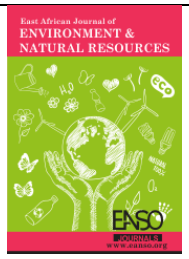

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Original Article

Adaptation Strategies to Climate Variability by Amboseli Ecosystem Households in Kajiado County, Kenya

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ABSTRACT

The Amboseli ecosystem has been made fragile by climate related challenges causing household vulnerability. As a result, the pastoral community has had to put in place mechanisms to cope and reduce vulnerability. The aim of this study was to determine the adaptation strategies at the household level and how effective they were at minimizing risks at the household level. The study used a mixed method, which focused on descriptive and correlational research designs. It targeted a population of 47, 058 residents from which a sample of 374 households was selected. Cluster and convenient sampling were used for quantitative and qualitative data respectively. A questionnaire with open and closed ended questions and with Likert scale format were used to collect quantitative data while interview schedules were used for qualitative data. Qualitative data was collected from interview schedules with key informants. Descriptive statistics was used to analyse qualitative data while quantitative data were analysed using inferential statistics Results showed that climate variability is indeed causing livelihood vulnerability and thus the need for intervention inform of adaptation strategies by the individual households, community and at the national and county levels. This study recommends livestock diversification, crop farming small scale businesses and employment of household members so as to reduce vulnerability and live decent lives. In addition, there is need to empower women through education, offering of small loans and grants for businesses as well as involvement in decision making on matters pasture and water management.

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INTRODUCTION

Pastoralists have historically been compelled to adjust to unfavourable environments (Brooks, 2006). They often inhabit regions characterized by limited resources and severe weather, which renders them vulnerable to the effects of climate change. They have developed mechanisms to cope with a variety of environmental conditions (GebreMichael et al., 2010), including the maintenance of drought-tolerant animals, consumption reduction, migration, and early warning systems. Adaptation strategies, encompassing both conventional and contemporary approaches, have gained worldwide recognition and innovation.

Migration, livestock division, restocking, and group alliances were among the traditional adaptation strategies identified by pastoralists in Southern Ethiopia, according to a study by Gebresenbet and Kefale (2012). However, it failed to demonstrate how each strategy mitigates the vulnerability of households. Research findings suggest that pastoralists in Sudan, a country with a significant reliance on livestock for subsistence, employ well drilling as a coping mechanism in response to water scarcity. According to a study by Kagunyu (2014), during periods of drought in Kenya, Borana pastoralists employ the practice of curling their livestock in order to complement their food supply. Additionally, the research unveiled that livestock mobility is diminished during periods of drought, resulting in decreased market prices and consequently no competitive edge. The objective of this research initiative is to examine the impact of adaptation strategies to reducing susceptibility of households among Kajiado pastoralists.

Huq and Reid (2004) posit that the reduction of climate variability necessitates the implementation of diverse management and adaptation strategies. One of the sustainable approaches to climate change adaptation is the consolidation of livelihoods. Christensen et al. (2004) assert that households have implemented diverse strategies in order to accommodate climatic variability and change. Thomas and Twyman (2005) concurred that pastoralists must resort to a variety mechanism meant for mitigating negative issues associated with. Additionally, the study asserts that intervention by governments and other institutions is necessary to mitigate vulnerability. This study was therefore carried out to find out the various coping mechanisms put in place at the household level to minimize vulnerability.

According to research works conducted by ACTED (2011), numerous communities residing in the ASALs lack assets essential for livelihood and their capacity to cope was diminished throughout the 2009 drought. Gebresenbet and Kefale (2012) corroborated this notion, further asserting that in light of the global emergence of novel climate change risks, local communities must enhance their conventional adaptation strategies. This study documents and analyses the current strategies in order to determine their effectiveness in mitigating household vulnerability. Included in the analysis of adaptive strategies were wage labour, small business development, bead production, and agricultural production.

According to Thornton et al. (2008), Kenyan pastoral farmers have devised a wide variety of solutions to deal with the dangers posed by climate change and vulnerability. The International Panel on climatic Change (IPCC) (2014) defines adaptive capacity as "the capacity of a system to evolve in response to climate change." Furthermore, Kagunyu (2014) argues that coping techniques may be adding to

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environmental deterioration when pastoral lifestyles in East Africa become unsustainable. Mulo (2016) adds that by diversifying their sources of income, pastoralists may create one of the most successful adaption methods. Input may be necessary for the successful implementation of adaptation strategies in Kajiado (Ombogo, 2013). The study's overarching goal is to delve more into the question of whether or not, among the assortment of group ranches in the study region, livelihood diversification, successfully reduces vulnerability at the family level.

Mobility is a prerequisite for pastoralists to adopt as an adaptation strategy, according to Ndikumana (2000); however, he does not elaborate on the manner in which mobility mitigates vulnerability to climate variability. This study provides an in-depth understanding of how Maasai pastoralists in Kajiado manage their vulnerability via wage labour (Adano & Witsenburg, 2004). Households employ various strategies to mitigate risk, one of which is wage labour.

Pastoralists employ a wide array of additional tactics in order to boost the survival rate and productivity of their livestock, thereby reducing the susceptibility of households to environmental unpredictability. Risk sharing through the division of livestock among clansmen, acquaintances, and relatives residing in regions less affected by drought, paddocking, vigilant surveillance of livestock and environmental fluctuations, and the implementation of early warning systems are a few examples. Pastoralists' indigenous knowledge has ceased to be relevant (Boko et al., 2007). In addition, Macchi (2008) notes that the indigenous knowledge of marginalized pastoralists is unlikely to be useful and that the magnitude of future climate threats will likely exceed their capacity for adaptation.

Abate (2016) found that some traditional coping methods used by pastoralists in southern Ethiopia had lost their efficacy and were difficult to adapt elsewhere. Therefore, it is crucial to include contemporary adaptation strategies with traditional understandings and account for gender-based assumptions in order to overcome climate volatility (Daze, 2012). Kihila (2018) adds that if communities are able to overcome the existing constraints, sustainable indigenous practises can enhance the management of the negative consequences of climate unpredictability. Various studies, suggest that using indigenous knowledge when mobilizing resources since many projects fail to acknowledge the community's resources for indigenous knowledge. Indigenous wisdom becomes irrelevant as a result of acculturation and Western influence. It is crucial to create documentation strategies and databases sensitive to cultural differences in order to preserve indigenous knowledge. Furthermore, it will be beneficial to combine scientific and indigenous coping methods through culturally sensitive technology transfer in order to address the increasing severity of climate risks.

Climatic variability has a significant effect on pastoralists, however the level of vulnerability is depended upon various factors, such as alternative sources of income, the age of household heads, the number of dependents, the prevalence of illiteracy, the availability of early warning information, the nature of the workforce, and the state of existing institutional structures (Opiyo et al., 2014). To what extent pastoralists are able to adapt to climate change depends on social aspects like education and food security, economic factors like per capita income, and physical features like natural resources. Their instigation of unfavourable conditions severely limits the ASALs' capacity for adaptation (Duguma, 2013) recommends establishing frameworks for resource sharing, building water basins and boreholes, mapping natural resources to facilitate sharing, ensuring safe migration, and encouraging peaceful dialogue between warring tribes to lessen the likelihood of conflict. Afforestation and replanting are viable options for the ASAL's dry ecosystems. Trees provide several benefits, including reducing desertification and increasing land cover (UNDP, UNCCD, and UNEP, 2009).

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To adapt to climatic unpredictability, pastoralists must surmount both internal and external challenges. Disputes with neighbouring communities regarding grazing land, water sources, borders, and agricultural expansion are examples of external obstacles (Eriksen & Marin, 2011). Internal barriers to adaptive capability include familial disputes, the poaching of livestock, and vector-borne diseases. Additional external barriers encompass limited engagement in community affairs, insufficient coordination and policies by the government, restricted availability of financial support, information, markets, grazing land, veterinary services, illiteracy, knowledge, and skills, as well as veterinary services, water sources, and grazing land (Riche et al., 2009). Moreover, historically, women have been the most susceptible group in times of famine and drought; therefore, societal norms and customs that allocate responsibilities and obligations to men and women hinder the development of exceptional adaptability (Omolo, 2010).

MATERIALS AND METHODS

The study took place at the southern part of Kajiado County in Amboseli Ecosystem. The study area was subdivided into six sections named as group ranches for purposes of this study. Some are existing group ranches whereas some have since been converted into individual parcels of land. Kimana/Tikondo, Olgulului/Olararashi, Eselenkei, Mbirikani, Kuku, and Rombo). Amboseli Ecosystem is situated between longitudes 36º 0'E and 37º0'E and latitudes 1º0'S and 3 º0'S. It covers approximately 506,329 hectares with a population of 191,846 people and 47,058 households (KNBS, 2019). The residents of this area are mainly Maasai whose main source of livelihoods is Pastoralists.

Determination of the Sampling Size and Sampling frame

A formula by Kothari (2004) was used to determine the sample frame for each group ranch as follows:

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

Where Pi represents the proportion of population included in stratum i, N1 –Population size of the strata, N is the total population of the study area, n represents the sample size.

Table 1: Sampling Frame showing the sample size drawn from each Group Ranch

Group Ranch/Strata	N_1	N	$P_1 = N_{1/N}$	n	$n_1 = P_{1*} n$
Olgululi-Ololarashi	4452	47058	0.0946	384	36
Eselenkei	1232	47058	0.0262	384	10
Imbirikani	6631	47058	0.1409	384	54
Kimana	9261	47058	0.1968	384	76
Kuku	11172	47058	0.2374	384	91
Rombo	14310	47058	0.3041	384	117
Total	47058				384

Data Collection and Statistical Data Analysis

Primary data was collected through semi structured questionnaires, which were administered to randomly selected Maasai pastoralists. Climate data was obtained from Kenya Meteorological Department. Satellite images were acquired from GIS and remote sensing. Data was collected during dry and wet seasons of both short rains (September, October and November) and long rain in March, April and May. Formal consent was sought from the respondents before participating in the data collection process. Collected primary data was cleaned and coded. It was further analysed using inferential statistics, ANOVA and regression analysis. Qualitative data was analysed through thematic analysis and PCA was used to analyses relationships between livelihood vulnerability indicators.

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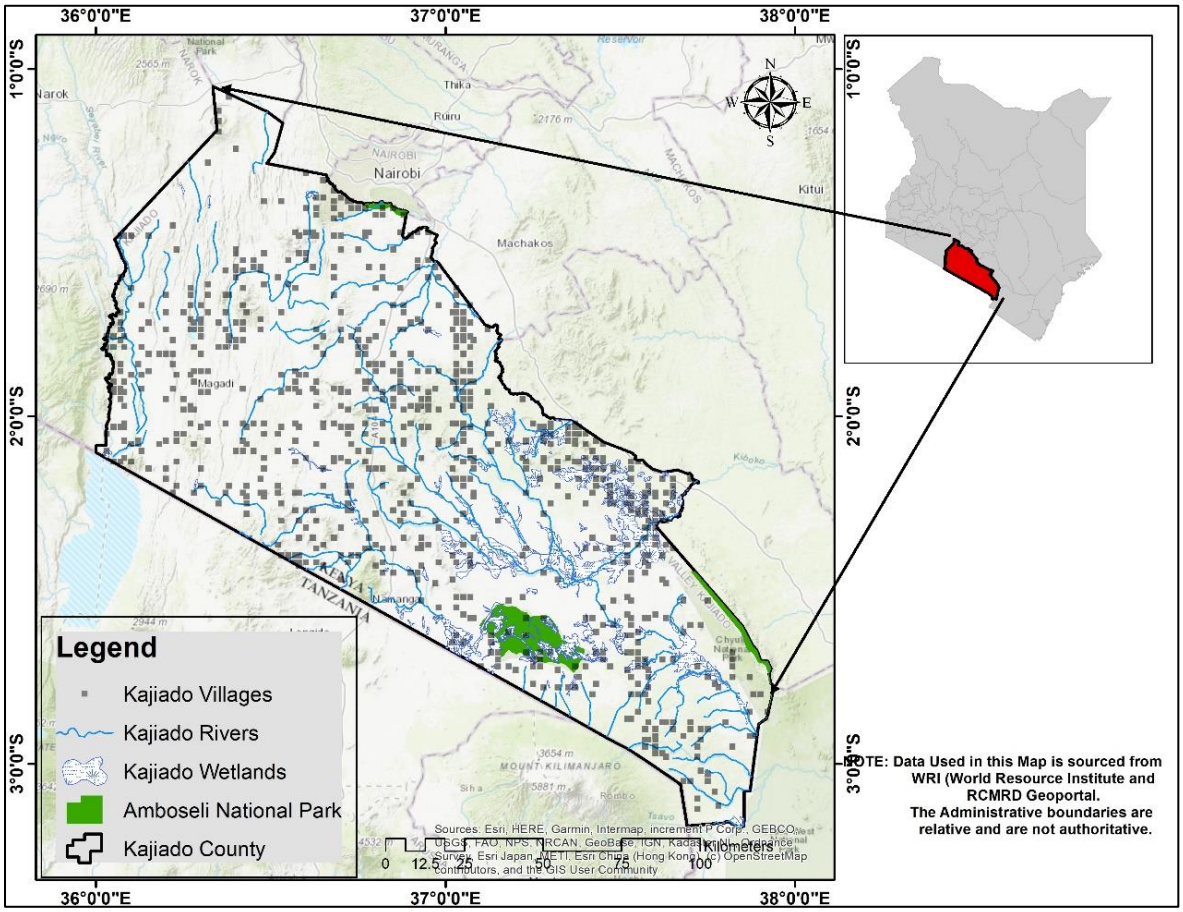
Study Area

Figure 1: Map of Kajiado County showing drainage pattern, key wetlands distribution of human settlements, Amboseli National Park and the rangeland hosting the group ranches



Source: (RCMRD, 2021).

RESULTS AND DISCUSSIONS

Participants were asked to assess how much they agreed or disagreed with statements about the Amboseli ecological region's selected adaption measures. For this analysis, we used a three-point Likert Scale. The scale went from "Disagree = 1" to "Agree = 3". We arbitrarily assumed that the "Disagree" rating represented a variable with a mean rating of 0 to 1.4 on the continuous Likert scale (where 0 Mean 1.4). To illustrate a 1.5-point scale, we used the "Moderately agree" score. We interpreted a "Agree" rating as standing for a variable whose mean rating was between 1.5 and 3.0 on a continuous Likert scale (1.5 Mean 3.0). *Table 3* below shows the results.

Results show that the community has embarked on adaptation strategies to reduce vulnerability. Some of these strategies are government introduced such as boreholes, water pans construction, Livestock insurance and Land demarcation while others are initiatives by the community itself such as beading, crop farming and small business enterprises and some by well-wishers for example IFAW, Amboseli Trsut for Elephants, Big Life foundation and ACC. All of the strategies above be it by the government, community or general are all reducing vulnerability in different levels.

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Table 2: Adaptation strategies across GRs

Adaptation Strategy	Mean	Std.	Analysis N
The Amboseli Ecosystem has enough Boreholes that have been introduced by government	1.99	.153	362
There is Water pans Amboseli Ecosystem region that have been introduced by government	2.06	.431	362
There is land demarcation Amboseli Ecosystem that have been introduced by government	1.57	.407	362
There is insurance for livestock and crops in Amboseli Ecosystem that have been introduced by government	1.63	.229	362
The government has put in place installation of early warning systems as an adaptation strategy to deal with climate variability	1.69	.160	362
The Community has put in place cultivation as an adaptation strategy to deal with climate variability	2.47	.777	362
The Community has embarked on wage labour as an adaptation strategy to deal with climate variability	2.02	.375	362
The Community has embarked on small scale enterprise as an adaptation strategy to deal with climate variability	1.56	.636	362
The Community has embarked on bead making as an adaptation strategy to deal with climate variability	1.79	.602	362

Source: Survey data (2021)

The community adaption approaches had the highest coefficient of correlation ($r = 0.646$, $p < 0.001$), while the government plans demonstrated a slightly lower coefficient ($r = 0.668$, $p < 0.05$). These results indicate a significant and positive association between the two factors. A strong favourable association exists between government and community activities ($r = 0.655$, $p < 0.05$). This indicates that there was a statistically significant correlation between each adaption variable and the total score. The study's focus group discussions (FGDs) and interviews support and confirm these findings. According to a focus group discussion, there is a scarcity of grazing during dry seasons, particularly in the Rombo region. Pastoralists turned to agricultural farming and employment for wages as a strategy to cope with the decline in their main source of income. Nasipa village, primarily known for livestock rearing, faced challenges during drought seasons when their herds were unable to graze in their usual habitats. Consequently, the villagers depended on neighbouring villages such as Maili Tatu for provisions of food. In order to support this assertion, an interview conducted with KWS in Amboseli and another one at the IFAW office in Amboseli shown that the local population largely depended on bead manufacturing and tourist entertainments as strategies to deal with the unpredictable climate. The FGDs performed in both Kimana and Imbirkani revealed that the most prevalent methods of adaptation were planting crops and generating income.

Table 3: Correlation Results on Adaptation Strategies

		Reduction of vulnerability due to climate variability stresses
Government adaptation strategies	Pearson Correlation	.668
	Sig. (2-tailed)	.002
Community adaptation strategies	Pearson Correlation	.646**
	Sig. (2-tailed)	.000
Household adaptation strategies	Pearson Correlation	.655
	Sig. (2-tailed)	.001

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Regression Analysis between Strategies and their Effect on Household Vulnerability

The examined adaption techniques encompass crop cultivation, employment, small-scale entrepreneurship, tourist (hospitality) entertainment, and bead production. The categorization was divided into three groups: general adaptation techniques, community adaptation strategies, and government initiatives (at the national and county levels). An analysis was conducted to assess the efficacy of each category, with the aim of formulating practical suggestions for different stakeholders. Household-level adaptation methods were those specifically tailored to individual households, whilst community-level adaptation strategies encompassed those used by the entire community.

Government strategies refer to the specific measures implemented by the government, either at the county or national level, in the research region to mitigate the effects of climate change and variability. Presented here is the concise overview of the three kinds of adaption techniques.

The community adaption approaches had the highest coefficient of correlation ($r = 0.646$, $p < 0.001$), while the government plans demonstrated a slightly lower coefficient ($r = 0.668$, $p < 0.05$). These results indicate a significant and positive association between the two factors. A strong favourable association exists between government and community activities ($r = 0.655$, $p < 0.05$). This indicates that there was a statistically significant correlation between each adaption variable and the total score. The study's focus group discussions (FGDs) and interviews support and confirm these findings. According to a focus group discussion, there is a scarcity of grazing during dry seasons, particularly in the Rombo region. Pastoralists turned to agricultural farming and employment for wages as a strategy to cope with the decline in their main source of income. Nasipa village, primarily known for livestock rearing, faced challenges during drought seasons when their herds were unable to graze in their usual habitats. Consequently, the villagers depended on neighbouring villages such as Maili Tatu for provisions of food. In order to support this assertion, an interview conducted with KWS in Amboseli and another one at the IFAW office in Amboseli shown that the local population largely depended on bead manufacturing and tourist entertainments as strategies to deal with the unpredictable climate. The FGDs performed in both Kimana and Imbirkani revealed that the most prevalent methods of adaptation were planting crops and generating income.

ANOVA was employed in this study to assess the goodness of fit of the model. The results are presented in *Table 4* below.

Table 4: ANOVA results on the goodness of fit of the model under study.

Results on the goodness of fit						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
General adaptation Strategies	Regression	2.309	4	.567	89.983	.000[b]
	Residual	16.999	357	.038	62.992	
	Total	19.308	361		55.439	

a. Dependent variable: Reduction of vulnerability due to climate variability stresses.
b. Predictors: General adaptation strategies

When examining the general adaptation strategies, the generated F figures were as follows: $F = 89.983$, $F = 62.992$, $F = 55.439$. These F-values demonstrated significance at the 5% level (Sig. $F < 0.05$), indicating that the models were appropriate for defining the relationship between the dependent variable and the independent variable. This suggests that the variables selected for this study were indeed correct. General adaptation strategies encompassed measures implemented at the household level, such as crop farming, small business enterprises, and employment. The study revealed that bead making was the predominant adaptation strategy,

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particularly in the Olgulului-Ololarashi group ranch. This was especially prominent in the Amboseli area, which experiences a significant influx of tourists, particularly during the high season from August to December.

Eselenkei, the second group ranch in terms of livestock holdings, displayed the fewest adaptation strategies. The study suggests that residents in this area should consider adopting a pasture harvesting mechanism akin to the one implemented in Olkiramatian in Kajiado East. Additionally, there's a recommendation to increase the number of wells and water pans through collaborative efforts involving county/national governments, NGOs working in the area, and other well-wishers. This would enhance water availability and subsequently reduce vulnerability. Another proposed strategy is for the community to explore livestock insurance against drought, diseases, and famine. Additionally, they could diversify by engaging in crop cultivation during the rainy seasons. These measures can contribute to improved resilience against the impacts of climate variability.

Table 5: Regression results on adaptation strategies

Model			Unstandardized Coefficients		Standardized Coefficients	t-test value	Sig.
			B	Std. Error	Beta		
General adaptation Strategies	(Constant)		1.506	.026		14.585	.000
	Government adaptation strategies		.495	.141	-.037	-4.638	.000
	Community adaptation strategies		.531	.030	-.101	-.011	.000
	General adaptation strategies		.649	.012	.029	1.498	.000

a. Dependent Variable: Reduction of Vulnerability Due to Climate Variability Stresses,

The calculated t-value for the constant (t = 14.585) is highly significant at the 0.000 percent level (Sig. p < 0.05). This indicates that all the independent variables included in the study have a significant effect. The results demonstrate that each of these variables is statistically significant, as their p-values are below 5%. Based on the beta results, the study interprets the model as follows:

$$y = 1.506 + 0.495x_1 + 0.531x_2 + 0.649x_3$$

The beta value of 0.495 indicates that government adaptation policies have a considerable and favourable impact on lowering susceptibility caused by the stress of Climate Variability. This is due to the presence of adjacent boreholes, which decreased the distances people had to traverse in order to find water. Consequently, women, who mostly focus on household tasks, have the opportunity to engage in income-generating endeavours like bead making and small-scale commercial ventures such as selling milk. Over time, the level of susceptibility in households decreased. These data suggest that increasing Government adaption initiatives in the area resulted in a significant 49.5% decrease in sensitivity to climate pressures.

The implementation of community adaptation measures had a notable impact on reducing sensitivity to climate-related pressures in the region, as evidenced by the beta value of 0.531. This indicates that for every one unit increase in community adaptation techniques within the Amboseli environment, there was a corresponding 0.531 decrease in vulnerability. Community adaptation options would involve using pasture management techniques, such as designating a specific area of land within the community for usage during periods of drought. Additional methods under this category encompassed the practice of clansmen sharing risks and providing annual financial assistance to school-going youngsters from disadvantaged households, which was particularly prevalent in the Olgulului-Ololarashi group ranch. Furthermore, the community excavated shallow wells at

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appropriate locations along seasonal rivers. Moreover, the group possessed a robust network that provided them with information on regions that had seen higher precipitation and had sufficient grazing land. This allowed them to relocate to such areas during periods of drought, which decreased their susceptibility to losses in cattle.

Community food preservation tactics were utilized to mitigate hunger during drought seasons when food supply was limited. These efforts involved preserving food using traditional knowledge.

The implementation of general adaption measures has a notable impact on mitigating susceptibility. Throughout Amboseli ecosystem there was a beta coefficient value of 0.649 which suggested that a unit increase in General adaption mechanisms within the region resulted to a 0.649 change in decrease in susceptibility due to climate variability stressors.

Common adaptation tactics encompassed the implementation of water rationing measures during periods of drought, provision of veterinary services by various entities including the County government, national government, and philanthropic organizations such as IFAW and Big Life Foundation. KWS, for instance, has been reported to engage in collaboration with the local community. This collaboration aims not only to protect their livestock from predators but also to actively participate in Community Social Responsibility initiatives. As part of these efforts, KWS assists the community by providing water transportation services during important ceremonies such as marriages, initiations, and graduations, utilizing their institutional vehicles. This fostered a really positive rapport between the Community and Kenya Wildlife Service. The implementation of these efforts leads to an enhancement in the safety of wild animals, as the community has wholeheartedly embraced wildlife conservation, resulting in the accumulation of many advantages. In addition, old prestige acts like a lion hunt by morans were now perceived differently since the society had a different perception of wild animals owing to the accompanying advantages. The community derived more employment opportunities from the local NGOs and KWS. Young graduates obtained employment possibilities with organizations that ultimately decreased home vulnerability by providing money and making basic requirements more affordable.

Additionally, it was alleged that scholarships were provided to academically talented yet financially disadvantaged pupils. The Big Life Foundation assists school-going youngsters in high school, universities, and colleges. In order to motivate and encourage hard effort, the organization provides a full scholarship to every top-performing student who successfully completes both the Kenya Certificate of Secondary Education (KCSE) and Kenya Certificate of Primary Education (KCPE) examinations. This served as a source of incentive for applicants annually, inspiring them to become more focused, diligent, and strive for excellence in their exams, with the aim of obtaining scholarships that would ultimately alleviate their families' financial problems.

Furthermore, Kenya Wildlife Services has employed community rangers to oversee the interaction between domesticated animals and wild creatures during daylight hours, particularly in grazing areas. These rangers also maintain accurate records of incidents involving predation. This effort effectively halved human-wildlife confrontations by providing compensation to affected communities based on the kind and number of livestock lost, as well as the nature of the conflict. The Kenya Wildlife Service (KWS) played a crucial role in administering these compensations. This circumstance resulted in a mutually beneficial outcome for both the community and KWS. Livestock keeping continued as usual, but at the same time, efforts were made to conserve and protect wild species that were previously at risk of being killed. The provision of community benefits and enhancement of their quality of life has fostered a positive and collaborative connection between benefactors and the Community. This has greatly

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facilitated research endeavours, allowing for seamless operations throughout the Amboseli Ecosystem.

CONCLUSION

Households in the Amboseli Ecosystem adopted to some strategies in order to cope with climate variability. The adaptive strategies were diverse and were largely influenced by financial capacity of the household. The strategies included crop farming, small business enterprise, employment, tourism and bead making. These strategies reduced vulnerability to climate stress but they were not sufficient to shield households during periods of severe drought. As a result, women respondents called for empowerment by improving their financial capacity through self-help groups that enable them to gain financial independence and access to loans to start up small business enterprises, which improve income and reduce vulnerability at the household level.

Recommendations

The County government together with well wishes could Improve efficiency of existing adaptation strategies, such as farming, bead making and create viable women-led enterprises that improve livelihoods at the household level.

That there is need to set up milk coolers at strategic location in the group ranches so as to minimize milk losses, which reduces disposable income by the County government, office of the Woman representative. There should be collaboration among the county government, national government and non-governmental organizations to reduce the levels of poverty in the pastoralist communities through sustainable adaptation strategies that can reduce inequality; such could be done by increasing employment opportunities among young graduates at the household and community levels through affirmative action.

The national government through Parastatals should sink boreholes and construction of water pans in strategic areas across the six group ranches in order address water scarcity and reduce competition of livestock and wildlife in few water sources, thereby degrading the land and creating conflicts with livestock owners. Capacity building among pastoralists should be conducted by the County government, well-wishers, group ranch leaders and Amboseli Ecosystem Trust to fodder production in the huge pieces of land so as to reduce vulnerability of livelihoods to climate change and variability.

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