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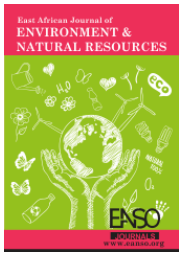

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Original Article

Climate Shocks and Food Security: Community Perceptions of Floods and Droughts in Kenya's Lower Nyando Basin

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Floods, Drought, Climate variability, Food security, Community perceptions, Resilience, Lower Nyando Basin, Kenya, Sub-Saharan Africa.

ABSTRACT

Floods and droughts have intensified across Sub-Saharan Africa, undermining food security and rural livelihoods. In Kenya's Lower Nyando Basin (LNB), where households depend primarily on rain-fed agriculture and fishing, these climatic shocks are recurrent and highly disruptive. This study examined community perceptions of floods and droughts and their implications for food security using a mixed-methods design that combined a household survey of 378 respondents with 12 key informant interviews and 10 focus group discussions. Quantitative analyses employed correlation and regression models, while qualitative data provided contextual insights into household coping mechanisms. The results indicated that communities perceived both floods (84.7%) and droughts (81.6%) to have increased in frequency and intensity over the past two decades. Farming, the main livelihood and income source (39.6%), was the most vulnerable to climatic shocks. Food security outcomes were severely compromised: 77.5% of households reported food inadequacy during droughts and 56.9% during floods, with shortages lasting more than four months annually for nearly two-thirds of respondents. The Household Food Insecurity Access Scale (HFIAS) further confirmed high levels of deprivation, with households frequently reducing meal frequency, consuming less-preferred foods, or going entire days without eating. Regression models showed that both floods and droughts had significant associations with food adequacy ($p < 0.05$), although the explanatory power was modest ($R^2 = 0.1655$ for droughts; $R^2 = 0.1144$ for floods). The study concluded that food insecurity in the LNB was cyclical and chronic, directly linked to climate shocks. It recommended investments in small-scale irrigation and drainage, climate-smart agriculture, improved post-harvest storage, livelihood diversification, and gender-responsive social protection to build resilience in vulnerable floodplain ecosystems.

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INTRODUCTION

Climate change poses profound risks to food security worldwide, but the impacts are disproportionately severe in Sub-Saharan Africa, where agriculture is predominantly rain-fed and highly sensitive to climatic variability (IPCC, 2019). The region has witnessed increasing temperatures, altered rainfall patterns, and more frequent extreme events, including floods and droughts, which directly undermine agricultural productivity and rural livelihoods (Kipkemboi et al.,2021; Rosenzweig et al., 2013; Schmidhuber & Tubiello, 2007). In this context, local communities' perceptions of climate change and variability are crucial, as they shape adaptation decisions and influence policy effectiveness (Juana et al., 2013).

A growing body of literature demonstrates that African farmers are acutely aware of changes in climate and their implications for food security (Kalele et al., 2021; Ouko & Odiwuor, 2023; Muthoka et al., 2024a; Abdullahi et al., 2024; Radeny et al., 2020). In South Africa, farmers have reported warmer summers, colder winters, and increased frequency of droughts (Gandure et al., 2012; Mandleni & Anim, 2011). Similar perceptions have been recorded among pastoralists in the Eastern Cape, where 86% observed rising temperatures and persistent drought conditions (Mandleni & Anim, 2011). In West Africa, farmers from Benin, Burkina Faso, Ghana, Niger, and Togo identified delayed rainfall onset, early cessation, and more frequent hot days as indicators of climate change (Akponikpè et al., 2010). In Ghana, the majority of farmers perceived an increase in temperature and a decline in rainfall (Acquah-de Graft & Onumah, 2011). Likewise, in Nigeria, nearly 89% of surveyed farmers reported a significant rise in temperature, linking it to crop failures and reduced yields (Apata et al., 2009; Sofoluwe et al., 2011). Other studies have highlighted how climate variability exacerbates pest infestations, increases water demand for crops, and lengthens drought episodes, further jeopardising household food security (Gandure et al., 2012). In Kenya, farmers have consistently reported changes in rainfall patterns, shortened growing seasons, and rising temperatures, with adverse effects such as crop failure, declining yields, declining fish species, loss of biodiversity and increased pest outbreaks (Franklin et al., 2021; Kalia, 2024; Nyambariga, 2024; Muthoka et al., 2024b).

Adaptation strategies have therefore become essential for sustaining agricultural livelihoods under climate stress. The Intergovernmental Panel on Climate Change (IPCC, 2001) defines

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adaptation as adjustments in human or natural systems in response to actual or expected climatic stimuli, which may reduce harm or exploit opportunities. Farmers across Sub-Saharan Africa have adopted a range of strategies, including crop diversification, use of drought-resistant varieties, shifting planting dates, irrigation, tree planting, and soil and water conservation (Ndung'u, 2015; Thorburn, 2015; Tessema et al., 2020; Temesgen Tadesse et al., 2016; Yibekal Abebe et al., 2020). In Ethiopia, for example, households have diversified crops, planted trees, engaged in mixed farming, and adopted off-farm income-generating activities as buffers against climate shocks (Seid Sani et al., 2016; Abate et al., 2022; Wondimagegn et al., 2021). In Southern and Eastern Africa, water harvesting, wastewater reuse, and small-scale irrigation have been crucial (Gbetibuou, 2009; Nyanga et al., 2011), while in West Africa, soil conservation, upland farming, and short-duration crops have been prioritised (Sofoluwe et al., 2011; Nkiaka et al., 2019). Climate-smart agriculture (CSA) is increasingly recognised as a vital framework for enhancing resilience and productivity, while also contributing to climate mitigation (Lipper et al., 2018; Khatri-Chhetri et al., 2017; Ouko et al., 2024; Obiero et al., 2024). In Kenya, smallholder farmers have embraced drought-tolerant maize and sorghum, crop diversification, and mixed farming to adapt to erratic rainfall and recurrent droughts (Mutunga et al., 2017; Smit & Skinner, 2020; Singh et al., 2022).

Despite the growing literature, evidence at sub-national scales remains uneven. The Lower Nyando Basin in Western Kenya represents one of the country's most vulnerable landscapes. The region is characterised by recurrent flooding, prolonged dry spells, and erratic rainfall, compounded by high poverty levels, environmental degradation, and overdependence on natural resources (Raburu et al., 2012; Obiero et al., 2012; Abubakar et al., 2013). Preliminary observations suggest that local households perceive climate change as a major threat, citing frequent crop failures, livestock losses, and declining incomes. While adaptation strategies such as planting drought-resistant crops, reintroducing indigenous varieties, and practising improved water management have been documented, there is limited systematic analysis of how communities perceive the effects of floods and droughts on food security, and how these perceptions shape adaptation responses.

This study seeks to address the knowledge gap on how communities in the Lower Nyando Basin (LNB) perceive and experience the impacts of floods and droughts on food security. Specifically, it aims to determine the relationship between flooding and drought events and household food security in the basin, while also assessing the adequacy, availability, and accessibility of food under these climatic conditions. In addition, the study analyses household food insecurity experiences using the Household Food Insecurity Access Scale (HFIAS) to capture both the severity and frequency of food-related challenges. Finally, it documents the extent and duration of food shortages, as well as community perceptions of how floods and droughts affect agricultural production. By combining household-level perspectives with statistical evidence, the study contributes to a deeper understanding of food security dynamics in floodplain ecosystems and provides insights for resilience-building strategies in vulnerable communities.

METHODOLOGY

Study Area

The study was carried out in Kadibo, Nyando, and Lower Nyakach sub-counties within the Lower Nyando Basin (LNB) of Kisumu County, Kenya (Figure 1). The Nyando River extends 153 km across a basin area of 3,500 km² in the Lake Victoria Basin, originating in the highlands at an altitude of 1,700 metres above sea level and draining into Lake Victoria at 1,134 metres above sea level. The Kano plains, located between latitudes 1°30'N and 0°05'S and longitudes 34°–35°50'E, form the extensive lowlands of the basin and constitute the main floodplain area. The LNB is ecologically diverse but also highly vulnerable to climate-related shocks, particularly recurrent

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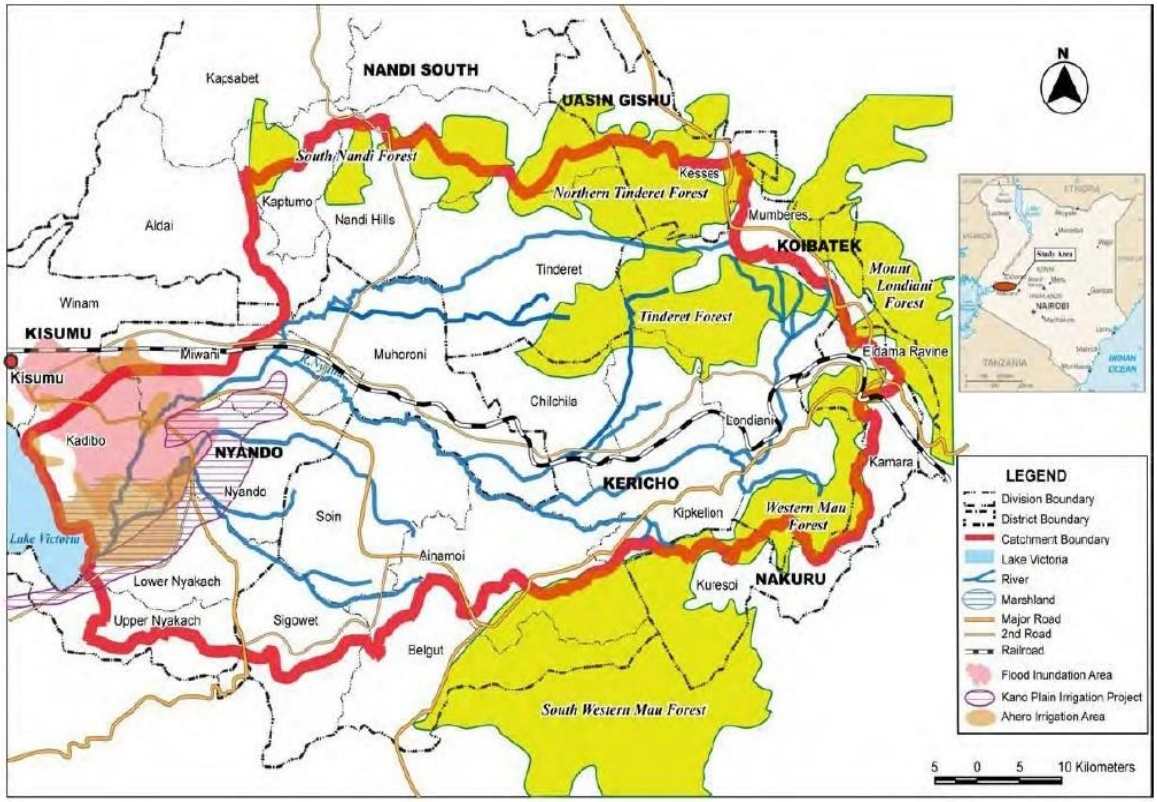
flooding and droughts that undermine household livelihoods (Raburu et al., 2012; Obiero et al., 2012). Climatic variability is pronounced, with extreme droughts occurring every 3–4 years during the short rains, every 7–8 years in the hot dry season, and every 5–8 years during the long rains (Awange et al., 2008). The frequency and magnitude of floods have also intensified in recent decades, largely due to climate change, deforestation in the upper catchment, and land-use change (Swallow et al., 2008; Orindi & Eriksen, 2005; Abubakar et al., 2013). The basin's wetlands, which play a critical role in food production, have declined by nearly 79% between 1991 and 2006 following large-scale rice irrigation and other land conversions (Swallow et al., 2007, 2009). These conditions render subsistence farming and fishing communities in the basin particularly vulnerable to food insecurity.

Figure 1: Map of the Drainage Basin of the Nyando River



Source: *JICA IFM, 2014*

Study Design

The research employed a mixed-methods cross-sectional survey design, integrating quantitative and qualitative approaches to enhance the reliability and depth of findings. The household survey generated standardised data on socio-demographics, livelihoods, and food security outcomes, while Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs) provided contextual insights into community perceptions, institutional responses, and social dynamics. Triangulation of these data sources strengthened the validity and robustness of the study.

Sampling Procedure

The study population consisted of households residing in flood- and drought-prone zones of the Lower Nyando Basin. Using Cochran's formula as presented by Mugenda and Mugenda (1999), a representative sample size of 384 households was calculated at a 95% confidence level and 5% margin of error. After data cleaning, 378 complete responses were analysed. Households were selected through simple random sampling. For the qualitative component, purposive sampling was used to select 12 key informants, including agricultural officers, county commissioners,

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ministry representatives, and leaders of community-based organisations. In addition, 10 FGDs were conducted, stratified by gender and age to ensure inclusivity, with each group comprising 7–13 participants.

Data Collection

Household surveys were administered face-to-face using semi-structured questionnaires covering socio-demographic characteristics, livelihood activities, adaptation strategies, and food security status. KIIs were conducted with officials from the Ministry of Agriculture, Livestock and Fisheries; Ministry of Environment and Forestry; Ministry of Water and Sanitation; the National Irrigation Board; the National Water Conservation and Pipeline Corporation; county officials; and local leaders. FGDs were organised in community meeting spaces, each lasting approximately 45 minutes, and explored themes including gender roles in adaptation, livelihood diversification, and nutrition knowledge. Snowball sampling was employed to complement participant recruitment. Secondary data were also reviewed from government reports, academic publications, and institutional documents to support triangulation.

Data Analysis

Quantitative data were coded and analysed using SPSS version 26. Descriptive statistics (frequencies and percentages) summarised household characteristics, while Chi-square tests and regression models examined relationships between floods, droughts, and food security. Statistical significance was set at $p < 0.05$. Qualitative data from KIIs and FGDs were transcribed and analysed thematically using NVivo 14 Pro. A grounded theory approach guided coding, where emerging themes were refined into categories, with field notes serving as memos to enrich interpretation (Robson, 2002; Miles et al., 2014). Similar themes were consolidated, and new codes were introduced as necessary (Beotto & McKinnon, 2013). Thematic analysis was thus conducted through iterative coding, allowing for the identification of recurrent patterns and triangulation with quantitative findings.

Ethical Considerations

Ethical procedures were observed to protect participant rights. Both oral and written consent were obtained, taking into account local languages (Luo and Kiswahili) and cultural norms. Confidentiality and anonymity were maintained throughout the study.

RESULTS AND DISCUSSION

Socio-Demographic Characteristics of Respondents

The majority of surveyed households in the Lower Nyando Basin (LNB) were male-headed (67.7%), with female-headed households accounting for 25.4%, while a small share were child-headed (6.3%) or elderly-headed supporting orphans (0.5%) (Table 1). Husbands (53.2%) and wives (44.7%) were the primary respondents, reflecting strong household engagement in livelihood decision-making. Respondents were predominantly above 30 years (86.1%), aligning with findings from Gandure et al. (2012) and Juana et al. (2013), who noted that climate change perceptions are often strongest among mature farmers due to accumulated experience.

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Table 1: Socio-Demographic Characteristics of the Respondents

Demographic Characteristic	Attribute	Frequency	Percent
What is the type of household	Male headed	256	67.7
	Female headed	96	25.4
	Child headed	24	6.3
	Elderly supporting orphans	2	0.5
What is the role of the respondents in the household	Husband	199	53.2
	Wife	167	44.7
	Child	8	2.1
Age of the respondent	<18	4	1.1
	18-29	47	12.8
	30-50	176	48.1
	>50	139	38
Gender of the respondents	Male	190	51.4
	Female	180	48.6
Marital status of the respondent	Married	303	81
	Single	7	1.9
	Widowed	64	17.1
Level of education of the respondents	None	42	11.9
	Primary	202	57.1
	Secondary	93	26.3
	College	17	4.8
How long have you lived in this sub-county	Up to 10 years	29	7.7
	11-20 years	29	7.7
	21-30 years	61	16.1
	Over 30 years	259	68.5
	Total	378	100
How many are you in this household	0-3	65	17.2
	4-7	268	70.9
	8-11	27	7.1
	12 and above	18	4.8
Primary occupation of the respondents	Farmer	230	51.9
	Fisherman	72	16.3
	Business	104	23.5
	Formal Employment	10	2.3
	Housewife	13	2.9
	Unemployed	10	2.3
	Student	4	0.9

Education levels were generally low, with 57.1% having only primary education and 11.9% with no formal schooling, similar to findings in South Africa (Mandleni & Anim, 2011) and Ghana (Acquah-de Graft & Onumah, 2011), where limited education constrained adaptation. Most respondents (68.5%) had lived in the basin for more than 30 years, underscoring the role of long-term local knowledge in climate perception (Franklin et al., 2021). Household sizes averaged

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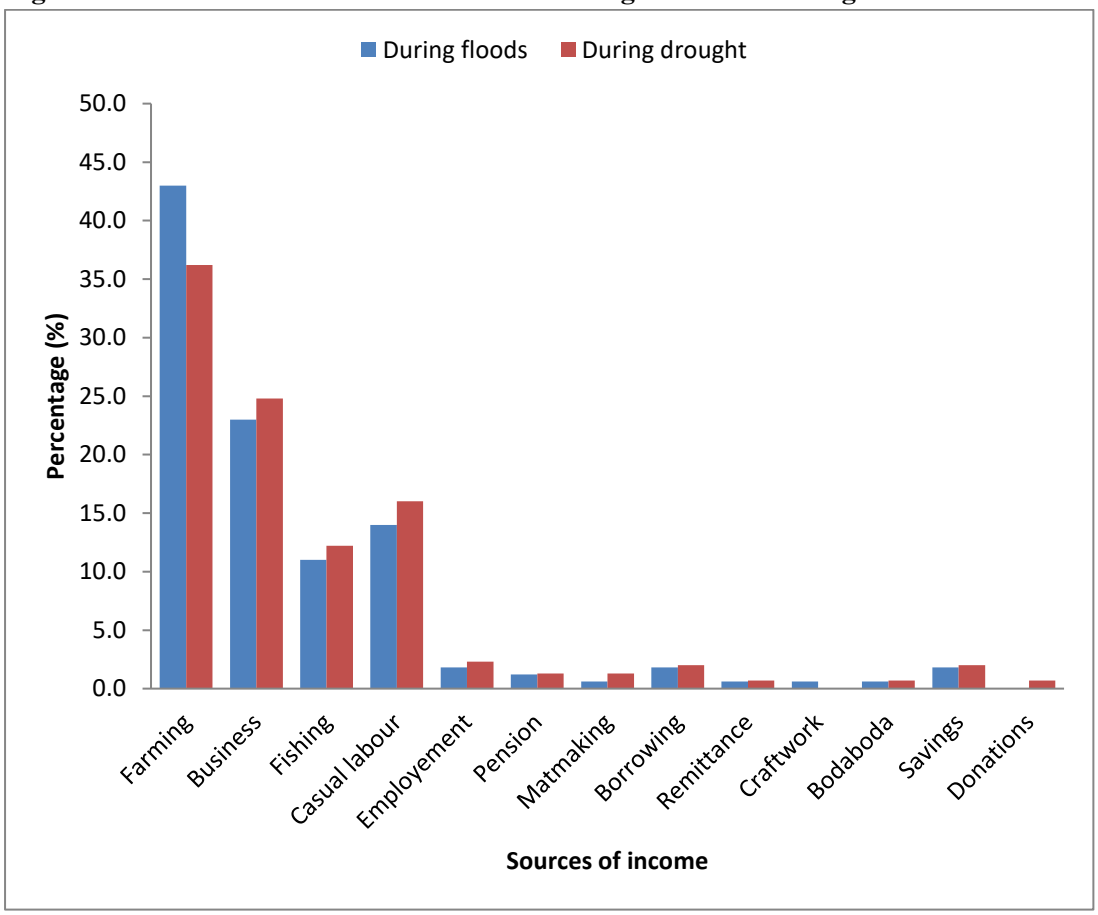
4–7 members (70.9%), reflecting the extended family structure common in floodplains. Livelihoods were mainly farming (51.9%), fishing (16.3%), and business (23.5%), confirming the basin's dependence on climate-sensitive sectors.

Household Income Sources During Floods and Droughts

Farming remained the primary source of household income across both flood and drought seasons (39.6%), significantly higher than other income sources ($\chi^2 = 225.46$, df = 12, $p < 0.0001$) (Figure 2). Business, fishing, casual labour, and small-scale employment supplemented incomes, though their contribution did not vary significantly by season ($\chi^2 = 0.86$, df = 10, $p = 0.9999$). These findings mirror those from Nigeria (Apata et al., 2009), where reliance on farming as the dominant livelihood increased vulnerability to climate shocks.

Figure 2: Source of Income for Households during Flood and Drought Seasons



This dependence was consistently emphasised in qualitative discussions, where participants noted that *"Farming is our backbone, but it is also our biggest risk because both floods and droughts destroy it completely"* (FGD, mixed group). Similarly, a key informant observed that "*Alternative livelihoods are limited, and even fishing, which used to support households, is declining due to environmental changes"* (KII, fisheries officer), highlighting the narrow livelihood base that amplifies exposure to climate shocks.

Relationship Between Flooding, Drought, and Food Security

Correlation analysis revealed generally weak to moderate positive relationships between climate shocks and food adequacy (Table 2). For instance, the expected timing of floods was positively correlated with food adequacy during floods (r =

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0.2874) and droughts (r = 0.2778). Similarly, the expected timing of droughts correlated with food adequacy during droughts (r = 0.3218). Notably, food adequacy during floods and droughts showed the strongest positive correlation (r = 0.3636), suggesting that households experiencing food insecurity in one season were likely to face it in the other. This cyclical nature of vulnerability was also articulated by community members, with one respondent stating, *"If drought does not affect us, floods will, and either way, we end up without enough food"* (FGD, women group). Such narratives reinforce the statistical evidence that food insecurity in the basin is recurrent rather than episodic.

Table 2: Correlation Results of the Relationship between Flooding and Drought Events with Food Security

	Floods	Drought	Food adequacy during floods	Food adequacy during drought
Floods	1.0000			
Drought	0.0695	1.0000		
Food adequacy during floods	0.2874	0.1692	1.0000	
Food adequacy during drought	0.2778	0.3218	0.3636	1.0000

The model summary of the regression analyses is shown in Table 3. In the first regression model, the dependent variable was the adequacy of food during drought periods, while the independent variables were the expected months of flooding and drought. The model demonstrated statistical significance (F = 31.83, p = 0.0000), with an R^2 value of 0.1655. In the second regression model, the dependent variable was food adequacy during flood periods. This model was statistically significant (F = 20.73, p = 0.0000), with an R^2 value of 0.1144.

Table 3: Model Summary of the Regression Analyses

Model	R^2	Adjusted R^2	Std. Error of the Estimate	F	*P*
1[a]	0.1655[b]	0.1603	0.37966	31.83	0.0000
2[c]	0.1144[d]	0.1089	0.47096	20.73	0.0000

[a]Dependent variable: food adequacy during drought. [b]Predictors (constant): flooding, drought.

[c]Dependent variable: food adequacy during floods. [d]Predictors (constant): flooding, drought.

Regression analysis further confirmed that both flooding and drought significantly influenced food adequacy (Table 4). For food adequacy during droughts, expected months of flooding (β = 0.0957, p = 0.000) and drought (β = 0.0389, p = 0.000) were both significant predictors (Model 1: R^2 = 0.1655, F = 31.83, p = 0.000). Similarly, during floods, both flooding (β = 0.1257, p = 0.000) and drought (β = 0.0246, p = 0.003) significantly predicted food adequacy (Model 2: R^2 = 0.1144, F = 20.73, p = 0.000). These findings align with Awange et al. (2008) and Swallow et al. (2009), who showed that extreme climate events directly compromise household food security in Kenyan basins.

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Table 4: Results of the Regression Model of Floods and Drought on Food Adequacy

Model	Variable	Standardized coefficient (β)	Std. Error	t	*p*
1	Floods	0.09567**	0.01877	5.10	0.000
	Drought	0.03888**	0.00671	5.80	0.000
2	Floods	0.12571**	0.02306	5.45	0.000
	Drought	0.02461**	0.00833	2.95	0.003

Note: **indicates significance at $p < 0.05$

Food Quantity, Availability, and Accessibility

Food consumption patterns varied significantly between flood and drought periods. During floods, 45.2% of households reported eating two meals per day compared to 62.3% during droughts ($\chi^2 = 11.24$, $p = 0.0105$) (Table 5). However, food types consumed—vegetables, maize, millet/sorghum, rice, and beans—did not vary significantly between seasons ($\chi^2 = 1.07$, $p = 0.9566$). Food sourcing was mainly market-based (56.8%), reflecting reduced subsistence production, consistent with patterns observed by Nyanga et al. (2011) in Zambia. However, access to market-based food sources was frequently constrained, as participants explained that *"Food may be available in the market, but many households cannot afford it, especially during drought periods"* (FGD, female group). In addition, physical access was disrupted during floods, with a key informant noting that *"Flooding cuts off roads and markets, making it difficult for households to obtain food even when they have money"* (KII, county official).

Table 5: Quantity, Availability and Accessibility of Food

Quantity, Availability and Accessibility of Food	Attribute	During Floods (%)	During Drought (%)	χ^2	*P*
How many meals do you take per day	One	15.3	9.2	11.246	0.0105
	Two	45.2	62.3		
	Three	33.3	21.3		
	Four	5			
	None	1.2	7.3		
	Total	100	100		
What types of foods are available	Vegetables	26.4	31.4	1.072	0.9566
	Maize	21.9	20.1		
	Millet/Sorghum	16.4	15.7		
	Rice	12.1	13.8		
	Beans/Green grams	13	10.5		
	Any other	10.1	8.4		
	Total	100	100		
Where do you get food from	Farm	36.8	29.5	5.66	0.2258
	Market	50.7	62.9		
	Other towns	7.7	2.7		
	Any other	4.9	2.2		
	Granary		2.7		

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Quantity, Availability and Accessibility of Food	Attribute	During Floods (%)	During Drought (%)	χ^2	*P*
	Total	100			
Is the food easily accessible	Yes	49.3	27.4	10.27	0.0014
	No	50.7	72.6		
	Total	100	100		
Is the food adequate for the entire household	Yes	43.1	22.5	9.32	0.0023
	No	56.9	77.5		
	Total	100	100		
Does your household get a sustained supply of food	Yes	32.3	11.1	13.07	0.0003
	No	67.7	88.9		
	Total	100	100		

Accessibility emerged as a critical challenge: 61.7% of households indicated that food was not easily accessible in both seasons, with droughts more severe (72.6% vs. 50.7% in floods; χ^2 = 10.27, p = 0.0014). This disparity was echoed in discussions where participants emphasised that *"Drought is more severe because it lasts longer and affects every stage of production, leaving households with no food reserves"* (FGD, male farmers). Furthermore, the adequacy of food was low—77.5% reported food inadequacy during droughts compared to 56.9% in floods (χ^2 = 9.32, p = 0.0023). Qualitative accounts illustrate the depth of this inadequacy, with participants reporting that *"During drought, we sometimes reduce meals to once a day, and there are days when we go to sleep hungry"* (FGD, women group). Another respondent added that *"Even during floods, food is not enough because crops are destroyed before harvest"* (FGD, mixed group), indicating that both extremes undermine household food sufficiency. Sustained food supply was even more constrained, with only 11.1% of households reporting stability during drought (χ^2 = 13.07, p = 0.0003). These findings corroborate Sofoluwe et al. (2011), who reported similar drought-driven reductions in food adequacy in Nigeria.

Household Food Insecurity Access Scale (HFIAS)

The HFIAS results highlighted widespread and severe food insecurity (Table 6). Nearly all households worried about food availability, with 32.3% "sometimes" and 31.7% "often" concerned (χ^2 = 30.96, p = 0.0001). Resource constraints forced households to consume fewer or less-preferred foods, with 46.1% reporting inability to eat preferred foods (χ^2 = 42.8, p = 0.0001). These coping strategies were vividly described by participants, who noted that *"We eat whatever is available, not what we prefer, because we do not have the resources to choose"* (FGD, female-headed households). Alarmingly, 33% reported reducing the number of meals due to food scarcity (χ^2 = 30.76, p = 0.0000). This reduction in meal frequency reflects severe deprivation, as one participant explained, *"We prioritise children, but even then, there are times when everyone eats less than they should"* (FGD, women's group).

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Table 6: Household Food Insecurity Access Scale (HFIAS)

Statements	Never	Rarely	Some-times	Often	Total	χ^2	*p*
Did you worry that your household would not have enough food?	3 (0.8 %)	133 (35.2 %)	122 (32.3%)	120 (31.7 %)	378 (100.0 %)	30.96	0.0001
Were you or any household member not able to eat the kinds of food you preferred because of a lack of resources	6 (1.7 %)	115 (33%)	161 (46.1%)	67 (19.2 %)	349 (100.0 %)	42.8	0.0001
Did you or any household member eat just a few kinds of food a day after, due to a lack of resources?	16 (4.7 %)	123 (36.2 %)	103 (30.3%)	98 (28.8 %)	340 (100.0 %)	22.48	0.0001
Did you or any household member eat food that you preferred not to eat because of a lack of resources to obtain other types of food?	6 (1.7 %)	141 (40.6 %)	124 (35.7%)	76 (21.9 %)	347 (100.0 %)	36.63	0.0000
Did you or any household member eat fewer meals because there was not enough food?	2 (0.6 %)	121 (34.4 %)	113 (32.1%)	116 (33.0 %)	352 (100.0 %)	30.76	0.0000
Did you or any household member eat fewer meals in a day because there was not enough food?	4 (1.1 %)	166 (46.9 %)	86 (24.3%)	98 (27.7 %)	354 (100.0 %)	42.8	0.0000
Was there ever no food at all in your household because there were not enough resources to get more?	60 (18.3 %)	105 (32.0 %)	118 (36.0%)	45 (13.7 %)	328 (100.0 %)	13.6	0.0035

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Statements	Never	Rarely	Some-times	Often	Total	χ^2	*p*
Did you or any household member go to sleep at night hungry because there was not enough food?	69 (19.4 %)	152 (42.7 %)	81 (22.8%)	54 (15.2 %)	356 (100.0 %)	18. 54	0.00 03
Did you or any household member go a whole day without eating anything because there was not enough food?	110 (33.6 %)	137 (41.9 %)	60 (18.3%)	20 (6.1 %)	327 (100.0 %)	31. 23	0.00 00

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Chronic deprivation was evident: 32% of households sometimes had no food at all, while 41.9% reported going a whole day without food at least occasionally ($\chi^2 = 31.23$, $p = 0.0000$). In extreme cases, households reported complete food deprivation, with participants stating that *"There are days when there is nothing at all in the house, and we have to sleep hungry"* (FGD, elderly group), underscoring the severity of food insecurity in the basin. These results underscore a high prevalence of moderate to severe food insecurity, consistent with findings by Franklin et al. (2021) in Kenya and Wondimagegn et al. (2021) in Ethiopia.

Duration and Intensity of Food Shortages

The majority of households (64.7%) reported food shortages lasting more than four months annually ($\chi^2 = 90.56$, $p < 0.0001$) (Table 7). This prolonged period of food shortage was consistently highlighted in qualitative data, where respondents noted that *"Hunger is not seasonal anymore; it can last for many months, especially when floods and drought occur in the same year"* (FGD, mixed group). Nearly all respondents agreed that both floods (94.9%) and droughts (92.8%) negatively affected food production. Participants further explained that *"Floods wash away crops during harvesting, while drought prevents crops from growing at all, so either way, production is affected"* (FGD, male farmers), illustrating how both hazards disrupt different stages of the agricultural cycle. Reported food losses were substantial: during floods, households lost up to four bags of food (32.3%), while during droughts, losses reached over five bags in 22.4% of households.

Table 7: Effects of Floods and Drought on Food Production

Question	Attribute	Frequency	Per Cent	χ^2	p
How many months do you experience food shortages in a year?	One	11	2.9	90.56	0.0001
	Two	49	13.1		
	Three	72	19.3		
	More than 4 months	242	64.7		
	Total	**374**	**100**		
Do you think flooding affects food production in your area?	Yes	355	94.9	81.0	0.0001
	No	19	5.1		
	Total	**374**	**100**		
Do you think drought affects food production in your area?	Yes	347	92.8	73.96	0.0001
	No	27	7.2		
	Total	**374**	**100**		
Quantities of food in bags lost due to floods	44958	59	16.2	18.44	0.0024
	45019	118	32.3		
	45082	53	14.5		
	45145	45	12.3		
	45208	36	9.9		
	Any other	54	14.8		
	Total	**365**	**100**		
Quantities of food in bags lost due to drought	44958	67	20	7.78	0.1684
	45019	70	20.9		
	45082	75	22.4		
	45145	44	13.1		
	45208	35	10.4		
	Any other	44	13.1		

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Question	Attribute	Frequency	Per Cent	χ^2	*p*
	Total	**335**	**100**		
Food production Activity affected by drought	Planting	69	47.6	32.72	0.0001
	Harvesting	24	16.6		
	Weeding	38	26.2		
	Land preparation	14	9.7		
	Total	**145**	**100**		
Result of the drought effects	Poor harvesting leading to no food	85	72.6	21.16	0.0001
	Crops dry up because of a lack of water	32	27.4		
	Total	**117**	**100**		
Food production Activity affected by floods	Planting	48	32.9	122.48	0.0001
	Harvesting	73	50		
	Weeding	15	10.3		
	Pollination	2	1.4		
	Applying fertilizer	4	2.7		
	Land preparation	4	2.7		
	Total	**146**	**100**		
Result of the floods effects	Great production due to excess water	28	23.3	29.16	0.0001
	Low production due to excess water	92	76.7		
	Total	**120**	**100**		

Production processes were severely disrupted. Drought mainly affected planting (47.6%), leading to widespread crop failure and poor harvests (72.6%). Floods, in contrast, disrupted harvesting (50.0%), resulting in low production due to excess water (76.7%). These findings align with Abubakar et al. (2013) and Swallow et al. (2007), who observed that recurrent floods and droughts exacerbate crop losses and undermine agricultural productivity in floodplain ecosystems.

The results confirm that the Lower Nyando Basin is highly vulnerable to floods and droughts, with profound implications for food security. Seasonal shocks reduce food availability, accessibility, and adequacy, leading to chronic food insecurity lasting several months each year. While farming remains the main livelihood, its dominance as an income source exacerbates vulnerability. The evidence strongly supports previous studies across Sub-Saharan Africa (Apata et al., 2009; Asfaw et al., 2015; Lipper et al., 2018), which show that households dependent on rain-fed agriculture are disproportionately affected by climate variability.

CONCLUSION AND POLICY RECOMMENDATIONS

This study set out to examine community perceptions of floods and droughts and their implications for food security in the Lower Nyando Basin (LNB) of Kenya. The findings demonstrate that food insecurity in the basin is both structurally embedded and climate-induced, arising from the interaction between recurrent floods and droughts and underlying socio-economic constraints. While quantitative results confirm significant relationships between climate shocks and food adequacy, the qualitative evidence provides critical depth by revealing the lived realities and systemic limitations that constrain household adaptation. Farming remains the dominant livelihood and primary source of

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income, yet it is also the most climate-sensitive activity, leaving households with few viable alternatives during periods of environmental stress. The strong correlation between food adequacy during floods and droughts underscores the cyclical and reinforcing nature of food insecurity, further evidenced by HFIAS results showing widespread deprivation, including reduced meal frequency, consumption of less-preferred foods, and, in severe cases, complete food deprivation. With most households experiencing food shortages for more than four months annually, the evidence points to a system characterised by chronic and structural food insecurity rather than temporary shocks.

These findings underscore that climate variability has both immediate and long-term consequences for household welfare in floodplain ecosystems. The results align with broader regional evidence that households dependent on rain-fed agriculture are disproportionately vulnerable to climate variability. However, in the LNB, this vulnerability is intensified by structural constraints, including small landholdings, low education levels, limited access to extension services, and inadequate livelihood diversification. Together, these factors restrict adaptive capacity and reinforce a cycle in which exposure to climate shocks translates directly into food insecurity. Without targeted and sustained interventions, the combined effects of floods and droughts will continue to erode resilience, deepen household vulnerability, and entrench poverty in the region.

In light of these findings, a set of integrated policy responses is required to address both the immediate impacts of climate shocks and the structural drivers of vulnerability. Strengthening agricultural extension and climate information services is critical, particularly through the provision of localised, timely forecasts and training in climate-smart agriculture practices such as crop diversification, soil and water conservation, and the adoption of drought- and flood-tolerant crop varieties. At the same time, investments in infrastructure—including small-scale irrigation, flood control systems, and drainage networks—are essential to stabilise agricultural production and reduce exposure to climatic extremes. Enhancing food system stability will also require targeted support for community grain reserves, seed banks, and improved post-harvest storage to minimise seasonal shortages and reduce reliance on volatile markets.

Beyond agricultural interventions, promoting livelihood diversification is essential for building long-term resilience. Expanding opportunities in aquaculture, integrated rice–fish systems, and small-scale enterprises can reduce dependence on rain-fed agriculture and provide alternative income streams during periods of climatic stress. In parallel, social protection mechanisms such as targeted cash transfers and improved access to credit can buffer vulnerable households against prolonged food insecurity while enabling investment in adaptive strategies. Importantly, these interventions must be gender-responsive, addressing systemic barriers that limit women's access to land, financial resources, and extension services, despite their central role in household food production and management.

These strategic interventions are strongly aligned with global, national, and continental development frameworks. At the global level, strengthening climate-resilient agriculture, food systems, and social protection directly advances United Nations Sustainable Development Goals, particularly SDG 2: Zero Hunger, SDG 13: Climate Action, and SDG 1: No Poverty, by addressing food insecurity, enhancing adaptive capacity, and reducing vulnerability among at-risk populations. At the national level, the proposed measures support Kenya's development agenda as articulated in Kenya Vision 2030 and the Agricultural Sector Transformation and Growth Strategy (ASTGS), both of which prioritise food security, climate resilience, and inclusive agricultural growth. Furthermore, the emphasis on irrigation, livelihood diversification, and value chain development aligns with the Kenya Climate Smart Agriculture Strategy. At the continental level, these interventions contribute to the aspirations of the African Union Agenda 2063,

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particularly the goal of achieving inclusive growth and sustainable development, as well as the commitments under the Comprehensive Africa Agriculture Development Programme (CAADP), which emphasises agricultural transformation, resilience-building, and food security across Africa. By situating local-level findings within these broader policy frameworks, the study underscores the relevance of context-specific interventions in advancing multi-scalar development goals.

Collectively, these findings highlight the need for a holistic and integrated approach to resilience-building in flood- and drought-prone ecosystems. Addressing food insecurity in the Lower Nyando Basin requires not only responding to climatic shocks but also tackling the structural inequalities and institutional gaps that constrain adaptation. The insights generated from this study provide important lessons for similar vulnerable regions across Sub-Saharan Africa, where the convergence of climate variability and socio-economic constraints continues to drive persistent and multidimensional food insecurity.

Limitations of the Study and Areas for Further Research

This study has several limitations that should be acknowledged. First, it relied on a cross-sectional survey conducted at a single point in time. While this provided valuable insights into household perceptions and practices, it limited the ability to capture seasonal variations and long-term changes in food security outcomes. A longitudinal design tracking households across multiple seasons would better capture the dynamic interactions between floods, droughts, and food security. Second, the study depended heavily on self-reported data from households, which may be subject to recall bias, particularly in estimating past impacts of floods and droughts or the duration of food shortages. Although triangulated with focus group discussions and key informant interviews, future research would benefit from integrating objective measures such as rainfall and river flow records, satellite imagery, and market price data to validate perceptions. Third, while the study established associations between adaptation strategies and food security, the explanatory power of the regression models was modest, suggesting that other important variables—such as household asset levels, remittances, social protection programs, and market dynamics—were not fully captured. Incorporating these additional factors into future analyses would provide a more comprehensive understanding of the determinants of resilience.

Building on these limitations, three key areas for further research are proposed. First, there is a need for longitudinal panel studies that monitor households over time to assess the sustainability and effectiveness of adaptation strategies under changing climatic conditions. Second, more in-depth gender-focused research is necessary to examine how intra-household dynamics, cultural norms, and resource inequalities shape adaptation decisions and food security outcomes. Third, experimental and intervention-based research—such as piloting subsidised small-scale irrigation schemes, community seed banks, or rice–fish systems—would provide concrete evidence on which adaptation measures most effectively enhance resilience and food security in floodplain contexts.

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