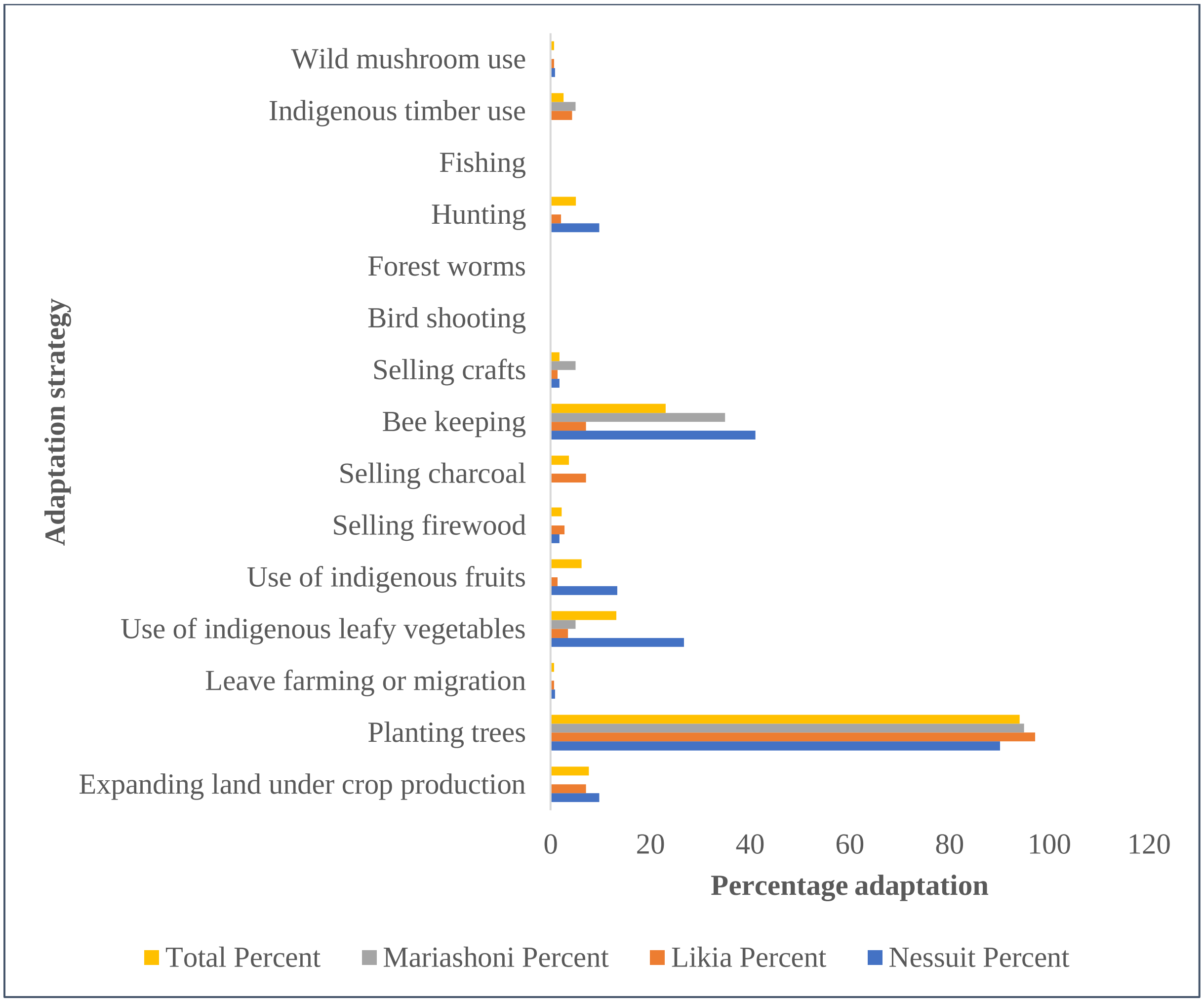
Figure 11: Other adaptation strategies used by FACs to mitigate climate change across the study area



Socio-Economic Factors Influencing Climate Change Adaptation Strategies

For this study, the following factors were hypothesised to be affecting a FAC choice of adapting to climate variability or not; the age of the household head, level of education of household head, gender of household head, years of residence of the household head, farming experience, total household size, and receiving climate variability information. A logistic regression model for predicting the adoption or non-adoption of climate variability was fitted using nine (9) predictor variables (see *Table 7*, description of model variables). A multiple linear regression model with k predictor variables x_1, x_2, …., xk and a response y, was fitted. The general logistic regression model can be written as follows: -

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots \beta_k x_k + \varepsilon$$

Where: y denotes the dependent (or study) variable, x_1, x_2, ….,x_k are the independent (or explanatory) variables, β_0 is the model constant, β_1, β_2,…,β_k are the model coefficients, ε are the residual terms of the model and the distribution assumption.

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Table 7: Description of the model variables

Variables	Description
HHHAGE	Age of head of household (1 if ≥ 38 years old, 0 otherwise)
HHHEDU	Education level of head of the family (1 until intermediate level, 0 otherwise)
RESGENDER	Gender of the respondent (Female = 1, otherwise 0)
HHHYRES	Years of residence (1 if ≥ 20 years, 0 otherwise)
FAREXP	Farming experience (1 if ≥ 20 years, 0 otherwise)
HHSIZE	Household size (1 if ≥ 5 members, 0 otherwise)
FARMSIZE	Farm size (1 if ≥ 2 acres, 0 otherwise)
HHINCOME	Monthly income (1 if monthly income is > Ksh. 5000, otherwise 0)
CRIMVRINFO	Access to information on climate variability (Yes=1, No=0)
ADPTD	If the farmer has adjusted his farming, (If yes 1, otherwise 0)

The output's first table (*Table 8*) shows the model summary and overall fit statistics. The adjusted R^2 of the model is 0.054 with the R^2 = 0.081, which means that the linear regression explains 8.1% of the variance in the data.

Table 8: Model summary showing overall fit statistics

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.285[a]	.081	.054	.233
a. Predictors: (Constant), climvarinfo, resgender, farmsize, hhsize, hhhedu, hhyres, hhincom, hhhage, farmexp				

The logistic regression model for predicting adaptation to climate variability among forest-adjacent communities in three selected Eastern Mau Forest sub-counties (i.e., Nessuit, Likia and Mariashoni) is summarised in *Table 9*.

Table 9: Logistic regression model output

Coefficients[a]						
Model		**Unstandardised Coefficients**		**Standardised Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	(Constant)	.912	.056		16.387	.000
	HHHAGE	.088	.036	.165	2.453	.015
	HHHEDU	-.080	.044	-.111	-1.816	.070
	RESGENDER	-.048	.027	-.097	-1.732	.084
	HHYRES	.078	.036	.143	2.132	.034

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Coefficients[a]					
Model	**Unstandardised Coefficients**		**Standardised Coefficients**	**t**	**Sig.**
	B	**Std. Error**	**Beta**		
FARMEXP	-.078	.034	-.160	-2.267	.024
HHSIZE	-.036	.029	-.075	-1.256	.210
FARMSIZE	.039	.032	.071	1.226	.221
HHINCOM	.006	.030	.013	.205	.837
CLIMVARINFO	.024	.029	.049	.845	.399
a. Dependent Variable: ADAPTD					

Therefore, the logistic regression model equation can be written as follows:-

Adaptd = 0.912+0.088hhhage-0.80hhhedu-0.048resgender+0.078hhyres-0.078farmexp-0.036hhsize+0.039farmsize+ 0.006hhincom+0.024climavarinfo

When we write the variable codes in full, the model appears as below: -

Adaptation = 0.912+0.088household head agee-0.80household head education level-0.048gender of the resposent+0.078 years of residence-0.078farming experience-0.036household size+0.039farmsize+ 0.006household income+0.024acess to climate *information.*

DISCUSSION

Farmers' Perception of Climate Change and Variability

Farmers in this study reported experiencing increasing temperatures and more variable rainfall, changing the onset of rainfall, drought, and floods. These observations about climate variability in Mau East are consistent with the observations by Kinyanjui *et al*. (2020) and Kiura (2021). In these studies, it was noted that there had been an overall long-term decline in rainfall amounts in Mau Forest while the temperature has been rising gradually (Kinyanjui *et al*., 2020). Kong'ani (2016) and Bartzke *et al*. (2018) also reported that droughts and floods have been increasing in frequency and severity in the Mau Forest ecosystem. Chaudhry (2015) also supports these findings and his work reported that Mau Forest has manifested an abrupt rise in the average temperatures, rainfall variability and severe frost spells.

Farmers' Response Strategies to Climate Change and Variability

For this study, eight crop production response strategies were identified. These strategies are compared to those that have been reported in other parts of the world. For example, farmers in the Punjab province of Pakistan were also found to be engaging in changing crop varieties, changing planting dates, planting shade trees, irrigation, soil conservation, crop diversification and changing fertilisers (Abid *et al*., 2015). Similarly, in the Central Rift Valley of Ethiopia, farmers also engage in planting short-season crops, soil and water conservation, tree planting and crop diversification (Belay *et al*., 2017). Nevertheless, the adoption rates for each strategy differ between the stud area and the other study areas.

Farmers in East Mau Forest engage more in early planting, the use of fertilisers and pesticides, crop diversification, and planting short-season crops. This mirrors the findings by Abid *et al.* (2015), who also reported that changing planting dates and fertiliser application are among the most common and highly adopted climate change adaptation strategies in Pakistan. One key reason why these strategies are preferred could be due to their effectiveness as well as low capital requirement. The study by Abid *et al.* (2015) also associated the higher rate of adoption of those strategies with low cost and ease of access.

In East Mau Forest, crop diversification and irrigation were among the least utilised strategies. This is in agreement with the findings of Abid *et al.* (2015) who reported that irrigation, soil conservation, crop diversification and migration to urban areas were among the least utilised strategies. Irrigation as a response strategy has been noted to be among the least utilised strategies despite its potential for alleviating the impacts of climate change and variability in most areas, especially the semi-arid areas (Downing, 1997; Alemayehu & Bewket, 2017). Traditionally, rain-fed agriculture has been the norm in East Mau Forest. However, with increased variability in weather patterns characterised by prolonged droughts and delays in rainfall onset and early cessation, irrigation might offer a lifeline to the farmers. However, the cost associated with the purchase and installation of irrigation infrastructure is high and this could be the reason why the adoption rates are low.

The result of the study shows that FACs in East Mau Forest are using the forest as an adaptation strategy. For example, the use of leafy vegetables, as well as beekeeping (in the forest) and collection of wild fruits and mushrooms, are some of the strategies that were reported. The findings from this study corroborate findings from other studies, such as Gross-Camp *et al.* (2015) and Nkem *et al*. (2010), who found that forests can act as 'safety nets' for poor households by providing goods during times of agricultural shortfalls occasioned by climate variability. However, forest access and availability of these non-timber forest products are increasingly becoming complex as competing needs such as biodiversity conservation becomes a priority among many nations.

Socioeconomic Determinants to Climate Variability Adaptation

Age of the Household Head

The results of the logistic regression model (*Table 9*) indicate that age is positively (i.e., had a positive beta coefficient (β)) and significantly related to farmers' adaptive strategies to climate variability effects. This implies that the probability of adaptation significantly increases with the age of the respondent. The regression coefficient associated with household head age is 0.088, suggesting that each one-unit increase in age is associated with a 0.088 unit increase in adaptation to climate variability. The association between age and climate variability adaptation is also statistically significant (p = 0.015) at a 5% confidence level. It can be predicted that such farmers have gathered experience as they age and are therefore more interested and or have more incentives in taking climate change adaptation measures. Perhaps

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older farmers have witnessed the negative effects of climate variability and therefore see it necessary to adapt to climate variability effects.

Moreover, these older farmers may have tried traditional ways of climate variability strategies (which might or might not have worked too well) and are now ready to depart from their indigenous knowledge and embrace novel methods (e.g., modern farming techniques) that, although unfamiliar to them are showing promise of helping them cope with the negative impacts of climate variability. This finding corroborates other studies, such as Belay *et al.* (2017), whose study in the Central Rift Valley of Ethiopia found that increase in age had a positive effect and increased the probability of farmers adapting to climate variability. Tazeze *et al*. (2012) found similar results in their study carried out in Babilie District, East Harerghe Zone of Oromia Regional State of Ethiopia. They opined that perhaps as the age of the household head increases, the person is expected to acquire more experience in weather forecasting, and that helps increase the likelihood of practising different adaptation strategies to climate change. However, some studies have found that younger farmers are more likely to adapt to climate change than older ones by sowing the newest and improved crop cultivars (Mabe *et al.*, 2014), diversifying their crops, varying their crop calendar, using cover cropping, and implementing farm insurance. Some others contend that young farmers have more initiative, are more active and take more risks in cultivating new and improved drought-resistant and early-maturing cultivars (McCarthy *et al*., 2001).

Education of the Household Head

The results of the regression model (*Table 9*) indicate that the education of the household head is negatively (i.e., had a negative beta coefficient (β)) related to farmers' adaptive strategies to climate variability effects. The regression coefficient associated with household head education is -0.080, suggesting that each one-unit increase in education is associated with a -0.080 unit decrease in adaptation to climate variability. However, the variable was not significant (i.e., p = 0.070) at a 5% confidence level. This implies that the probability of adaptation reduces, although not significantly with higher levels of education for a respondent farmer gets. This finding contradicts the popular notion that the more educated members of society are, the better informed they are of the negative impacts of climate variability and the more willing they would be to adopt innovative strategies to mitigate these impacts. For example, Deressa *et al*. (2008) in their study in the Nile Basin of Ethiopia found that the education of the head of household increases the probability of adapting to climate change. In that study, the results showed that a unit increase in the number of years of schooling would result in a 1% increase in the probability of soil conservation and a 0.6% increase in change in planting dates to adapt to climate change. Moreover, almost all the marginal values of education were positive across all adaptation options in that study, indicating the positive relationship between education and adaptation to climate change. Similar findings were reported by Belay *et al.* (2017), where they found that education had a positive effect on farmers' adaptation strategies, where a unit increase in schooling resulted in significant increases in adaptation

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options with a 1% probability level. In this study, perhaps with an increase in education, farmers find alternative (possibly higher paying) jobs or engage in other lucrative enterprises away from agriculture; hence do not embrace strategies to adapt to climate variability impacts.

Gender of the Head of Household

The gender of the household head had a negative beta coefficient (β) suggesting that it has a negative influence on the adoption of adaptation strategies by forest-adjacent communities. The regression coefficient associated with the gender of the household head is -0.048, suggesting that change in gender of the household head is associated with a 0.048 unit decrease in adaptation to climate variability. However, the association between gender and climate variability adaptation is not statistically significant (p = 0.084) at a 5% confidence level. Because the majority of households in the study area were headed by men, it implies that having a household headed by a woman would result in a decline in adaptation to climate variability. These findings are corroborated by Djoudi and Brockhaus (2011), whose study in Mali found that despite women having a high dependence on natural resources like forests and land, their control of these resources was socially and culturally restricted. Fortmann and Rocheleau (1997) opine that the lack of access to credit and land is a common obstacle experienced by women across the globe. Therefore, since access to resources necessary to adapt to climate variability is skewed towards men, then it makes sense to argue that women-headed households in such environments will have diminished capacity to adapt to climate variability.

Residence Period

The number of years that the household head lived in the study area had a positive beta coefficient (β) suggesting that it has a positive influence on the adoption of developed adaptation strategies by forest-adjacent communities. The regression coefficient associated with household head residence period is 0.078, suggesting that each one-unit increase in residence period is associated with a 0.078 unit increase in adaptation to climate variability. The association between residence period and climate variability adaptation is also statistically significant (p = 0.034) at a 5% confidence level. It is speculated that more adaptation strategies were probably developed by people who lived in the study area for a long time because of increased experience, knowledge, and gained information on adverse climate change effects. According to Ellis (2000) and Nhemachena and Hassan (2007), communities living for a long period in a certain area usually develop a large number of adaptation strategies.

Farming Experience

Longer years of farming experience are associated with increased rates of adaptation to climate variability as people have experience with weather patterns and crops that are better suited to certain conditions. The farming experience of the household head had a negative beta coefficient (β) suggesting that it has a negative influence on the adoption of adaptation strategies by forest-adjacent communities. The regression coefficient associated with household head farming

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experience is -0.078, suggesting that each one-unit increase in farming experience is associated with a 0.078-unit decrease in adaptation to climate variability. The association between farming experience and climate variability adaptation is also statistically significant (p = 0.024) at a 5% confidence level. This contradicts the findings of several studies (e.g., Mabe *et al*., 2014; Awazi & Tchamba, 2018; Khan *et al*., 2020), which found that farming experience generally increases farmers' adaptation to climate variability. Perhaps in this study, the lack of adaptation with increased farming experience could be because FACs are getting comfortable with their usual farming practices and resisting changing their "tried and tested" approaches in favour of strategies that they simply do not know.

Household Size

Large households are normally associated with an increased probability of adaptation to climate variability due to labour availability. The household size had a negative beta coefficient (β) suggesting that it has a negative influence on the adoption of adaptation strategies by forest-adjacent communities. The regression coefficient associated with the household size is -0.036, suggesting that each one-unit increase in the size of the household is associated with a 0.036 unit decrease in adaptation to climate variability. However, the association between household size and climate variability adaptation is not statistically significant (p = 0.210) at a 5% confidence level. The findings negate the popular notion that the larger the size of the household, the better the chance of adapting to climate change. These findings contradict the results by Awazi *et al*. (2018), whose study in Cameroon found that larger households have a higher propensity to adapt in the face of climate variability and change than smaller households. Results obtained in the present study differ from arguments by Hassan and Nhemachena (2008), who found that households with larger family sizes are expected to enable farmers to implement various adaptation measures.

Farm Size

Large farm sizes are normally associated with an increased probability of adaptation to climate variability due to the availability of land to plant varied crops and practice other adaptation strategies, including grazing. The farm size had a positive beta coefficient (β) suggesting that it has a positive influence on the adoption of adaptation strategies by forest-adjacent communities. The regression coefficient associated with farm size is 0.039, suggesting that each one-unit increase in the size of the household farm is associated with a 0.039-unit increase in adaptation to climate variability. However, the association between farm size and climate variability adaptation is not statistically significant (p = 0.221) at a 5% confidence level. Although not significant, the findings of this study corroborate the findings of other similar studies (e.g., Mabe *et al.*, 2014; Khan *et al*., 2020), which found that the larger the size of the household, the better the chance of adapting to climate change.

Household Income

Higher household income is usually associated with an increased probability of adaptation to climate variability due to the availability of resources. In this study, household income had a positive beta coefficient (β) suggesting that it

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has a positive influence on the adoption of adaptation strategies by forest-adjacent communities. The regression coefficient associated with monthly household income is 0.006, suggesting that each one-unit increase in household income is associated with a 0.006 unit increase in adaptation to climate variability. However, the association between household income and climate variability adaptation are not statistically significant (p = 0.837) at a 5% confidence level. Although not significant, the findings of this study corroborate the findings of other similar studies (e.g., Mabe *et al.,* 2014; Khan *et al*., 2020), who found that the higher the household income, the better the chance of adapting to climate change.

Information on Climate Change

Access to relevant information on climate variability in a regular manner is associated with increased rates of adaptation to climate variability. The level of access to climate variability-related information had a positive beta coefficient (β) suggesting that it has a positive influence on the adoption of adaptation strategies by forest-adjacent communities. The regression coefficient associated with climate information access is 0.024, suggesting that each one-unit increase in access to climate variability information is associated with a 0.024-unit increase in adaptation to climate variability. However, the association between access to climate information and climate variability adaptation is not statistically significant (p = 0.399) at a 5% confidence level. Although not significant, the findings of this study corroborate the findings of other similar studies (e.g., Mabe *et al.,* 2014; Awazi *et al*., 2018; Khan *et al*., 2020) found that the higher the access to climate information, the better the chance of adapting to climate change.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

This study was conducted so as document how forest-adjacent communities in East Mau perceive climate variability, how they adapt to it, and the factors that influence their choice of response strategies. The results show that farmers in the Eastern Mau Forest are strongly aware of the climate variability (96% of respondents were aware) and have clear opinions on changes, especially in rain patterns and the intensity of climate events. This is corroborated by studies in other parts of Africa, e.g., in the Limpopo Province of South Africa, where a large majority of respondents in three regions of Limpopo Province related changes in long-term climate patterns to increased variability and unpredictability and identified climate as a ‘‘livelihood-affecting risk’’ (Thomas *et al*., 2007).

The study findings from the logistic model fitting of select socioeconomic factors show that the age of the household head, household head years of residence, farm size, household income and access to climate information all had a positive beta coefficient (β), suggesting that they influence the adoption of adaptation strategies by forest-adjacent communities.

The analysis of rainfall and temperature around the Eastern Mau Forest block from 1997 to 2017 revealed that there had been a general increase in temperature and a decline in the amount of rainfall in the study area. These results corroborate the perceptions of FACs that

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their area was getting hotter and drier. This is important as people will usually perceive change before they can adapt.

Recommendations

Based on the results of this study, the following recommendations are made with an aim to help FACs in East Mau to be better suited to adapt to climate variability: -

Leverage the high levels of climate variability awareness among FACs in the study area by rolling out a comprehensive communication strategy that is anchored on sharing accurate and timely weather forecasts at the household level. As FACs already perceive variability in weather (such as delays in rain onset and early secessions), households will benefit from this information by planning and implementing strategies that will help them cope with these variabilities, e.g., uptake of short rotation crops or diversification of their livelihood options. This intervention can be implemented by the government (National and or devolved) or by NGOs operating in the area.

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REFERENCES

Abid, M., Scheffran, J., Schneider, U. A., & Ashfaq, M. J. E. S. D. (2015). Farmers' perceptions of and adaptation strategies to climate change and their determinants: the case of Punjab province, Pakistan. *Earth System Dynamics*, *6*(1), 225-243.

Abrams, L. (2018). Unlocking the potential of enhanced rainfed agriculture. *Stockholm: Stockholm International Water Institute*.

Alemayehu, A., & Bewket, W. (2017). Smallholder farmers' coping and adaptation strategies to climate change and variability in the central highlands of Ethiopia. *Local Environment*, *22*(7), 825-839.

Asifat Dr, J. T. (2019). Climate change awareness and its determinants in a growing city in the southwestern Nigeria using Multivariate Analysis. *Journal of Environmental Sustainability*, *7*(1), 2.

Awazi, N. P., & Tchamba, M. N. (2018). Determinants of small-scale farmers adaptation decision to climate variability and change in the North-West region of Cameroon. *African Journal of Agricultural Research*, *13*(12), 534-543.

Balama, C., Augustino, S., Eriksen, S., & Makonda, F. B. (2016). Climate change perceptions and adaptation strategies by forest-adjacent communities in Kilombero

Article DOI: https://doi.org/10.37284/eajfa.5.1.1009

district Tanzania. *Journal of Environment and Earth Science*, *6*(10), 39-53.

Baldyga, T. J., Miller, S. N., Driese, K. L., & Gichaba, C. M. (2008). Assessing land cover change in Kenya's Mau Forest region using remotely sensed data. *African Journal of Ecology*, *46*(1), 46-54.

Bartzke, G. S., Ogutu, J. O., Mukhopadhyay, S., Mtui, D., Dublin, H. T., & Piepho, H. P. (2018). Rainfall trends and variation in the Maasai Mara ecosystem and their implications for animal population and biodiversity dynamics. *PloS one*, *13*(9), e0202814.

Belay, A., Recha, J. W., Woldeamanuel, T., & Morton, J. F. (2017). Smallholder farmers' adaptation to climate change and determinants of their adaptation decisions in the Central Rift Valley of Ethiopia. *Agriculture & Food Security*, *6*(1), 1-13.

Brown, D., Chanakira, R. R., Chatiza, K., Dhliwayo, M., Dodman, D., Masiiwa, M., ... & Zvigadza, S. (2012). Climate change impacts, vulnerability and adaptation in Zimbabwe. International Institute for Environment and Development.

Chaudhry, S. (2015). The Impact of Climate Change on Human Security: The case of the Mau Forest Complex. *Development 58*(2–3), 390–398.

Davidson, D. J., Williamson, T., & Parkins, J. R. (2003). Understanding climate change risk and vulnerability in northern forest-based communities. *Canadian Journal of Forest Research*, *33*(11), 2252-2261.

Deressa, T. T., Hassan, R. M., Alemu, T., Yesuf, M., & Ringler, C. (2008). Analysing the determinants of farmers' choice of adaptation methods and perceptions of climate change in the Nile Basin of Ethiopia. IFPRI Discussion Paper 00798. Intl Food Policy Res Inst.

Djoudi, H., & Brockhaus, M. (2011). Is adaptation to climate change gender neutral? Lessons from communities dependent on livestock and forests in northern Mali. *International Forestry Review*, *13*(2), 123-135.

Downing, T. E., Ringius, L., Hulme, M., & Waughray, D. (1997). Adapting to climate change in Africa. *Mitigation and adaptation strategies for global change*, *2*(1), 19-44.

Ellis, F. (2000). Rural livelihoods and diversity in developing countries. Oxford university press.

Fortmann, L., & Rocheleau, D. (1997). Women and agroforestry: Four myths and three case studies. *Women working in the environment, ed. CE Sachs*, 193-211.

Gross-Camp, N. D., Few, R., & Martin, A. (2015). Perceptions of and adaptation to environmental change in forest-adjacent communities in three African nations. *International Forestry Review*, *17*(2), 153-164.

Habiyaremye, G., Jiwen, G., de la Paix Mupenzi, J., & Balogun, W. O. (2011). Demographic pressure impacts on forests in Rwanda. *African Journal of Agricultural Research*, *6*(19), 4533-4538.

Hassan, R. M., & Nhemachena, C. (2008). Determinants of African farmers' strategies for adapting to climate change: Multinomial choice analysis. *African Journal of Agricultural and Resource Economics*, *2*(311-2016-5521), 83-104.s

IPCC (2014): *Summary for Policymakers*. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 32pp.

Khan, I., Lei, H., Shah, I. A., Ali, I., Khan, I., Muhammad, I., ... & Javed, T. (2020). Farm households' risk perception, attitude and adaptation strategies in dealing with climate change: promise and perils from rural Pakistan. *Land use policy*, *91*, 104395.

Kibue, G. W., Liu, X., Zheng, J., Pan, G., Li, L., & Han, X. (2016). Farmers' Perceptions of Climate Variability and Factors Influencing Adaptation: Evidence from Anhui and Jiangsu, China. *Environmental Management*, 1-11.

Kinyanjui, J. M., Mburu, D. M., & Kigomo, M. K. (2020). Trend and Variability in Interannual Air Temperature Over South West Mau Forest, 1985-2015. *Journal of Natural Sciences Research, 11*(6), 29-34.

Kiura, K. M. (2021). *Carbon Sequestration Dynamics and its Implication on Climate Variability in the South West Mau Forest, Kenya* (Doctoral dissertation, JKUAT-AGRICULTURE).

Kogo, B. K., Kumar, L., & Koech, R. (2021). Climate change and variability in Kenya: a review of impacts on agriculture and food security. *Environment, Development and Sustainability*, *23*(1), 23-43.

Kong'ani, L. (2016). *Relationship between community livelihood options and climate change knowledge and practices: a case study of Maasai Mau forest, Narok County, Kenya* (Doctoral dissertation, University of Nairobi).

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and psychological measurement*, *30*(3), 607-610.

Kundu, P. M. (2007). Application of Remote Sensing and GIS Techniques to Evaluate the Impact of Land Use Cover Change on Stream flows: The case of River Njoro in Eastern Mau- Kenya. *PhD Thesis, Egerton University, Kenya.*

Langat, D. K., Maranga, E. K., Aboud, A. A., & Cheboiwo, J. K. (2016). Role of Forest Resources to Local Livelihoods: The Case of East Mau Forest Ecosystem, Kenya. *International Journal of Forestry Research.*

Lee, T. M., Markowitz, E. M., Howe, P. D., Ko, C. Y., & Leiserowitz, A. A. (2015). Predictors of public climate change awareness and risk perception around the world. *Nature climate change*, *5*(11), 1014-1020.

Article DOI: https://doi.org/10.37284/eajfa.5.1.1009

Mabe, F. N., Sienso, G., & Donkoh, S. A. (2014). Determinants of choice of climate change adaptation strategies in Northern Ghana. *Research in Applied Economics*, *6* (4), 75-94.

Maddison, D. J. (2007). *The perception of and adaptation to climate change in Africa*. World Bank working paper 4308. Washington, DC: World Bank.

Mairura, F. S., Musafiri, C. M., Kiboi, M. N., Macharia, J. M., Ng'etich, O. K., Shisanya, C. A., ... & Ngetich, F. K. (2021). Determinants of farmers' perceptions of climate variability, mitigation, and adaptation strategies in the central highlands of Kenya. *Weather and Climate Extremes*, *34*, 100374.

McCarthy, J. J. (2001). Climate change 2001: impacts, adaptation, and vulnerability: contribution of Working Group II to the third assessment report of the Intergovernmental Panel on Climate Change: Cambridge University Press.

Myers, N. (1990). The world's forests and human populations: The environmental interconnections. *Population and Development Review,* 16, 237-251.

Negi, V. S., Maikhuri, R. K., Pharswan, D., Thakur, S., & Dhyani, P. P. (2017). Climate change impact in the Western Himalaya: people's perception and adaptive strategies. *Journal of Mountain Science*, *14*(2), 403-416.

Nhemachena, C., & Hassan, R. (2007). Micro-level analysis of farmers adaption to climate change in Southern Africa. Intl Food Policy Res Inst.

Nkem, J., Kalame, F. B., Idinoba, M., Somorin, O. A., Ndoye, O., & Awono, A. (2010). Shaping forest safety nets with markets: adaptation to climate change under changing roles of tropical forests in Congo Basin. *environmental science & policy*, *13*(6), 498-508

Ochieng, M. A., & Koske, J. (2013). The level of climate change awareness and perception among primary school teachers in Kisumu municipality, Kenya. *International Journal of Humanities and Social Science*, *3*(21), 174-179.

Olang, L. O., & Kundu, P. M. (2011). Land degradation of the Mau Forest complex in Eastern Africa: a review for management and restoration planning. In Ema Ekundayo (ed) *Environmental Monitoring, 15*, 245-262.

Ouko, C. A., Mulwa, R., Kibugi, R., Owuor, M. A., Zaehringer, J. G., & Oguge, N. O. (2018). Community perceptions of ecosystem services and the management of Mt. Marsabit Forest in Northern Kenya. *Environments*, *5*(11), 121.

Serdeczny, O., Adams, S., Baarsch, F., Coumou, D., Robinson, A., Hare, W., ... & Reinhardt, J. (2017). Climate change impacts in Sub-Saharan Africa: from physical changes to their social repercussions. *Regional Environmental Change*, *17*(6), 1585-1600.

Sombroek, W. G., Braun, H. M. H., & Van der Pouw, B. J. A. (1980). "The Exploratory soil map and agro-climatic map of Kenya," Report E 1, Kenya Soil Survey, Nairobi, Kenya

Article DOI: https://doi.org/10.37284/eajfa.5.1.1009

Somorin, O. A. (2010). Climate impacts, forest-dependent rural livelihoods and adaptation strategies in Africa: A review. *African Journal of Environmental Science and Technology*, *4*(13), 903-912.

Tazeze, A., Haji, J., & Ketema, M. (2012). Climate change adaptation strategies of smallholder farmers: the case of Babilie District, East Harerghe Zone of Oromia Regional State of Ethiopia. *Journal of Economics and Sustainable Development*, *3*(14), 1-12.

Thomas, D. S., Twyman, C., Osbahr, H., & Hewitson, B. (2007). Adaptation to climate change and variability: farmer responses to intra-seasonal precipitation trends in South Africa. *Climatic change*, *83*(3), 301-322.

U.S. Census Bureau (2018). Census and Survey Processing System (CSPro). https://www.census.gov/data/software/cspro.html.Accessed August 2018.

World Bank (2021). Climate Risk Profile: Kenya. Accessed October 2022 from https://climateknowledgeportal.worldbank.org/sites/default/files/2021-05/15724-WB_Kenya%20Country%20Profile-WEB.pdf