Gendered Livelihood Vulnerability to Climate Change in Makueni County, Kenya

VIRGINIA KAVUU MUIA[1,2,*], ALFRED OWUOR OPERE[2] AND DOROTHY AKINYI AMWATA[3]

[1]*Department of Environmental Studies and Resources Development, Chuka University. P.O Box, 109-60400, Chuka, Kenya*

[2]*Institute for Climate Change and Adaptation, University of Nairobi. P.O Box, 30197-00100, Nairobi, Kenya*

[3]*School of Agriculture and Environmental Sciences, Murang'a University of Technology. P.O. Box 75-10200, Murang'a, Kenya*

E-mail: vkavuu@chuka.ac.ke, aopere@uonbi.ac.ke, damwata@mut.ac.ke

[*] **Corresponding author**

ABSTRACT

Climate change is not gender neutral as its effects are not felt equally by men and women. Existing gender disparities result into gender differentiated vulnerabilities which in turn result into gender differentiated impacts. The goal of this study was to evaluate the susceptibility of livelihoods to climate change in the arid and semi-arid regions of Makueni county, Kenya based on gender. A semi-structured questionnaire was utilized to obtain cross-sectional primary data from 400 household heads selected using multi stage random sampling. The Kenya Meteorological Department provided rainfall and temperature data. The data was analyzed using two livelihood vulnerability indices: the composite Livelihood Vulnerability Index (LVI) and the Intergovernmental Panel for Climate Change (LVI-IPCC) vulnerability index. The results revealed gendered disparities in livelihood vulnerability to climate change. According to the composite livelihood vulnerability index (LVI), women in Makueni county are more vulnerable to climate change (LVI women: 0.296, LVI men: 0.275). Women exhibited higher vulnerability in six out of the seven major components considered: natural disasters and climate variability (women: 0.375, men: 0.358), livelihood strategies (women: 0.363, men: 0.319), water (women: 0.342, men: 0.317), food (women: 0.295, men: 0.276), social networks (women: 0.274, men: 0.247), and socio-demographic profile (women: 0.170, men: 0.127). According to the LVI-IPCC approach, women and men exhibited similar degrees of vulnerability (men: 0.038, women: 0.034), but there were significant differences in the vulnerability contributing factors, with women exhibiting higher vulnerability in all three vulnerability factors: exposure (women: 0.375, men: 0.358), sensitivity (women: 0.290, men: 0.278) and adaptive capacity (women: 0.259, men: 0.221). The study recommends adoption of gender-responsive climate change policies in order to address gender-based discrimination, impediments and inequities that increase men's and women's vulnerability.

Key words: Climate change, Gender, Livelihood, Vulnerability, Kenya

INTRODUCTION

Climate change is seen as the defining issue of the twenty first century, with human activity arguably responsible for a 1.0°C rise in global temperature beyond pre-industrial levels (Anonymous 2019a). This warming is projected to endure for decades to millennia as a result of rising anthropogenic greenhouse gas emissions. Climate change effects, such as heat waves, increased precipitation, floods, drought, wild fires, and cyclones are becoming more visible in all parts of the world (Anonymous 2020b). Nonetheless, these effects are not evenly distributed, but rather differentiated based on geographical, political, economic, social, and cultural disparities, which often shape vulnerability to climate change. Anonymous (2022a) defines vulnerability as "conditions dictated by physical, social, economic and environmental processes that influence an individual's, community's, or system's susceptibility to the effects of hazards". Hertel and Rosch (2010) synthesized this notion, arguing that vulnerability to climate change is dynamic, localized, and emerges along gender, socioeconomic and poverty lines. Men and women face climate change consequences differently because of disparities in their conventional roles, cultural expectations, and livelihoods. Understanding gender characteristics is thus a critical prerequisite for sustainable climate change interventions.

Climate change disproportionately affects women, who account for more than half of the world's population (Alam et al. 2015). They constitute majority of the world's poor and bear the brunt of the consequences of climate change, which exacerbates existing gender disparities and puts their livelihoods, health, and safety at risk (Anonymous 2010, 2022a). Women are thought to be more susceptible to the effects of climate change for a variety of reasons. First of all, they have limited access to and control over resources (Khadka et al. 2022, Anonymous 2023a). Gender-based constraints to land, social capital, financial resources and technology make it more difficult for women to adapt to climate change (Mujere 2015, Anonymous 2019b). Second, women have less education and limited access to information. High illiteracy levels prevent women from securing decent jobs, government funding and other opportunities which when compounded by discriminatory laws and gender norms increase their vulnerability to climate change (Anonymous 2022b). Third, women have restricted mobility. They not only lack the economic and social resources that would allow them to relocate, but they also confront cultural and religious limitations that impede their mobility during disasters (Anonymous 2014). Fourthly, women are socially excluded from decision-making processes, leaving them marginalized and more susceptible to the effects of climate change (Maharjan et al. 2012, Dhungana 2014, Anonymous 2023b). These and other factors such as poverty, political hurdles and gender discriminatory roles render women more vulnerable to climate change (Anonymous 2013).

In Africa, women are on the frontline confronting the threats that climate change poses to their families' health and way of life. However, they are ill-equipped and under-resourced to make the necessary adjustments to cope with climate change (Anonymous 2011). Several studies show that the effects of climate change are felt more strongly by rural people, the majority of whom are women (Bradshaw 2010, Nyasimi et al. 2018). In Kenya, patriarchal conventions that assign gender roles give women a greater share of the burden of caring for the home. As primary caregivers, their responsibilities include fetching water and firewood, obtaining food, tending to the sick, children and elderly, and engaging in agricultural work for sustenance. Besides, women have additional impediments to knowledge, technology, decision making, and access to financial services and markets, all of which contribute to their increased vulnerability to disasters (Anonymous 2020a). Although debates on gender usually centre on how women are more susceptible to the effects of climate change, men have unique vulnerabilities that should be considered in climate change initiatives. The difficulties posed by climate change in Africa have been the subject of several research studies; yet, the connection between gender and climate change is still largely unexplored. With little, inconsistent, and patchy empirical evidence, the topic is still substantially unexplored. This study, thus aimed at closing this research gap by investigating how gender influences climate change vulnerability in Makueni County, Kenya.

METHODOLOGY

Study area description
Makueni county, which is primarily inhabited by the Akamba peoples of Kenya, is located in Kenya's lower eastern region and spans an area of 8,034.7 km^2. The county lies between 259 and 2138 m above sea level and is divided into four distinct areas: the undulating and extremely steep Kilungu, Kilome and Mbooni uplands to the northwest, the vast open plains with gently sloping terrain extending to the south-east from Kilome's foothills, Kibwezi bottomlands bounded by the Chyulu Hills mountain range to the southwest and the Yatta linear plateau to the northeast. The county has a population of 987, 653 persons, which is rising at an annual rate of 1.4%. The average household size is 4.0 members. Women make up 51% of the population. The bottom of the county's demographic pyramid is heavily populated (44% of the population is under the age of 15). Absolute poverty affects 34% of the population. The county's illiteracy rate is low, at 22%. Agriculture is the county's most important economic activity accounting for 78% of the county's Gross Domestic Product. Firewood is the primary source of energy for cooking, with 78% of the population relying on it (Anonymous 2019c,d).
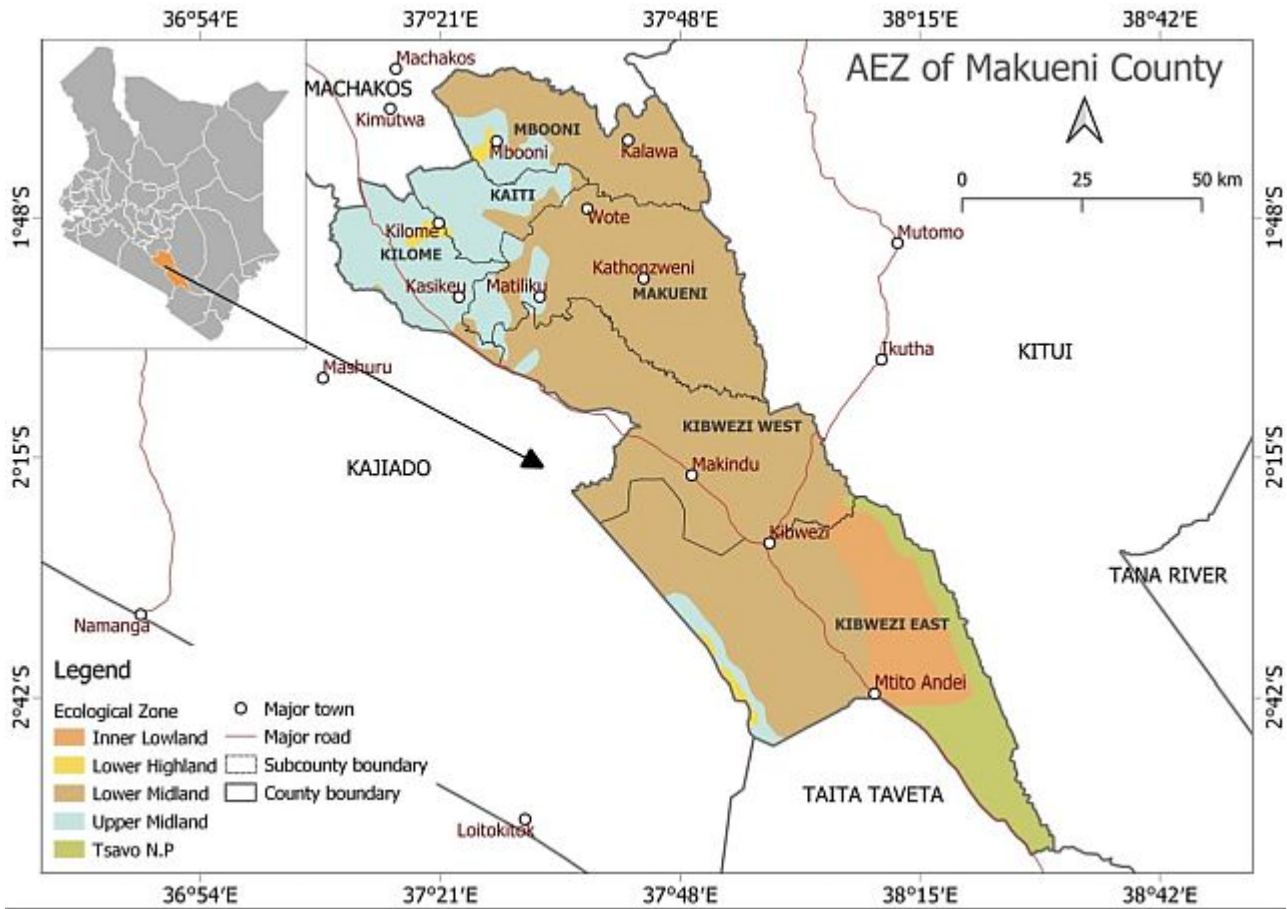
Figure 1. Study area

Sampling procedure

The proportion of the population who took part in this study was determined using the Yamane (1967) formula:

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

Where, N = target population, e = precision level (0.05), n = sample size

In substitution:

$$n = \frac{244,669}{1+244,669\,(0.05)^2} = 399.34$$

$$= 400$$

To identify the households that took part in this study, the area was first divided into clusters that represented the nine sub counties in Makueni County. Multistage random sampling was then used to identify the villages and households who participated in this study. Table 1 displays the number of households from each sub-county that took part in the study. The numbers were computed based on the total number of households in each sub-county.

Data collection

Questionnaires were used to collect cross-sectional primary data for this study. The pre-tested semi-structured questionnaire was administered to a population sample of 400 household heads who

Table 1. Survey participants per sub-county

Sub-county	Number of households	Sample size (households)
Kathonzweni	18,365	30
Nzaui	30,819	50
Kilungu	14,586	24
Mukaa	28,185	46
Makindu	21,756	36
Makueni	34,479	56
Mbooni East	23,734	39
Mbooni West	24,833	41
Kibwezi	47,912	78
Total	**244,669**	**400**

provided information on vulnerability to climate change. The Kenya Meteorological Department provided rainfall and temperature data.

Data analysis

Data analysis was done using two livelihood vulnerability indices: the composite Livelihood Vulnerability Index (LVI) and the Intergovernmental Panel for Climate Change (LVI-IPCC) vulnerability index.

Livelihood vulnerability index – Composite index approach

The LVI has seven major components which include health, food, water, climate variability and natural disasters, social networks, livelihood strategies and socio-demographic profile. Each of these major components is composed of a number of sub-components. Despite the fact that each primary component has a variable number of sub-components, a balanced weighted average approach is utilized to ensure that each sub-component contributes equally to the overall index. Because each sub component is assessed on a distinct scale, standardization must first be performed in order to generate an index for each of them. The following equation was used for standardization in this study:

$$Index_{s_g} = \frac{S_g - S_{min}}{S_{max} - S_{min}} \qquad (2)$$

Where s_g is the sub-component for gender g, and S_{min} and S_{max} are the minimum and maximum values derived using data from both gender categories, respectively. The minimum and maximum values for variables that measure frequencies, such as percentage, were set to 0 and 100, respectively. The sub-components were averaged standardization using equation (3) to find the value of each major component.

$$M_g = \frac{\sum_{i=1}^{n} index_{s_{g}i}}{n} \qquad (3)$$

Where M_g is one of the seven major components for gender (g), $index_{s_{g}i}$ is the sub-components that make up each main component indexed by i, and n is the number of sub-components in each main component. After determining the values for each

of the seven main components for gender, they were averaged using equation (4) to generate the overall LVI score for gender.

$$LVI_g = \frac{\sum_{i=1}^{7} W_{M_i} M_{gi}}{\sum_{i=1}^{7} W_{M_i}} \qquad (4)$$

Where LVI_g, the Livelihood Vulnerability Index for gender g is the weighted average of the seven major components. The number of sub-components that make up each main component determines the weights of each major component W_{M_i}. This study adopts Hahn et al. (2009), scale which ranges from 0 (least vulnerable) to 0.5 (most vulnerable). Table 2 lists all the major components as well as the sub-components that comprise each major component.

LVI-IPCC framework approach

The LVI-IPCC approach which groups the LVI's seven primary components into three vulnerability contributory factors i.e., exposure, sensitivity and adaptive capacity, as shown in table 3, was also used to determine gendered livelihood vulnerability to climate change in Makueni County. The LVI-IPCC calculation uses the same equations (2), (3), and (4) as the LVI calculation. However, under the LVI-IPCC technique, the primary components of the LVI are not combined into the LVI in one step as they are in the composite LVI approach; rather, they are first combined into the LVI using the following equation:

$$CF_g = \frac{\sum_{i=1}^{n} W_{M_i} M_{g_i}}{\sum_{i=1}^{n} W_{M_i}} \qquad (5)$$

Where CF_g is an IPCC defined vulnerability contributory factor for gender g, M_{g_i} is the main component for gender g indexed by i, W_{M_i} is the weight of each major component and n, is the total number of major components in each IPCC contributory factor. After determining exposure, sensitivity and adaptive capacity, the LVI-IPCC is calculated by integrating the three vulnerability contributory factors using the following equation:

$$LVI - IPCC_g = (e_g - a_g) * s_g \qquad (6)$$

Where $LVI - IPCC_g$ represents the Livelihood Vulnerability Index for gender g, e represents the calculated exposure score for gender g, a represents

Table 2. LVI major components and sub-components

Major/Sub-components	Explanatory notes for sub-components	Units	Data source
Socio-demographic profile			
Dependency ratio	Ratio of people aged 15 to 64 years old (inactive population) to people aged 15 to 64 years old (active population)	Ratio	Survey
Proportion of male/female headed households	If a male household head is absent for more than six months, the female is considered the head of the household.	Percent	Survey
Average age of male/female head of household	Household heads' average age	1/Years	Survey
The proportion of households where the head of the household has not attended school	Percentage of households where the head of the household reports having attended 0 years of school	Percent	Survey
The proportion of households with orphans	The proportion of households with at least one orphan under the age of 18 whose one or both parents have died.	Percent	Survey
Livelihood strategies			
The proportion of households in which no family member works in a different community.	Percentage of households where no family member works and earns a living outside of their community Question is modified to give a positive vulnerability score when a household doesn't have a member working outside the community	Percent	Survey
Percentage of households whose sole source of income is agriculture	Percentage of households reporting agriculture as their sole source of income	Percent	Survey
Average agricultural livelihood diversification index	The inverse of (the number of agricultural livelihood activities reported by a household +1) The livelihood activities considered in this study included crop farming, animal rearing and collecting of natural resources for sale	1/# Livelihoods	Survey
Social networks			
Average receive : Give ratio	The ratio of (the number of types of help received by a household in the previous month +1) to (the number of types of help given to someone else by a household in the previous month +1)	Ratio	Survey
Average borrow : Lend money ratio	The ratio of a household borrowing money in the previous month to a household lending money in the previous month	Ratio	Survey
Percentage of households that sought assistance from their local government in the previous 12 months	The percentage of households who reported seeking help from their local government. Question is modified to give a positive vulnerability score when a household seeks help as seeking help is seen as a sign of helplessness which signifies vulnerability	Percent	Survey
Health			
Average time to health facility on foot	The average time it takes households to walk to the nearest health facility.	Minutes	Survey
Percentage of households with a chronically ill family member	Percentage of households with at least one chronically ill member	Percent	Survey
Percentage of households in which a family member missed work or school in the previous two weeks	The percentage of households where a member missed work or school in the previous two weeks due to illness.	Percent	Survey

Major/Sub-components	Explanatory notes for sub-components	Units	Data source
Average Malaria Exposure *Prevention Index	Months of malaria exposure*owning at least one bed net (with bed net = 0.5, without bed net = 1) due to illness	Months* Bed net Indicator	Survey
Food			
Percentage of households relying solely on family farm for food	Percentage of households who solely rely on their family farm for food	Percent	Survey
Average number of months households struggle to find food	Average number of months in a year households struggle with food shortage	Months	Survey
Average Crop Diversity Index	The inverse of (a household's number of crops grown +1)	1/#Crops	Survey
Percentage of households that do not save crops	Percentage of households that do not save crops from their harvest	Percent	Survey
Percentage of households that do not save seeds	Percentage of households that do not save seeds for future seasons	Percent	Survey
Water			
Percentage of households reporting a water conflict	Percentage of households reporting the occurrence of water conflicts in their community	Percent	Survey
Percentage of households that use a natural water source	The proportion of households that get their water from natural sources such as rivers, streams, and traditional river wells.	Percent	Survey
Average time to water source on foot	Average time households take to reach their primary water source on foot	Minutes	Survey
Percentage of households without a reliable water supply	Percentage of households reporting that water is not available at their primary water source every day	Percent	Survey
Inverse of the average amount of water stored per household.	The inverse of (the average number of litres of water stored by each household+1)	1/Litres	Survey
Natural disasters and climate variability			
Average number of floods, drought and windstorms in the past six years	Total number of droughts, floods and wind storms reported by households in the past six years	Count	Survey
Percentage of households that did not receive a warning about impending natural disasters	Percentage of households who did not receive any prior warning about imminent natural disasters in the past six years	Percent	Survey
Percentage of households affected by recent natural disasters in terms of injury or death	The proportion of households reporting a natural disaster-related death or injury in the previous six years.	Percent	Survey
Mean standard deviation of monthly average of average maximum daily temperatures (last six years)	The standard deviation of the average daily maximum temperature by month between 2015 and 2020	Celsius	Kenya Meteorological Department
Mean standard deviation of monthly average of average minimum daily temperatures (last six years)	The standard deviation of the average daily minimum temperature by month between 2015 and 2020	Celsius	Kenya Meteorological Department
Mean standard deviation of monthly average precipitation (last six years)	The standard deviation of the average monthly precipitation between 2015 and 2020	Millimeters	Kenya Meteorological Department

Table 3. LVI-IPCC vulnerability contributory factors

Vulnerability contributing factors	Main components
Sensitivity	Food, Health, Water
Exposure	Natural disasters and climate variability
Adaptive capacity	Socio-demographic profile, Social networks, Livelihood strategies

the estimated adaptive capacity score for gender g, and represents the sensitivity score for gender g. This study adopted the LVI-IPCC scale developed by Hahn et al. (2009), which ranges from -1 (least vulnerable) to 1 (most vulnerable).

RESULTS

Demographic profile of the respondents
The respondents for this study were 400 farmer households in Makueni County of which 67.83% were male and 32.17% were female. Male respondents' mean years of education was 11.40±3.81 years, while female respondents' mean years of education were 10.31±4.36 years. The mean of the Natural Logarithm for male household head income was 9.29±0.79, while that of female household head income was 8.97±0.87. Male headed households had a mean household size of 5.34±2.05 persons and female headed households had a mean household size of 4.86±1.8 persons. Male headed households had an average of 5.31±5.04 acres of land, while female headed households owned an average of 4.87±5.23 acres.

LVI - The Composite Index Approach
The whole area (Makueni County)
Table 5 documents the gendered livelihood vulnerability analysis results for Makueni county. According to the results, female headed households in the county are more vulnerable to climate change impacts (LVI: 0.296) than male headed households (LVI: 0.275). An analysis of the major LVI components revealed that female headed households were more vulnerable in six out of the total seven major components, including socio-demographic profile, livelihood strategies, social networks, food, water, and natural disasters and climate variability. Similarly, female headed households exhibited a higher vulnerability in majority of the LVI sub-components. The findings also revealed that vulnerability in both male and female headed households was majorly influenced by three factors, namely natural disasters and climate variability (female: 0.375 and male: 0.358), livelihood strategies (female: 0.363 and male: 0.319) and water availability (female: 0.342 and male: 0.317).

When the LVI scores were plotted on a vulnerability spider diagram, the results were as displayed in Figure 2. The diagram shows that, with the exception of health, female headed households were more vulnerable in all main components. In addition, both male and female headed households were significantly vulnerable in terms of livelihood strategies, natural disasters and climate variability, water and food main components.

Makueni County Sub-counties
When the results were reviewed by sub-county, several differences in susceptibility between male and female headed households were observed (Tables

Table 4. Demographic profile of survey participants

Variable	Gender	Mean	Std. Dev.	Min	Max
Age	Male	50.39	13.03	26	89
	Female	48.45	12.94	23	73
Education years	Male	11.40	3.81	0	26
	Female	10.31	4.36	0	18
Household head income (Natural Logarithm)	Male	9.29	0.79	6.91	11.92
	Female	8.97	0.87	6.21	11.29
Household size	Male	5.34	2.05	1	16
	Female	4.86	1.8	1	10
Size of land (acres)	Male	5.31	5.04	0	30
	Female	4.87	5.23	0	25

Table 5. Gendered livelihood vulnerability Rresults for Makueni County

Major/Sub-components	Maximum value in all sub-counties	Minimum value in all sub-counties	Sub-component scores		Major component scores		Over-allLIV scores	
			Males	Females	Males	Females	Males	Females
Socio-demographic profile								
Dependency ratio	7	0	0.122	0.141	0.127	0.170	0.275	0.296
Average age of household head	0.043	0.014	0.241	0.276				
The proportion of households where the head has not attended the school	100	0	0.007	0.039				
The proportion of households with orphans	100	0	0.136	0.255				
Livelihood strategies								
The proportion of households in which no family member works in a different community.	100	0	0.321	0.426	0.319	0.363		
Percentage of households whose sole source of income is agriculture	100	0	0.476	0.543				
Average agricultural livelihood diversification index	0.5	0.25	0.160	0.120				
Social networks								
Average receive : Give ratio	7	0.25	0.169	0.163	0.247	0.274		
Average borrow : Lend money ratio	2	0.5	0.413	0.467				
Percentage of households that sought assistance from their local government in the previous 12 months	100	0	0.159	0.194				
Health								
Average time to health facility on foot	390	3	0.188	0.143	0.230	0.217		
Percentage of households with a chronically ill family member	100	0	0.368	0.349				
Percentage of households in which a family member missed work or school in the previous two weeks due to illness	100	0	0.246	0.209				
Average Malaria Exposure *Prevention Index	5	0.5	0.120	0.169				
Food								
Percentage of households relying solely on family farm for food	100	0	0.776	0.806	0.276	0.295		
Average number of months households struggle to find food	12	0	0.217	0.225				

| Major/Sub-components	Maximum value in all sub-counties	Minimum value in all sub-counties	Sub-component scores		Major component scores		Over-all LIV scores	
			Males	Females	Males	Females	Males	Females
Average Crop Diversity Index	1	0.07	0.065	0.086				
Percentage of households that do not save crops	100	0	0.111	0.132				
Percentage of households that do not save seeds	100	0	0.214	0.225				
Water								
Percentage of households reporting a water conflict	100	0	0.458	0.519	0.317	0.342		
Percentage of households that use a natural water source	100	0	0.565	0.643				
Average time to water source on foot	390	0	0.169	0.124				
Percentage of households without a reliable water supply	100	0	0.185	0.225				
Inverse of the average amount of water stored per household.	0.075	0.0003	0.210	0.197				
Natural disasters and climate variability								
Average number of floods, drought and windstorms in the past six years	8	0	0.310	0.371	0.358	0.375		
Percentage of households that did not receive a warning about impending natural disasters	100	0	0.428	0.473				
Percentage of households affected by recent natural disasters in terms of injury or death	100	0	0.048	0.047				
Mean standard deviation of monthly average of average maximum daily temperatures (last six years)	3.28	1.41	0.299	0.299				
Mean standard deviation of monthly average of average minimum daily temperatures (last six years)	1.57	0.77	0.588	0.588				
Mean standard deviation of monthly average precipitation (last six years)	8.78	0.37	0.472	0.472				
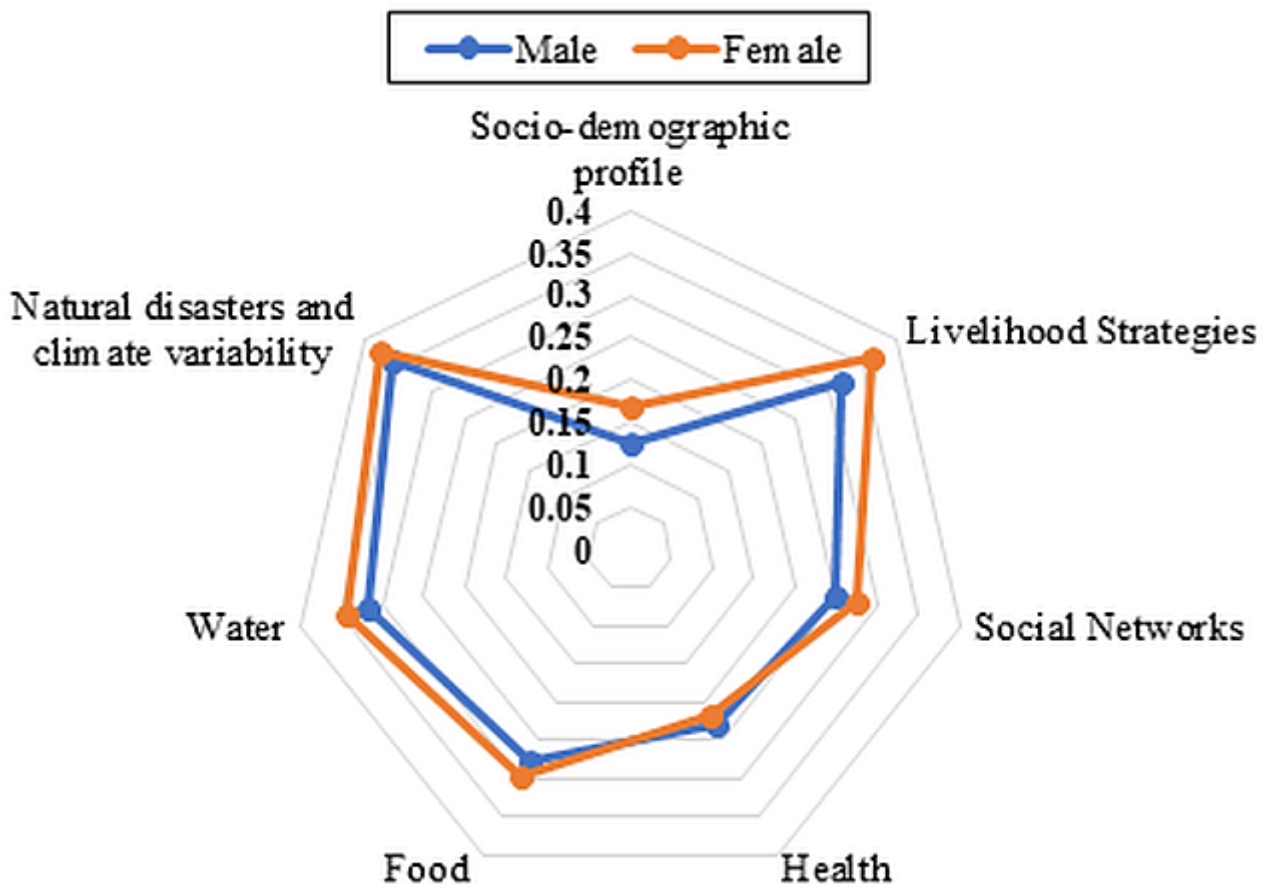
Figure 2: Vulnerability spider diagram of LVI major component scores for male and female house-
holds in Makueni County

6 and 7). In Kathonzweni sub-county, households headed by women were more vulnerable than those headed by men (0.271 versus 0.254). Women's vulnerability was highest in the livelihood strategies main component (0.489), whilst men's vulnerability was highest in the social networks' main component (0.487). Both groups exhibited lowest vulnerability levels in the socio-demographic profile (male: 0.084 and female: 0.124). In Nzaui sub-county, the overall livelihood vulnerability index for women was higher than that of men (0.289 versus 0.277). Both groups were most vulnerable in the social networks' main component (male: 0.462 and female: 0.482) and least vulnerable in the socio-demographic profile component (male: 0.111 and female: 0.090). In Kilungu sub-county, both male and female headed households exhibited similar levels of vulnerability (male: 0.286 and female: 0.285). Vulnerability in men was highest in the livelihood strategies main

component (0.445), while that of women was highest in the social networks' main component (0.515). Both groups had low levels of vulnerability in socio-demographic profile (male:0.122 and female:0.123). In Mukaa sub-county, men and women showed comparable degrees of vulnerability (0.310). However, male headed households were most vulnerable in the social networks' main component (0.479) and women in water main component (0.411). Both groups were least vulnerable in the socio-demographic profile (male: 0.122 and female: 0.140). In Makindu sub-county, men were more vulnerable than women (0.290 compared to 0.281). Vulnerability among male headed households was highest in the social networks' main component (0.517), while that of female headed households was highest in the livelihood strategies main component (0.555). Vulnerability among the two groups was lowest in the socio-demographic profile main

component (male: 0.053 and female: 0.067).

In Makueni sub-county, both male and female headed households had comparable levels of vulnerability (LVI: 0.286). Additionally, both groups recorded highest levels of vulnerability in the livelihood strategies main component (male: 0.464 and female: 0.529) and lowest levels of vulnerability in the socio-demographic profile component (male: 0.122 and female: 0.135). In Mbooni East sub-county, households headed by women were more vulnerable to climate change than those headed by men (0.320 against 0.302). Both groups recorded highest vulnerabilities in the social networks' main component (male: 0.509 and female: 0.451). Men were least vulnerable in the socio-demographic main component (0.135), and women were least vulnerable in the health main component (0.143). In Mbooni West sub-county, both men and women exhibited similar degrees of livelihood vulnerability with men being somewhat more vulnerable (male: 0.307 and female: 0.300). In both groups, vulnerability was highest in the social networks' main component (male:0.473 and female:0.492) and lowest in the health main component (male: 0.129 and female: 0.179). In Kibwezi sub-county, male headed households were more vulnerable (0.329) than female headed households (0.315). In this sub-county, both men and women exhibited highest levels of vulnerability in the social networks' main component (male: 0.537 and female: 0.432). Male headed households were least vulnerable in the socio-demographic main component (0.151) while female headed households were least vulnerable in the health main component (0.182).

The LVI-IPCC approach
The whole area (Makueni County)
Table 8 summarizes the gendered analysis results from the LVI-IPCC model. Although the results do not indicate a substantial difference in overall livelihood vulnerability between male and female headed households (male: 0.038, female: 0.034), distinct disparities are observed in the LVI-IPCC vulnerability contributory factors with female headed households exhibiting greater vulnerability in all three factors (Exposure – female: 0.375 and male: 0.358; Sensitivity – female: 0.290 and male: 0.278; Adaptive capacity – female: 0.259 and male: 0.221).

The gendered LVI-IPCC scores were further plotted on a vulnerability triangle and the results are shown in figure 3. The figure portrays a society in which female headed households are more vulnerable in all three indicators of livelihood vulnerability. It is also worth noting that the adaptive capacity indicator revealed a considerable vulnerability disparity between male and female headed households.

Makueni County Sub-counties
Table 9 documents results for the gendered LVI-IPCC scores for households in the nine sub-counties in Makueni County. According to the results, male headed households in Kathonzweni sub-county exhibited higher vulnerability to climate change than female headed households (male: -0.012 and female: -0.026). Female headed households in this sub county were, however, more sensitive (0.236 versus 0.203) and highly vulnerable in their capacity to adapt to climate change (female: 0.341, male: 0.322). In Nzaui sub-county, male headed households were more vulnerable to climate change (0.006 versus -0.008). Although both men and women in this sub-county had a comparable degree of adaptive capacity (male: 0.310 and female: 0.311), men were more exposed (0.337 versus 0.280) and women more sensitive to climate change (0.277 compared to 0.228). In Kilungu sub-county, the results indicated greater vulnerability in households headed by men (0.008 versus 0.001). Though the differences between male and female headed households with regards to adaptive capacity (male: 0.311 and female: 0.316) and sensitivity (male: 0.243 and female: 0.249) in this sub county were negligible, the male headed households were more exposed to climate change (0.345 versus 0.319). In Mukaa sub-county, both groups exhibited similar degrees of vulnerability (male: 0.016, female: 0.013). Nonetheless, a significant difference was observed in their levels of exposure as male headed households recorded a higher exposure (0.350 versus 0.334).

In Makindu sub-county, households headed by men were more vulnerable (-0.005 versus -0.020). Additionally, they were more exposed (0.301 versus 0.253), and more sensitive to climate change impacts (0.264 against 0.258). In Makueni sub-county, households headed by women were more vulnerable to climate change (-0.008 compared to -0.013).

Table 6. Gendered LVI sub-component scores for households in Makueni County sub-counties

Major/Sub-components	Max value	Min value	Kathonzweni M	Kathonzweni F	Nzaui M	Nzaui F	Kilungu M	Kilungu F	Mukaa M	Mukaa F	Makindu M	Makindu F	Makueni M	Makueni F	Mbooni East M	Mbooni East F	Mbooni West M	Mbooni West F	Kibwezi M	Kibwezi F
Socio-demographic profile																				
Dependency ratio	7	0	0.075	0.051	0.140	0.155	0.187	0.091	0.138	0.152	0.091	0.063	0.083	0.100	0.093	0.153	0.113	0.161	0.149	0.207
Average age of household head	0.043	0.014	0.103	0.172	0.276	0.207	0.241	0.241	0.207	0.241	0.138	0.207	0.276	0.276	0.448	0.448	0.345	0.345	0.241	0.241
The proportion of households where the head has not attended the school	100	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.100	0.080	0.000	0.000	0.115
The proportion of households with orphans	100	0	0.158	0.273	0.027	0.000	0.059	0.125	0.143	0.167	0.179	0.250	0.111	0.182	0.000	0.100	0.200	0.250	0.212	0.539
Livelihood strategies																				
The proportion of households in which no family member works in a different community.	100	0	0.737	0.750	0.568	0.600	0.765	0.511	0.500	0.667	0.893	1.000	0.800	1.000	0.278	0.600	0.560	0.563	0.481	0.634
Percentage of households whose sole source of income is agriculture	100	0	0.684	0.636	0.541	0.500	0.529	0.571	0.464	0.500	0.500	0.625	0.511	0.546	0.556	0.400	0.360	0.500	0.558	0.192
Average agricultural livelihood diversification index	0.5	0.25	0.000	0.080	0.160	0.200	0.040	0.040	0.080	0.040	0.040	0.040	0.080	0.040	0.280	0.320	0.320	0.240	0.240	0.400
Social networks																				
Average receive : Give ratio	7	0.25	0.159	0.145	0.209	0.222	0.091	0.212	0.199	0.151	0.181	0.179	0.117	0.130	0.142	0.166	0.179	0.179	0.173	0.142
Average borrow : Lend money ratio	2	0.5	0.407	0.487	0.313	0.307	0.313	0.333	0.453	0.333	0.513	0.460	0.320	0.273	0.440	0.487	0.360	0.360	0.687	0.460
Percentage of households that sought asistance from their local government in the previous 12 months	100	0	0.895	0.818	0.865	0.917	0.882	1.000	0.786	0.667	0.857	0.750	0.867	1.000	0.944	0.700	0.880	0.938	0.750	0.692
Health																				
Average time to health facility on foot	390	3	0.133	0.151	0.119	0.109	0.207	0.097	0.199	0.208	0.150	0.136	0.201	0.127	0.109	0.169	0.131	0.118	0.313	0.123
Percentage of households with a chronically ill family member	100	0	0.579	0.546	0.514	0.833	0.294	0.143	0.679	0.556	0.393	0.625	0.289	0.273	0.222	0.100	0.080	0.125	0.346	0.154
Percentage of households in which a family member missed work or school in the previous two weeks due to illness	100	0	0.158	0.182	0.243	0.333	0.118	0.143	0.321	0.278	0.286	0.250	0.267	0.091	0.111	0.150	0.160	0.313	0.346	0.154
Average Malaria Exposure*Prevention Index	5	0.5	0.087	0.091	0.111	0.093	0.158	0.127	0.111	0.129	0.080	0.098	0.053	0.100	0.117	0.151	0.147	0.160	0.227	0.296
Food																				
Percentage of households relying solely on family farm for food	100	0	0.947	0.909	0.946	1.000	0.941	0.571	0.929	0.944	0.786	0.875	0.978	1.000	0.722	0.750	0.680	0.750	0.423	0.500
Average number of months households struggle to find food	12	0	0.167	0.121	0.147	0.111	0.088	0.178	0.134	0.162	0.191	0.167	0.226	0.159	0.105	0.242	0.170	0.162	0.474	0.337
Average Crop Diversity Index	1	0.07	0.054	0.065	0.065	0.086	0.054	0.054	0.054	0.054	0.065	0.086	0.054	0.043	0.054	0.043	0.097	0.032	0.097	0.183
Percentage of households that do not save crops	100	0	0.000	0.000	0.081	0.000	0.000	0.143	0.036	0.000	0.143	0.000	0.089	0.091	0.000	0.050	0.160	0.000	0.404	0.269
Percentage of households that do not save seeds	100	0	0.000	0.000	0.054	0.000	0.059	0.143	0.036	0.000	0.143	0.125	0.111	0.091	0.500	0.300	0.440	0.375	0.577	0.346

Major/Sub-components	Max value	Min value	Kathonzweni		Nzaui		Kilungu		Mukaa		Makindu		Makueni		Mbooni East		Mbooni West		Kibwezi	
			M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Water																				
Percentage of households reporting a water conflict	100	0	0.421	0.455	0.432	0.333	0.235	0.714	0.500	0.722	0.571	0.500	0.422	0.546	0.611	0.650	0.600	0.750	0.289	0.385
Percentage of households that use a natural water source	100	0	0.105	0.455	0.243	0.750	0.882	1.000	0.821	0.889	0.250	0.375	0.622	0.455	0.833	0.700	0.880	0.938	0.212	0.346
Average time to water source on foot	390	0	0.102	0.149	0.106	0.067	0.082	0.066	0.169	0.165	0.181	0.167	0.178	0.118	0.290	0.207	0.117	0.123	0.204	0.105
Percentage of households without a reliable water supply	100	0	0.000	0.000	0.000	0.000	0.000	0.000	0.036	0.000	0.286	0.125	0.133	0.000	0.222	0.500	0.360	0.125	0.500	0.462
Inverse of the average amount of water stored per household.	0.075	0.0003	0.090	0.183	0.130	0.170	0.290	0.103	0.210	0.277	0.170	0.076	0.157	0.050	0.143	0.157	0.210	0.197	0.317	0.157
Natural disasters and climate variability																				
Average number of floods, drought and windstorms in the past six years	8	0	0.303	0.319	0.329	0.334	0.258	0.233	0.259	0.209	0.358	0.266	0.305	0.306	0.303	0.356	0.120	0.055	0.555	0.548
Percentage of households that did not receive a warning about impending natural disasters	100	0	0.263	0.182	0.487	0.167	0.706	0.571	0.607	0.611	0.321	0.125	0.333	0.546	0.722	0.700	0.400	0.188	0.262	0.654
Percentage of households affected by recent natural disasters in terms of injury or death	100	0	0.105	0.000	0.000	0.027	0.000	0.000	0.214	0.167	0.000	0.000	0.000	0.091	0.000	0.100	0.000	0.000	0.049	0.039
Mean standard deviation of monthly average of average maximum daily temperatures (last six years)	3.28	1.41	0.134	0.134	0.123	0.123	0.134	0.123	0.134	0.134	0.139	0.139	0.118	0.118	0.102	0.102	0.118	0.118	0.059	0.059
Mean standard deviation of monthly average of average minimum daily temperatures (last six years)	1.57	0.77	0.488	0.488	0.488	0.425	0.425	0.425	0.425	0.425	0.688	0.688	0.413	0.350	0.350	0.475	0.475	0.475	0.438	0.438
Mean standard deviation of monthly average precipitation (last six years)	8.78	0.37	0.277	0.277	0.630	0.630	0.560	0.560	0.460	0.460	0.301	0.301	0.429	0.429	0.361	0.361	0.474	0.474	0.291	0.291

Table 7. Gendered LVI major component and overall LVI scores for households in Makueni County sub-counties

| Major Components	Sub-County																	
	Kathonzweni		Nzaui		Kilungu		Mukaa		Makindu		Makueni		Mbooni East		Mbooni West		Kibwezi	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Socio-demographic profile	0.084	0.124	0.111	0.090	0.122	0.123	0.122	0.140	0.053	0.067	0.135	0.122	0.135	0.200	0.184	0.189	0.151	0.275
Livelihood Strategies	0.474	0.489	0.423	0.433	0.445	0.374	0.348	0.402	0.478	0.555	0.529	0.464	0.371	0.440	0.413	0.434	0.426	0.409
Social Networks	0.487	0.483	0.462	0.482	0.429	0.515	0.479	0.384	0.517	0.463	0.468	0.435	0.451	0.473	0.492	0.537	0.537	0.432
Health	0.239	0.242	0.247	0.342	0.194	0.127	0.327	0.293	0.227	0.277	0.148	0.140	0.143	0.129	0.179	0.182	0.308	0.182
Food	0.234	0.219	0.258	0.239	0.228	0.218	0.238	0.232	0.265	0.251	0.277	0.276	0.277	0.309	0.264	0.395	0.395	0.327
Water	0.144	0.248	0.182	0.264	0.298	0.377	0.347	0.411	0.292	0.249	0.233	0.302	0.423	0.440	0.433	0.426	0.304	0.291
Natural Disasters and Climate Variability	0.262	0.233	0.337	0.280	0.345	0.319	0.350	0.334	0.301	0.253	0.270	0.306	0.328	0.265	0.218	0.276	0.276	0.338
Overall LVI	**0.254**	**0.271**	**0.277**	**0.289**	**0.286**	**0.285**	**0.3101**	**0.3102**	**0.290**	**0.281**	**0.2860**	**0.2867**	**0.302**	**0.320**	**0.307**	**0.300**	**0.329**	**0.315**
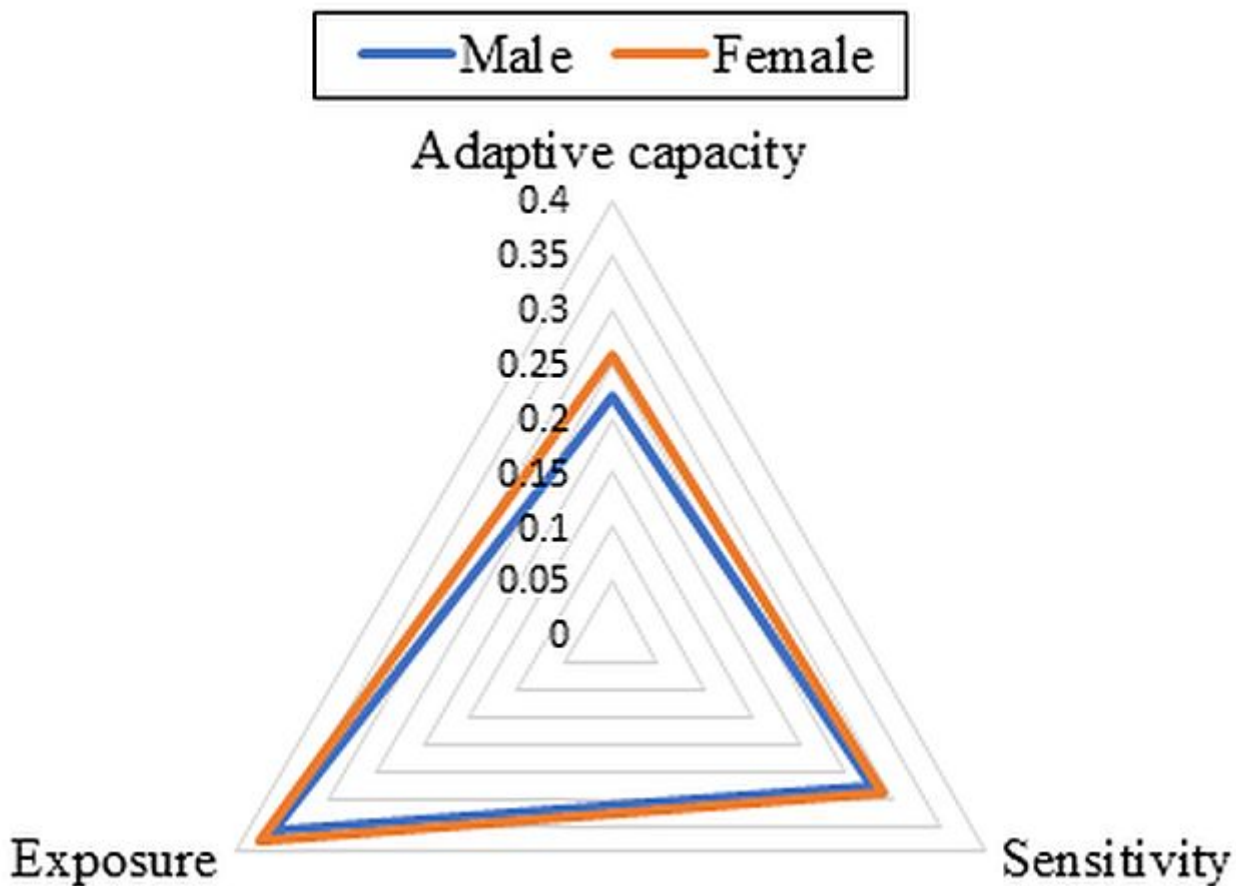
Figure 3. Vulnerability triangle of the LVI-IPCC contributing factors scores for male and female headed households in Makueni County

Despite having a lower sensitivity (0.224 against 0.270), they were more exposed (0.317 versus 0.270) and had a higher vulnerability in their adaptive capacity (0.353 against 0.319). In Mbooni East sub-county, male headed households were marginally more susceptible to climate change (-0.003 versus -0.006). Although both groups had a similar sensitivity to climate change (male: 0.290 and female: 0.297), households headed by women were more vulnerable in terms of adaptive capacity (0.347 against 0.318). In Mbooni West sub-county, households headed by men were more susceptible to climate change (-0.022 versus -0.040). Additionally, these households were more exposed (0.265 against 0.218) and exhibited a significantly higher sensitivity to climate change effects (0.302 compared to 0.298). However, female headed households in this sub county were more susceptible in terms of adaptive capacity (0.353 versus 0.339). In Kibwezi sub-county, female headed households were more vulnerable to climate change impacts (-0.007 compared to -0.025). Despite having

a lower sensitivity to climate change (0.273 compared to 0.338), they were more exposed (0.338 versus 0.276) and had a higher vulnerability in adaptive capacity (0.362 against 0.349).

DISCUSSION

LVI – the composite index approach
The findings show that vulnerability is a dynamic condition that varies not only from time to time, but also from place to place as being shaped by factors such as gender, availability of opportunities and

Table 8. Gendered LVI-IPCC scores for households in Makueni County

| Gender | LVI-IPCC Key Components | | | LVI-IPCC |
	Adaptive capacity	Sensitivity	Exposure	Scores
Male	0.221	0.278	0.358	0.038
Female	0.259	0.290	0.375	0.034

Table 9. Gendered LVI-IPCC scores for households in Makueni County sub-counties

Sub-county	Gender	LVI-IPCC Key Components			LVI-IPCC Scores
		Adaptive capacity	Sensitivity	Exposure	
Kathonzweni	Male	0.322	0.203	0.262	-0.012
	Female	0.341	0.236	0.233	-0.026
Nzaui	Male	0.310	0.228	0.337	0.006
	Female	0.311	0.227	0.280	-0.008
Kilungu	Male	0.311	0.243	0.345	0.008
	Female	0.316	0.249	0.319	0.001
Mukaa	Male	0.297	0.302	0.350	0.016
	Female	0.292	0.313	0.334	0.013
Makindu	Male	0.320	0.264	0.301	-0.005
	Female	0.332	0.258	0.253	-0.020
Makueni	Male	0.319	0.270	0.270	-0.013
	Female	0.353	0.224	0.317	-0.008
Mbooni East	Male	0.318	0.290	0.306	-0.003
	Female	0.347	0.297	0.328	-0.006
Mbooni West	Male	0.339	0.302	0.265	-0.022
	Female	0.353	0.298	0.218	-0.040
Kibwezi	Male	0.349	0.338	0.276	-0.025
	Female	0.362	0.273	0.338	-0.007

resources, social structures existing in given place, geography, and other environmental circumstances, among others. These findings are consistent with those of Abbasi et al. (2019), who pointed out that vulnerability is not a state that is felt but rather, one that is embodied depending on certain parameters and it differs depending on gender, time, location, and social positions. As far as the whole county is concerned, the results indicated that households headed by women are more vulnerable to climate change impacts than those headed by men. Comparable findings have been reported in other studies (Sujakhu et al. 2019, Nzengya and Maguta 2021). Women are regarded to be particularly vulnerable to climate change due to factors such as illiteracy, insufficient resources, and limited access to information (Abbasi et al. 2019). The results also revealed that households headed by women were more vulnerable than those headed by men in all key components considered except health. These findings corroborate those of Alhassan et al. (2019), who reported higher vulnerability among female headed houseolds in all key domains except health. Similarly, Aiswarya et al. (2023), observed increased vulnerability among female headed households in all LVI main components considered.

Although women in the county as a whole were more vulnerable to the effects of climate change, the situation differed in particular sub-counties. For example, in the sub-counties of Makindu, Mbooni West and Kibwezi, the results appeared counterintuitive as male headed households exhibited higher susceptibility to the effects of climate change than female headed households. Although this is contrary to expectations and contradicts several other studies (Ashrafuzzaman et al. 2022, Aiswarya et al., 2023), the results confirmed the findings of Balikoowa et al. (2018) and Andeyangtso and Ifeoma (2022), who established that households headed by men were more vulnerable than those headed by women, implying that the presumption that households headed by women are more vulnerable may disenfranchise vulnerable male headed households. In Kathonzweni, Nzaui and Mbooni East sub-counties, households headed by women were more vulnerable than those headed by men, a common observation in several other studies (Jeiyol et al. 2022, Wright et al. 2023). Additionally,

compared to households headed by men, households headed by women in these three sub-counties were more vulnerable to both livelihood strategies and water main components. Their vulnerability was greatly exacerbated as a result of this. Alhassan et al. (2019), made a similar observation, noting that female headed households in northern Ghana were more vulnerable in terms of livelihood strategies and water main components than male headed households. This was due to the female headed households not only having difficulty procuring water, but also failing to diversify their revenue sources beyond agriculture.

A somewhat unique scenario was discovered among households in Kilungu, Mukaa and Makueni sub counties, where both male and female headed households demonstrated similar degrees of livelihood vulnerability. Despite the similar overall LVI ratings, there were many variances in the major component scores as both groups documented distinct vulnerabilities. This adds to the developing understanding of the differing susceptibilities of men and women to the effects of climate change.

LVI-IPCC

The LVI-IPCC analysis yielded intriguing results, as male headed households were more vulnerable in the county as a whole and in the majority of sub-counties, a scenario not seen in the LVI analysis results. Such variations when data is subjected to both LVI and LVI-IPCC analysis are not new as other studies have reported similar disparities (Dendir and Simane 2019, Rai et al. 2022, Ntali and Lyimo 2022). These discrepancies can be explained by the variations in model parameters and presumptions used in computations. Despite the inconsistencies, both methodologies are useful in identifying factors that shape household vulnerability to climate change. The LVI-IPCC findings that categorize men as the most vulnerable can be explained by the existence of various development initiatives in the study area from both governmental and non-governmental entities that have resulted in the empowerment of women. In fact, women in Makueni county have a higher membership in social groups, some of which function as saving groups and enhance women's economic autonomy. The findings are congruent with

that of Phuong et al. (2023) who discovered that men in Pa Co, Vietnam were more vulnerable to climate change than women because of the latter's economic empowerment and role advancement.

Although male headed households recorded higher overall vulnerability in the county and most sub counties, female headed households in the county and the sub counties (excluding Mukaa) had a higher vulnerability in terms of adaptive capacity. Having lower income and smaller landholdings, women in Makueni county have a limited ability to adapt to climate change. People with lower incomes are typically impoverished and possess few assets that can be liquidated in difficult times. Secure land tenure also supports land use investments that help in both adaptation and mitigation of climate change. These findings are consistent with those of Alhassan et al. (2019) and Basiru et al. (2022) who found women to be more vulnerable in terms of their capacity to adapt to climate change.

CONCLUSIONS

The study examined the gendered susceptibility of households to climate change in Makueni county using two livelihood vulnerability indices, the LVI and the LVI-IPCC. Both approaches proved to be excellent tools for comprehending the diversity of vulnerability. The findings of this study support the assertion that vulnerability to climate is not gender neutral, but is differentiated and deeply intertwined with patterns of inequality. Further, the findings imply that an individual's vulnerability is influenced by a number of overlapping factors rather than just one. In Makueni County, three factors - livelihood strategies, social networks, and climate variability have a significant impact on vulnerability in both male and female headed households, albeit to varying degrees. These factors in turn increase households' exposure to and sensitivity to climate change, while limiting their capacity to adapt. Interventions aiming at boosting resilience by diversifying livelihoods and building solid social networks is crucial for enhancing household's adaptive capacity. Similarly, efforts towards climate change mitigation, though long term, can play a significant role in limiting climate change as the area is prone to frequent droughts. In general, policy interventions ought to

be specific and targeted based on who and what is vulnerable. They should consider the primary vulnerability drivers in each group and, as a result, initiate context-specific interventions to reduce households' vulnerability to climate change.

Authors' contributions: All authors contributed equally.

Conflict of interest: Authors declare no conflict of interest.

REFEREBCES

Abbasi, S.S., Anwar, Z.M., Habib, N., Khan, Q. and Waqar, K. 2019. Identifying gender vulnerabilities in context of climate change in Indus basin. Environmental Development, 31, 34-42. https://doi.org/10.1016/j.envdev.2018.12.005

Aiswarya, T.P., Parayil, C., Bonny, B.P., Nameer, P.O., Prema, A. and Sreya, P.S. 2023. Gendered vulnerabilities in small scale agricultural households of Southern India. International Journal of Disaster Risk Reduction, 84, 103475. https://doi.org/10.1016/j.ijdrr.2022.103475

Alam, M., Bhatia, R. and Mawby, B. 2015. Women and Climate Change: Impact and Agency in Human Rights, Security, and Economic Development. Georgetown Institute for Women, Peace and Security, Washington D.C. 72 pages. https://giwps.georgetown.edu/wp-content/uploads/2017/09/Women-and-Climate-Change.pdf

Alhassan, S.I., Kuwornu, J.K. and Osei-Asare, Y.B. 2019. Gender dimension of vulnerability to climate change and variability: Empirical evidence of smallholder farming households in Ghana. International Journal of Climate Change Strategies and Management, 11(2), 195-214. https://doi.org/10.1108/IJCCSM-10-2016-0156

Andeyangtso, B. and Ifeoma, M.S. 2022. Location and gender analysis of climate change vulnerability and implication for poverty reduction in Taraba State, Nigeria. Journal of Economics and Allied Research, 7(1), 191-204.

Anonymous. 2010. Poverty and Climate Change Reducing the Vulnerability of the Poor through Adaptation. Organisation for Economic Co-operation and Development, Paris.

Anonymous. 2011. Climate Change, Gender and Development in Africa. Economic brief. African Development Bank, Abidjan. 46 pages. https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/Climate%20Change%20Gender%20and%20Development%20in%20Africa.pdf

Anonymous. 2013. Overview of linkages between gender and climate change. United Nations Development Program, New York.

Anonymous. 2014. IOM Outlook on Migration, Environment and Climate Change. International Organization for Migration, Geneva.

Anonymous. 2019a. Global warming of 1.5°C: An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change. Intergovernmental Panel on Climate Change, Geneva.

Anonymous. 2019b. Differentiated impacts of climate change on women and men; the integration of gender considerations in climate policies, plans and actions; and progress in enhancing gender balance in national climate delegations. United Nations Framework Convention on Climate Change, Bonn.

Anonymous. 2019c. Counting Our People for Sustainable Development and Devolution of Services. Kenya National Bureau of Statistics, Nairobi.

Anonymous. 2019d. Makueni County Spatial Plan (2019-2029). The Government of Makueni County, Makueni.

Anonymous. 2020a. Climate Change: Evidence and Causes. The US National Academy of Sciences and The Royal Society, Washington, D.C.

Anonymous. 2020b. Kenya Gender Analysis. United Nations Development Program, New York.

Anonymous. 2022a. Vulnerability. Retrieved January 2023, from United Nations Office for Disaster Risk Reduction: https://www.undrr.org/terminology/vulnerability

Anonymous. 2022b. Dimensions and examples of the gender-differentiated impacts of climate change, the role of women as agents of change and opportunities for women. United Nations Framework Convention on Climate Change, Bonn.

Anonymous. 2023a. Climate Smart Agriculture Sourcebook. Retrieved from Food and Agriculture Organization of the United Nations: https://www.fao.org/climate-smart-agriculture-sourcebook/enabling-frameworks/module-c6-gender/chapter-c6-1/en/

Anonymous. 2023b. Inclusive, local and accountable engagement: Age, gender and diversity accountability report 2022. United Nations High Commissioner for Refugees, Geneva.

Ashrafuzzaman, M., Gomes, C., Dias, J.M. and Cerdà, A. 2022. Exploring gender and climate change nexus, and empowering women in the south western coastal region of Bangladesh for adaptation and mitigation. Climate, 10(11), 172. https://doi.org/10.3390/cli10110172

Balikoowa, K., Nabanoga, G. and Tumusiime, D.M. 2018. Gendered stereotyping: Evidence from gender differentiated household vulnerability to climate change in Eastern Uganda. Cogent Environmental Science, 4(1), 1512838. https://doi.org/10.1080/23311843.2018.1512838

Basiru, A.O., Oladoye, A.O., Adekoya, O.O., Akomolede, L.A., Oeba, V.O., Awodutire, O.O., Charity, F., Abodunrin, E.K. 2022. Livelihood vulnerability index: Gender dimension to climate change and variability in REDD + piloted sites, Cross River State, Nigeria. Land, 11(8), 1240. https://doi.org/10.3390/land11081240

Bradshaw, S. 2010. Women, Poverty and Disasters: Exploring the Links Through Hurricane Mitch in Nicaragua. Edward Elgar Publishing, Cheltenham. 256 pages.

Dendir, S. and Simane, B. 2019. Livelihood vulnerability to

climate variability and change in different agroecological zones of Gurage Administrative Zone, Ethiopia. Progress in Disaster Science, 3, 100035. http://dx.doi.org/10.1016/j.pdisas.2019.100035

Dhungana, R.K. 2014. Nepali hindu women's thorny path to liberation. Journal of Education and Research, 4(1), 39-57. https://doi.org/10.3126/jer.v4i1.10013

Hahn, M.B., Riederer, A.M. and Foster, S.O. 2009. The livelihood vulnerability index: A aragmatic approach to assessing risks from climate variability and change - A case study in Mozambique. Global Environmental Change, 19(1), 74-88. https://doi.org/10.1016/j.gloenvcha.2008.11.002

Hertel, T.W. and Rosch, S.D. 2010. Climate change, agriculture, and poverty. Applied Economic Perspectives and Policy, 32, 355-385. https://doi.org/10.1093/aepp/ppq016

Jeiyol, E., Onah, M.A., Adimanyi, O. and Ukange, C. 2022. Vulnerability of farming households to climate change and variability at Ikpayongo community, Gwer, Benue State, Nigeria: A gender perspective. Journal of Research in Forestry, Wildlife & Environment, 14(4), 72-86. https://www.ajol.info/index.php/jrfwe/article/view/241509

Khadka, C., Upadhyaya, A., Edwards-Jonášová, M., Dhungana, N., Baral, S. and Cudlin, P. 2022. Differential impact analysis for climate change adaptation: A case study from Nepal. Sustainability, 14, 9825. https://doi.org/10.3390/su14169825

Maharjan, A., Bauer, S. and Knerr, B. 2012. Do rural women who stay behind benefit from male out-migration? A case study in the hills of Nepal. Gender, Technology and Development, 16(1), 95-123. https://doi.org/10.1177/097185241101600105

Mujere, N. 2015. Gendered Vulnerability and Adaptation to Climate Change. University of Zimbabwe, Harare.

Ntali, Y.M. and Lyimo, J.G. 2022. Community livelihood vulnerability to drought in semi-arid areas of northern Cameroon. Discover Sustainability, 3, 22. https://doi.org/10.1007/s43621-022-00089-4

Nyasimi, M., Ayanlade, A., Mungai, C., Derkyi , M. and Jegede, M. 2018. Inclusion of gender in Africa's climate change policies and strategies. Pp.171-185. In: Filho, W.L., Manolas, E.. Azul, M.A., Azeiteiro, U. and McGhie, H. (Eds.). Handbook of Climate Change Communication (Vol. 1). Springer International Publishing, New York. https://doi.org/ 10.1007/978-3-319-69838-0_11

Nzengya, D.M. and Maguta, J.K. 2021. Gendered vulnerability to climate change impacts in selected counties in Kenya. Pp. 2045-2062. In: Oguge, N., Ayal, D., Adeleke, L. and da Silva, I. (Eds.). African Handbook of Climate Change Adaptation, Springer, Cham. https://doi.org/10.1007/978-3-030-45106-6_169.

Phuong, T.T., Tan, N.Q., Dinh, N.C., Chuong, H.V., Ha, H.D. and Hung, H.T. 2023. Livelihood vulnerability to climate change: Indexes and insights from two ethnic minority communities in Central Vietnam. Environmental Challenges, 10, 100666. https://doi.org/10.1016/j.envc.2022.100666

Rai, P., Bajgai, Y., Rabgyal, J., Katwal, T.B. and Delmond, A.R. 2022. Empirical evidence of the livelihood vulnerability to climate change impacts: A case of potato-based mountain farming systems in Bhutan. Sustainability, 14(4), 2339. https://doi.org/10.3390/su14042339

Sujakhu, N.M., Ranjitkar, S., Schmidt-Vogt, D., Su, Y. and Xu, J. 2019. Assessing the livelihood vulnerability of rural indigenous households to climate changes in Central Nepal, Himalaya. Sustainability, 11(10), 2977. https://doi.org/10.3390/su11102977

Wright, L.M., Drake, D., Link, G.D. and Berg, A.J. 2023. Climate change and the adverse impact on the health and well-being of women and girls from the Women's Health Expert Panel of the American Academy of Nursing. Nursing Outlook, 71(2), 101919. https://doi.org/10.1016/j.outlook.2023.101919

Yamane, T. (1967). Statistics: An Introductory Analysis, 2nd Edition. Harper and Row, New York.