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Effects of climate-change variability on livestock production and coping strategies in Maikona, Marsabit County, Kenya

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Abstract. *Wato M, Koech MK, Maraga JN. 2022. Effects of climate-change variability on livestock production and coping strategies in Maikona, Marsabit County, Kenya. Intl J Trop Drylands 6: 90-102.* Climate change is viewed as one of humanity's greatest challenges. This study sought to investigate the coping mechanisms pastoral communities have employed in Maikona Location (Marsabit County, Kenya) and their sustainability. The study employed quantitative and qualitative methods, targeting 145 respondents, including 127 household respondents, 14 Women and Youth group members in FGDs, and 4 technical/NGO representatives. Questionnaires, FGDs, and key informant checklists were the main tools. Data were analyzed both inferentially and descriptively. The study envisioned would give vital information to policy-makers and pastoral development stakeholders on the actual impacts facing the pastoralists and the existing and appropriate coping mechanisms while guiding the interventions and policy options. The study found that there had been real and perceived changes in temperature and rainfall patterns. Field inquiries indicated rainfall patterns significantly changed (94%) between 1980 and 2010, as well as a significantly declining trend of the data from the metrological department. These changes were established to negatively impact livestock production and the livelihood of the community in the study area. The local community was found to seek relief food, buy food on credit and sell livestock assets as common coping strategies. The sustainability of those strategies, however, is in immense doubt since most of the respondents were not even sure of their longevity, while others admitted they might not use them for long. Moreover, most (84%) of the respondents could not tell the consequences of their strategies on the environment. The external supports provided to the communities were largely in response to emergencies and were not viewed as sustainable in the long term. The study recommended constantly sharing rainfall data from the metrological department with the pastoralists to understand the dynamics of rainfall and temperature variations on livestock production and possible coping strategies customized for their situation and advise them on sustainability. The study further recommended the need for long-term support like establishing a livestock market, supporting education through sponsorship, and adopting policies that support mobility instead of sedentarization of the communities.

Keywords: Climate change, communities, livestock, Maikona

INTRODUCTION

Climate change has been defined as a significant variation of the mean state of climate-relevant variables such as temperature, precipitation, and wind over a period, mostly taken over 30 years (IPCC 2007; Srivastava and Rai 2012). Global climate change is a major threat that is greatly facing humanity. According to Intergovernmental Panel on Climate Change (IPCC 2007), climate change has increased global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea level. At continental and regional levels, numerous long-term changes in climate have been observed. They include the widespread changes in precipitation amounts and distribution, wind patterns, ocean salinity, and aspects of extreme weather resulting in heavy precipitation, heat waves, droughts, and the intensity of tropical cyclones. These changes threaten community ecosystems, livelihoods, and social groups (Watson et al. 1998; O'Brien and Leichenko 2000). As a livelihood option, the agriculture/Livestock production sector is one key sector that will bear the brunt of climatic changes.

Africa is one region where the effects of climate change are being felt particularly hard. Because of the lack of development, economic, and institutional capacity, African countries are supposed to be among the most vulnerable to the impacts of climate change (IPCC 2001). Therefore, climate change impacts can undermine and even undo the progress of Africans in improving their socio-economic well-being, including East Africans (WWFN 2006). In addition, many factors, including human diseases, widespread poverty, and high population density, also compound the negative impacts associated with climate change. For example, the increasing population pressure is estimated to double the demand for food, water, and livestock forage within 30 years (Davidson 2003).

Arid and Semi-Arid Lands (ASALs) and the poor are the most vulnerable and likely hardest hit by climate change due to their low adaptive capacity (IPCC 2001). Globally, those risks threaten around 70% of rural people living in extreme poverty (OECD 2001). Moreover, despite their low contribution to greenhouse gases, developing countries are experiencing the adverse impacts of climate change. Therefore, climate change seriously threatens the livelihoods and food security of millions living in Africa's

arid and semi-arid lands (WWFN 2006). That is because the agricultural systems and food production in Sub-Saharan Africa (SSA) primarily rely on climate-sensitive rainfall (Ketiem et al. 2009). The region's climatic data analysis shows that rainfall coefficient variation in semi-arid tropics can be as high as 50%. In contrast, most annual rainfall often falls in a few rainfall events within three to five months. Therefore, predictions indicate a more severe crop production decline is expected in many parts of Africa, leading to malnutrition, insecurity, hunger, and migrations (Ketiem et al. 2009).

The ASAL areas face several challenges, including the impacts of climate change. According to KARI (2004), one of the main challenges facing the ASALs ecosystem is enhancing communities' resilience, in which their livelihoods entirely depend on climate-sensitive resources. The vulnerability of pastoralists is escalating due to increasing population growth, recurrent natural disasters, and the declining carrying capacity of the land. The general agreement is that pastoral areas face an increased drought risk due to high temperatures and increased rainfall variability (IPCC 2007). Climate change impact has pushed many of the households in the ASALs to resort to several coping strategies. Moreover, many pastoral households have resorted to settling near trading centers and water points to access relief food and water without burdening their beast burdens to seek casual employment and allow easy movement of their herds. However, the failure of such coping strategies might endanger the pastoralists' survivalists. Some fear that pastoral livelihoods, especially in East Africa, are already rapidly becoming more unsustainable than other forms of rural livelihood (Morton 2010). The pastoralist might therefore be in danger of being the first environmental refugees. More research on the impact of climate change is needed for the pastoral system (DFID 2009).

Thus, this study is an effort aimed at reducing this gap by looking at the specific impact climate change has on the livelihoods of the pastoralists and what they do to cope as well as analyzing the effect of those coping mechanisms.

MATERIALS AND METHODS

Geographical features of the study site

The Maikona location is within the Chalbi desert basin in Kenya, below 600 m asl (Table 1). Therefore, the rainfall in the study area is usually unreliable, erratic, and highly variable in space and time. However, rainfall is the most important climatic factor affecting biological productivity and the widespread residents' economy. Though quite unpredictable, the area receives a bi-modal rainfall pattern averaging about 200-300mm per annum. The area's average temperature is about 30°C (Climate-Data.org 2015).

Design and locale of the study

The exploratory study employed both qualitative and quantitative methods, using the cross-sectional survey approach. The major study focused on assessing climate change has impacted the livestock production system and the coping strategies nature employed by pastoralists concerning the impact of climate change. Further, this study examined the sustainability of coping strategies employed. The study site was the Maikona location of Marsabit County, chosen because it is largely a pastoral district and is believed to give a good insight into the impact of climate change on the pastoral livestock production system. Therefore, this specific site was the Maikona sub-location. The study was conducted in villages around the Maikona trading center, whose geographical coordinates range from 2°54'02.30"N to 2°57'16.70"N and 37°37'55.40"E to 37°40'03.60"E.

Study population and sampling procedure

The study was conducted in the Maikona location of Marsabit North District. A total of 145 respondents participated in the study, including 127 household respondents, 14 Women and Youth group members in FGDs, and added with 4 technical/NGO representatives. According to the 2009 census data, Maikona had 1,265 households. Therefore, the households acted as the sampling frame. The researcher sampled 10% of the study's total households following Mugenda and Mugenda's (2003) sample determination. The 10% samples were taken to translate to a sample of about 127 households in three village clusters, as shown in Table 1, which were selected using systematic random sampling.

The quantitative data was collected by the pre-determined household interview schedule, while qualitative data were captured using key informant interviews and Focus Group Discussions (FGD). The heads of each household were the main respondents. In case the heads were unavailable, interviews were presented by the senior most adult. The researcher also interviewed selected purposive key informants, namely the Metrological Department officer, Arid Land Resource Management Officer, Livestock production officer, and a Pastoralist Community Initiative Development and Assistance (PACIDA) officer as an NGO representative. Besides the key informants' interviews, the researcher also conducted Focus Group Discussions (FGDs) with members of the pastoralist households. Youths (both females and males) and adult females were mainly targeted in the focus group discussion to incorporate their views because household heads, though as respondents for the household questionnaires, were expected to be mainly male adults. The groups had at least six members to enhance openness considering homogeneity in each group. In addition, secondary documents were reviewed to triangulate and compare the emerging issues. The secondary documents reviewed included documentaries, previous studies, and program reports by non-governmental and governmental bodies.

Table 1. Village clusters and the number of households sampled

No.	Village clusters	Number of respondents
1	Oromo Gala/Katello Demo	46
2	Guyo Roba	41
3	Diba Okotu	40
Total		127

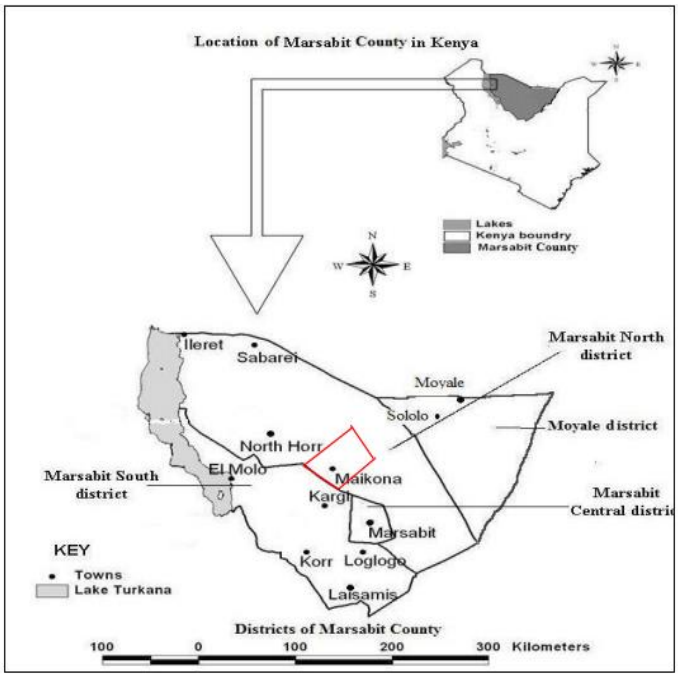

Figure 1. Map showing the study area in Marsabit County concerning Kenya (Waweru 2010)

Research instruments

The questionnaire was the main tool used to get views of the pastoralist households to gather information. At the same time, the Focus group discussion checklist helped gather information from the groups, mainly through historical resource trends, resource trends analysis, and problem analysis. A key Informant checklist was also used to gather information from officials of the Meteorological Department, the Ministry of Livestock, and NGOs. At the same time, a documentary review of climate change parameters was done.

Data collection

The collected data included; the traditional weather patterns of the area, historical climatic variables (temperature and rainfall) trends, the trend of the priority livestock numbers as an indicator of production within the last ten years, the awareness level of the pastoralists about the changing climate, the nature and types of the impacts the changing climate variability has had on the priority species livestock production and the coping strategies employed by the pastoralists in a reaction as well as the presence of external support to help the pastoralists adapt to the impacts of climate change.

Data analysis

The questionnaire data were coded, tabulated, and analyzed using Ms excel. The data collected from the officials and key informants were widely analyzed descriptively to align with the research questions. The analyses were used to portray statistical and descriptive inferences. Descriptive statistics were computed to establish the percentage of the responses, and the coefficient of correlation was computed to assess any relationship between livestock production and climatic variables of temperature and rainfall. The analyses result were presented using cross-tabulation tables and graphs (mainly line and bar).

RESULTS AND DISCUSSION

This chapter presents the interpretation and analysis of data collected during fieldwork. The interpretation and analysis are completed within the framework of the core objectives that the study sought to address. The respondents included members of selected households, the Meteorological Department, Livestock production officers, and local NGOs (PACIDA and Care Kenya). Data presented in this study are organized into four themes based on the key research questions that guided fieldwork, which were trends and patterns of temperature and rainfall, the effect of variability in climate parameters and on livestock production, coping strategies employed by the pastoral households, and the sustainability of those coping strategies. This study proceeded in different phases, and the first phase sought to establish the demographic and social characteristics of the respondents.

Demographic characteristics of the respondents

This section presents some of the demographic aspects of the respondents. Accordingly, the main demographic features of the respondents featured in this section include: the gender, occupation, and level of education of respondents.

Distribution of respondents by gender

The researcher found it important to establish the gender proportions of the respondents, and the distribution pattern is presented in Table 1. As described in this table,

most respondents (76%) were men, while the rest (24%) were women. This gender distribution has a lot of implications for understanding the perception of men and women. Also, to understand between male and female members of pastoralist households, the nature of strategies used to cope with adverse weather changes.

Distribution of respondents by the level of education

The researcher sought to establish the level of education of the individual respondents to draw basic indicators of one's socio-economic status. This distribution pattern, presented in Table 1, clearly shows that illiteracy was overwhelmingly high at 95% in the research community, especially among adults.

Distribution of respondents by occupation

Another basic indicator of socio-economic status sought by the researcher using the questionnaire was the occupation of the individual respondents, which is presented in Table 1. Livestock rearing, which the respondents rely on, was reported to be the main occupation, with 93% (n: 127). Casual employment, Business, and those destitute relying upon only relief all at 2% of the respondents, while those in formal employment were only 1 %.

The researcher decided to get the gender dynamics of this occupation because livestock rearing is the predominant occupation. Table 1 shows that more males are involved in livestock rearing than females. However, the difference was possibly insignificant because all family members normally took joint responsibility for rearing their family stock.

Climate parameter variability and their effect since 1980 in Marsabit

The researcher sought to establish the trends and patterns of climate parameters (temperature and rainfall) and their consequences in Marsabit County in Northern Kenya since 1980. This section, therefore, provides the findings on this objective.

Trends and patterns of rainfall in Marsabit County

Respondents were asked several questions about rainfall patterns in the study site. One question was their opinion if there had been changes in rainfall in recent years.

A clear majority of the respondents (95%) confirmed that there had been some changes in the rainfall patterns, while a minority (21%) could not verify whether there had been changes (Figure 2A). The barrier in the interpretation of time and the use of different calendars may have made some respondents not comprehend the changes. Therefore, the researcher sought to find out the real nature of the changes in rainfall. Figure 2B illustrates the result when the respondents were asked to indicate the nature of the changes in the rainfall patterns.

Nearly all the respondents (95%) indicated that the pattern of rainfall decreased as opposed to only 5%, who indicated that the changes as an increase in the amount of rainfall, citing the rains in late 2011 as an example, which was actually outside the study period. In addition, the respondents cited evidence of persistent drought, with a good number putting the drought cycle at every two years.

Table 1. Respondent characteristics (n = 127)

Criteria		Percentage (%)
Gender	Male	76
	Female	24
Education	No	95.3
	Primary	2.4
	High school	0.8
	Tertiary	1.6
Occupation	Livestock rearing	93
	Employment	1
	bussiness	2
	Casual labor	2
	Rely on relief food	2
Gender of livestock breeder	Male	48
	Female	52

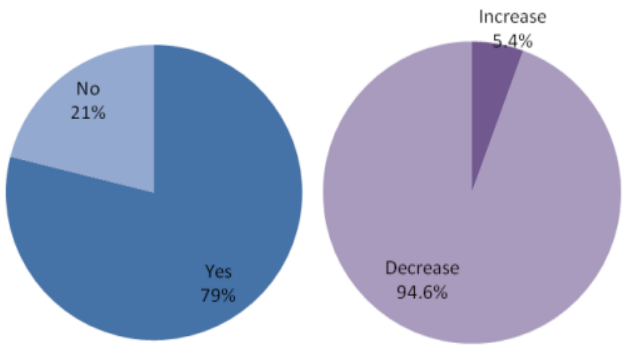

Figure 2. A. Changes in rainfall patterns in recent years. B. Nature of changes in rainfall

The respondents, however, seem oblivious to what caused the changes they experienced, as presented in Table 2. Most (38%) of the respondents negated knowledge of the causes of the changes they experienced. Similarly, a substantial percentage (20%) desperately answered that it was God's plan, and 12% thought it was God's punishment for persistent conflict and people's social ills. Furthermore, 10% thought that it was because the area is a desert and natural rainfall was scarce, and further desertification worsened the rainfall patterns. Only 2%, which was quite insignificant, thought the changes might be due to climatic change. That was an indicator of the community's poor awareness of the climate change facts that the world is grappling with the same problem.

To collaborate with the information from the pastoralists, the researcher sought rainfall data from the meteorological department and plotted it in Figure 3. The data revealed the rainfall pattern was changed slightly, which inclined towards a decrease. There is indeed a consistent pattern of decrease save for the 1997/1998 El-Niño rainfalls. However, it is worth noting that rainfall data are obtained from Marsabit metrological station, about 100

Km away from Maikona (since no such data are available at Maikona) but can indicate rainfall patterns for the entire area.

Impact of the changes in the rainfall pattern

As to the effect of change in rainfall patterns on their livelihoods, an overwhelming majority of the respondents (95%) answers were negative. These results are indicated in Figure 4. The majority of the respondents said that the change in rainfall pattern had a negative impact on them. They mentioned a reduction in pasture production, affecting livestock health and livelihoods. Furthermore, with each drought, the distance to water points was also reported to increase, taking distance for livestock and humans. As a result, during droughts, livestock dies, reducing their numbers and productivity, disrupting livestock breeding, and the numbers dwindle. During persistent droughts, the respondents reported relying heavily on relief food.

Trends and patterns of temperature in Marsabit County

Besides the rainfall issues in the study site, respondents were asked several questions on temperature patterns. One fundamental question was whether there had been changes in temperature patterns in recent years. Their responses were as presented in Figure 5.

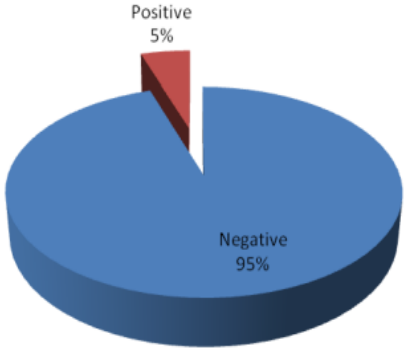

Figure 4. Response of impact of change in rainfall pattern

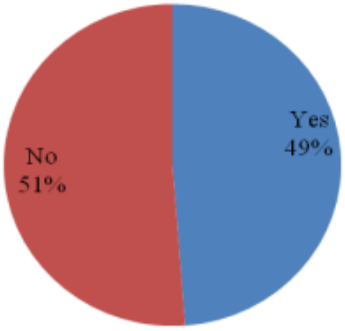

Figure 5. Changes in temperature patterns in the recent years

Table 2. Reasons for the cause of changes in the rainfall pattern in Maikona

Reasons	Frequency	Percentage
For decrease		
Don't Know	48	38
Weakening cultural practices	16	13
Existing desert and desertification	13	10
Social ills and Conflicts	10	8
God's plan and nature	28	20
Climate and weather changes	2	2
Strong wind and dust	2	2
Population increase& over-exploitation of resources	2	2
For Increase		
To save livestock and humans	6	5
Total	**127**	**100**

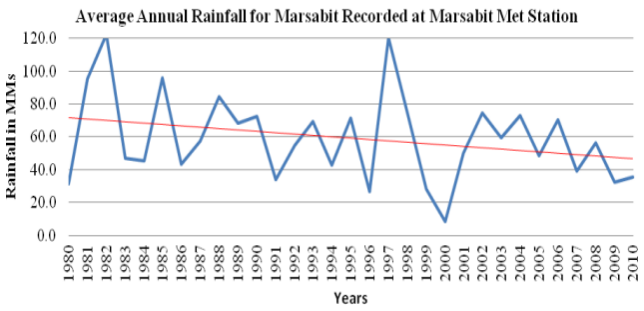

Figure 3. The trend in rainfall pattern in Marsabit between 1980 and 2010 (Source: KMD)

It could be concluded that half of the respondents (51%) said they had not noticed any changes in the temperature patterns, while 49% confirmed that t the temperature patterns had been changed. This disparity was not anticipated, and possible that the respondents may not comprehend or detect changes in temperature patterns. However, they complained that it was very hot those days, even during the interview. Nonetheless, the researcher sought to discover the real nature of the temperature changes. As a result, when those respondents who claimed they had experienced some changes were asked to refer to the nature of the changes in the temperature patterns, a whooping majority (97%) acclaimed to have experienced increased temperature, as indicated in Figure 6 below.

They gave the following justifications, shown in Table 3, when asked further to explain why they thought the temperature in the area was increasing.

As illustrated in Table 3, those factors could possibly increase temperatures as correctly perceived. Though the respondents answered them differently, many of their answers were fundamentally related. Therefore, they all agreed that there was extreme heat during the day. Some argued with cold nights, strong wind, and so on. However, most of the respondents did not exactly know when probed further about the possible cause of these signs and the increase in temperature, as evidenced in the answers tabulated in Table 4.

Most of the respondents (70%) could not tell directly what caused the temperature changes. In contrast, others allude to increases in the sunshine, degradation, drought, and people abandoning their culture hence being punished.

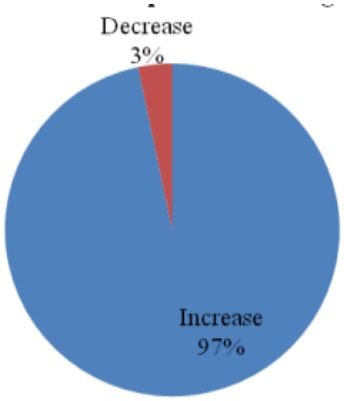

Figure 6. Nature of temperature changes

Table 3. Justifications for the nature of changes in temperature

Justifications	Frequency	Percentage
Heat all through	23	38
Extreme hot days and cold nights	18	29
Very hot during the day	8	13
Hot days with strong dry winds	9	15
Others	3	5
Total	**61**	**100**

Table 4. Reasons for temperature changes

Reasons for temperature changes	Frequency	Percentage
Unknown	42	70
Extreme sunshine	4	6
Drought	10	16
People abandoning culture	1	2
Land degradation	4	6
Total	**61**	**100**

Conventional temperature records

The researcher sought data from the meteorological department to understand the temperature trend in the study area. Though these data were obtained from Marsabit, the researcher believed that the data could give a fairly accurate regional trend. The trend in the temperature is shown in Figure 7A. A close look at this trend shows a marginally increasing mean annual temperature in Marsabit. However, as indicated in the trend line in Figure 7B, the average minimum temperature has increased by 0.6°C. That means the temperature is rising, which collaborates with the response by 38% of the respondents. Conversely, the trend in the average maximum temperature is nearly constant, as indicated in Figure 7C, thus bringing the trend in average annual temperature at a marginal increase of 0.6°C.

Impact of the changes in temperature levels

The researcher sought to investigate the impact of the changes in the temperature levels on the respondents' livelihoods after having established the perceived and real changes in temperature and possible reasons behind the changes. Most respondents (68%) indicated that the impact was negative, and a significant minority (32%) remained non-committal, whom the researcher concluded as lacking a clear understanding of the impact or question. Figure 8 below shows this response.

Interviews with the livestock production officer revealed that the impact was negative, though he could not provide formal data. As a community of pastoralists who entirely depend on livestock, the harsh or rather high-temperature levels made grazing difficult or disrupted the livestock feeding pattern, particularly during the day, reinforcing the responses of negative impacts. The high temperature was also unfavorable to pregnant goats, which many respondents claim caused miscarriage and premature births.

Climate parameter variability and livestock population

In the study area, the research also sought to examine the variability effect in climate parameters and pasture availability on livestock production. To achieve this, the researcher sought the respondents' opinions on the relationship between changes in their livestock production and the climatic variable of rainfall. Their responses are indicated in Figure 9.

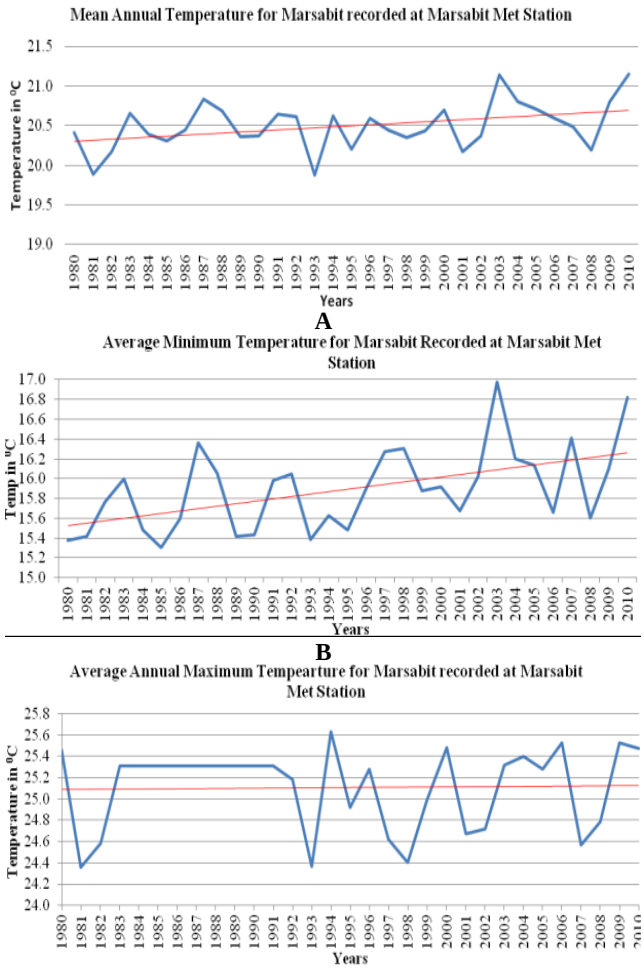

Figure 7. The trend in Marsabit between 1980 and 2010: A. temperature pattern, B. minimum temperature pattern, C. maximum temperature pattern (source: KMD)

Most of the respondents (92%) confirmed a relationship between changes in their livestock production and rainfall. Therefore, the researcher sought to find out from the respondents how the changes in rainfall affected livestock production. Among key issues raised were animals multiply during the rainy season, and increased rainfall increases livestock production, such as milk and meat. Conversely, during the dry season, livestock production reduces since the livestock population decreases because of extreme drought, less fodder, and heavy torrents kill livestock. Figure 9 shows the rainfall pattern from data obtained from Marsabit metrological station.

From the trend line, the pattern is a downward trend. Figure 9 shows that rainfall was highest in 1997/1998 during the El-Niño and lowest in 2000 during a severe drought in which the community reportedly lost many goats and sheep. The population trend for the area's three top-most priority livestock species was plotted to establish the trend and to compare with that of climatic parameters, as shown in Figure 10.

Figures 10 show that the population of goats remained nearly constant, with only a marginal decrease between 1981 and 2007. However, as the trend lines show, the decrease in the populations of camel and sheep is relatively rapid. Even though the population data obtained from the Ministry of Livestock Development is not specific to Maikona Location, for the former Marsabit district, it can be a good indicator of the trend of the livestock population in the area Maikona Location.

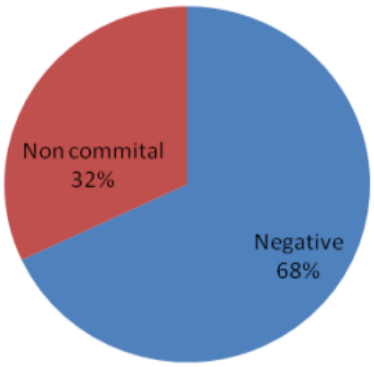

Figure 8. Impact of temperature change

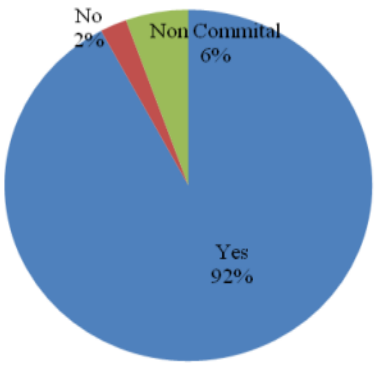

Figure 9. Relationship between changes in the production of your livestock and rainfall variation

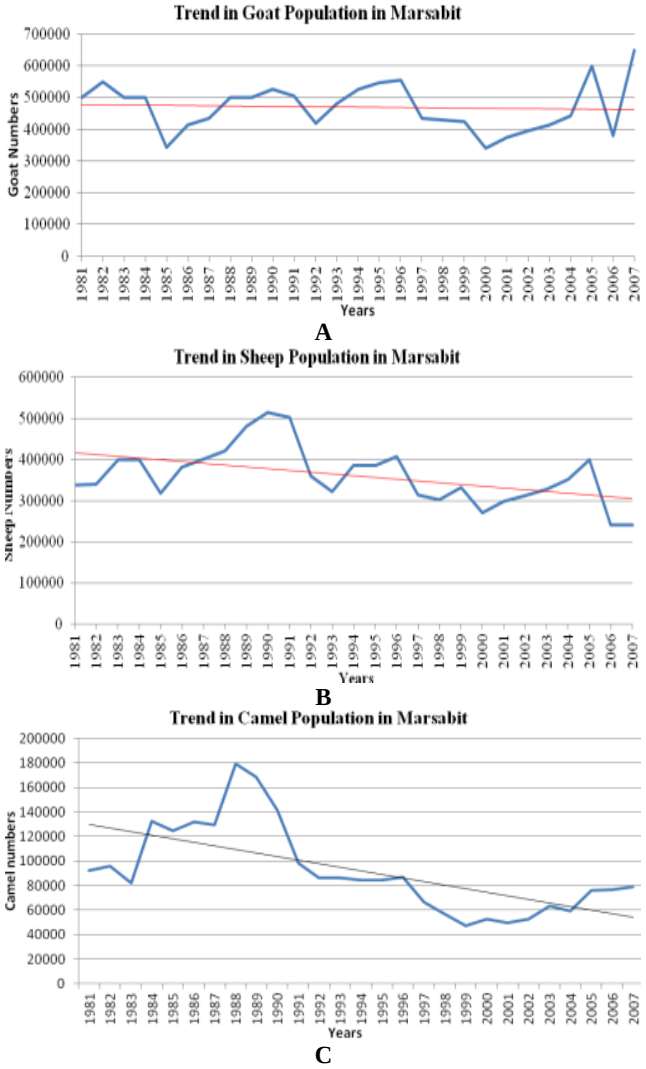

Figure 10. A. The population in the former Marsabit District: A. goats, B. sheep, C. camels (Source: MLD)

Therefore, the researcher envisioned making some conservative conclusions based on the data. Therefore, the population of sheep, goats, and camel in the study area is used since these three livestock types are the priority in terms of livelihood support for the community, as shown in Table 5. This table shows that the respondents' priority livestock types in livelihood support are sheep, the first priority at 80%, and goats, the second priority at 80%. In comparison, camel is the third most important livestock supporting community livelihoods at 79%. Therefore, the impact of the community's survival in the study area of climatic variables on these three most important livestock species is critical.

Relationship between climatic variables and livestock population

The researcher felt there was a need to determine the relationship between the climatic variables of rainfall and temperature and the three important livestock species. That would help establish whether the variations in livestock numbers were, indeed, a result of variations in climatic parameters.

Table 5. Priority response

Livestock type	Frequency	Percentage
1st livestock response		
Goat	10	8
Sheep	102	80
Cattle	0	0
Camel	10	8
Donkey	0	0
Others	5	4
Total	**127**	**100**
2nd livestock type		
Goat	101	80
Sheep	17	13
Cattle	0	0
Camel	2	2
Donkey	0	0
Others	7	6
Total	**127**	**100**
3rd livestock type		
Goat	8	6
Sheep	3	2
Cattle	6	5
Camel	100	79
Donkey	0	0
Others	10	8
Total	**127**	**100**

A closer look at the figures in Tables 8a and b reveals mixed relationships, which is not very obvious. However, in an actual sense, one would expect an obvious straight relationship between livestock population and those climatic variables. That may be attributed to the data quality, especially livestock data, due to the gaps and the fact that they were mainly estimates, even though some weak relationships can be observed. For example, the relationship between rainfall and goat and sheep population is weak and tends towards negative. One would expect this relationship to be strong and positive, but this is not obvious because the livestock population does increase even by a reducing margin as the human population owning the livestock increases. Again the rainfall measurement is confined to Marsabit meteorological station. At the same time, the livestock population is widespread, and due to the nomadic nature of the population, it may not be easy to correlate to the rainfall.

Nevertheless, the relationship between rainfall and camel population is positive, meaning that the camel numbers decrease and increase with rainfall. This trend is expected and may be accurate as opposed to goats and sheep since the camel population is not as naturally high as sheep and goats, and even small changes could be felt. Likewise, the relationship with temperature is not as straightforward as anticipated. Therefore, the researcher analyzed the relationship between the annual minimum, maximum, and average annual temperatures to enhance the actual position. Goats and camel numbers seemed to have a negative relationship with average annual temperature, which may be so because extreme temperatures do negatively affect livestock populations. On the other hand, the sheep population seemed to be more sensitive to minimum temperatures than the maximum.

Coping strategies to climatic parameter variations

This study was also attracted to coping with climate variability and pasture availability to establish the strategies employed by pastoral households. On this, the respondents were asked to indicate whether there were strategies they devised to survive or reduce the impact of climate variability. Their responses are captured in Table 9.

Asked which strategies they employed, the respondents outlined several strategies, among them separation of livestock herd, diversification of livestock herd, increasing mobility of livestock herd, migration to market centers/water points, buying/borrowing food on credit, reducing frequency/quality/quantity of meals, looking for casual employment, engage in small businesses, seeking relief food and remittance from relatives, seeking refuge in education, charcoal burning, change brewing, selling of household assets and livestock. The researcher went further to establish the three top most important priorities. According to the respondents, seeking relief food is the most important strategy at 45% (F: 57). Buying food on credit to be paid when the drought ends is the second priority strategy at 32%. In comparison, selling livestock, including lactating ones, is the third priority strategy at 28%. Other significant strategies worth mentioning are separating livestock herds, diversifying livestock species, increasing the mobility of livestock herds, and seeking casual employment around the trading centers. The result was tabulated in Table 10.

Table 8a. Livestock population and average annual rainfall Pearson(r) coefficient of correlations values

Livestock type	Pearson(r) values
Sheep	-0.0818261
Goats	-0.0232771
Camel	0.1588662

Table 8b. Livestock population and temperatures Pearson(r) coefficient of correlations values

Livestock type	Annual Min. Temp, Pearson(r) values	Annual Max. Temp Pearson (r) values	Ave. Annual Temp, Pearson (r) values
Sheep	-0.2232953	0.0994897	0.1175409
Goats	0.0049123	-0.0477104	-0.0962073
Camel	-0.4009187	0.0791865	-0.0695692

Table 9. Climatic variability coping strategy

Response	Frequency	Percent
Yes	125	98
No/Non-committal	2	2
Total	**127**	**100**

Table 10. Figures of the top three most important priority strategies

Coping strategies	1st Priority		2nd Priority		3rd priority	
	Freq.	%	Freq.	%	Freq.	%
None Committal	2	2	2	2	2	2
Diversification of livestock herd	15	12	8	6	2	2
Separation of livestock herd	20	16	6	5	5	5
Increased mobility of livestock herd	10	8	9	7	7	7
Migration to market centers/water points	7	6	0	0	0	0
Buying food on credit	2	2	41	32	16	16
Borrow food	0	0	2	2	0	0
Reduce the frequency of meals	1	1	0	0	3	3
Reduce the quality /quantity of meals	0	0	3	2	0	0
Rely on relief food	57	45	16	13	26	27
Rely on remittance from relatives	0	0	2	2	2	2
Seek refuge in education	1	1	6	5	3	3
Seek casual employment	9	7	11	9	4	4
Engage in small businesses	3	2	2	2	1	1
Burning of Charcoal	0	0	4	3	0	0
Sale of Livestock	0	0	15	12	27	28
Total	**127**	**100**	**127**	**100**	**98**	**100**

Table 11. Knowledge of the environmental impact of coping strategies

Response	Frequency	Percentage
Yes	20	16
No	107	84
Total	127	100

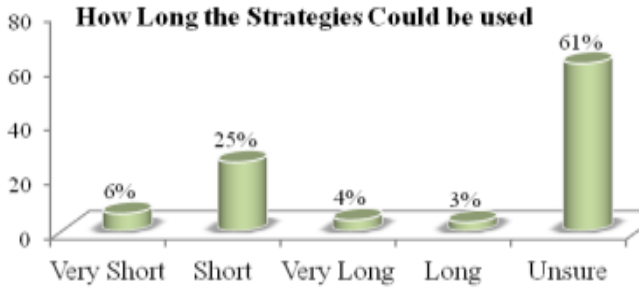

Figure 11. Duration for using the strategy

Sustainability of the coping strategies

Among the many ways sustainability has been defined, the simplest and most fundamental is "the capacity to endure." Sustainability is based on the simple principle that everything we need for survival and well-being depends directly or indirectly on our natural environment. Sustainability creates and maintains the conditions under which humans and nature can exist in productive harmony that permit fulfilling the social, economic, and other requirements of present and future generations.

Duration of the coping strategies could be used

The researcher was therefore interested in establishing whether the coping strategies used by the respondents can remain in serving them. In this study, the respondents were asked to indicate the duration they thought they would continue using these strategies, whose responses were as shown in Figure 11 above. From the graph distribution, it was clear that the respondents were unsure how long they could continue using the strategies they indicated. A significant number, 61%, thought they might not use the strategy for long, while 25% thought it was short-term. Moreover, to probe deeper as to why they would want to use the strategies they had indicated, the respondents gave reasons like lack of education, decreasing number of livestock, persistent drought, lack of capital, unreliable relief, and the general uncertainty of the weather conditions.

Respondent's awareness of the environmental impact of the coping strategies

After a significant establishment of coping strategies that the respondents employ, the researcher sought to find out if they knew of any impact their coping strategy may have on the environment. Table 11 shows the distribution of their responses. From the distribution of these findings, it was clear that most (84%) respondents were unaware of any environmental impact of the copying strategies they employ in navigating climatic changes. That is, in a way, closely related to the profile of the respondents, especially the educational profile. Therefore, this may be an indicator of low environmental awareness and the level of consciousness.

Impact of the coping strategy on future survival

Furthermore, to cement the investigation on sustainability, the respondents were asked whether they knew if their coping strategy (ies) affected their livelihood/survival in the future in any way. About 64% indicated that they knew, while the remaining 36% maintained that they were unaware. Those again become an issue worthy of concern since most of the strategies employed have some impact on the residents' future lives, yet a substantial number were unaware. Nevertheless, a question was posed to those who responded whether they knew the nature of the impact and whether they were aware of the impact of their present strategy on their future livelihood. Out of these, 86% indicated that they thought it was negative, while only 14% indicated that they knew it would be positive.

Some explanations for the negative impacts of those scoping strategies include increased poverty as sources of livelihoods diminish during livestock sales, separation of the family when livestock move far away, and inaccessibility of livestock products such as milk during such times to distance. As nomadic pastoralists settle near water points or market centers to access water and food relief, nomadism dies out, leading to a high concentration of people around those centers, and causing land degradation. Borrowing food on credit plunges the pastoralists' family into a debt cycle and decreases family wealth, risking bad debts for the small kiosk owners. Moreover, since the majority rely on relief food as a strategy, it creates dependency, breaking down the community's livelihood system.

On the other hand, respondents have noted that settling around the market centers for relief food and water has offered them a chance to take their children to school, which will secure their education and extended family. Also, since they relied on the remaining type of livestock when one is affected by droughts, the diversification of livestock herds has helped some respondents sustain their livelihoods. On the other hand, increased herd mobility is reported to have saved some herds during extended droughts.

Constraints inhibiting the development of coping strategies

The researcher sought to establish the constraints that inhibit respondents from developing coping strategies to cope with climate variability trends. Their responses cited some form of inhibition to cope effectively (85%). They mentioned two main constraints: lack of capital at 59% and low level of education at 51% to set up more effective strategies. Other constraints they blamed include the nature of the land and their environment, old age, general body weaknesses, having young children that inhibit long-distance movements, and inability to move long distances due to disability. Others condemned having fewer numbers of livestock or poverty to support them cope effectively, while some widows felt they lacked adequate support to cope effectively on their own. The conflict between pastoral communities in far-flung reserve grazing areas was also blamed for undermining coping. It should be noted that they did not suggest the strategies they would have wanted to set up if had had their capital, or rather, the strategies they had that were hard for them to adopt because of the high expenses involved.

Existence of external support

The researcher sought to know whether there are official government departments or Non-Governmental Organizations that support or ever supported them to overcome the impacts of climate variability. A majority of them, 98%, confirmed their support, while 1.6% denied it in overcoming climate variability's impact. Since many of the respondents had indicated such support, they were asked to indicate the sources of this external support. Their responses are indicated in Table 12.

In this regard, respondents recognize the support from official government departments in helping them cope with extreme climatic conditions at 40%. The NGOs have also been mentioned to cope with the impact of climate change by giving support in helping the people in the study area. The most active NGOs were PACIDA, Christian Children Fund (CCF), Community Initiative Facilitation and Assistance (CIFA), and the Red Cross. The government departments mentioned as giving the most assistance include the Government department of ALMP (now NDMA), the Livestock department, and the Department of Veterinary Services. The department of livestock production and veterinary services combined were mentioned by many respondents, having most supported them, followed by the Office of the President (Provincial Administration) and the ALRMP/NDMA at 15% and 12% of respondents, respectively.

The researcher sought to find out the nature of the support given by the NGOs and the government departments. Respondents gave multiple responses indicating having received more than one form of support. The responses are presented in Table 13 below.

From Table 13, the main form of support given by the government and NGOs was either a food voucher, food relief, or cash relief, followed by destocking and vaccination.

Future strategies for reducing the impact of climate change

The respondents were asked about their opinion of the strategies that would be used in the future and which would reduce the climatic change impact. Their responses were as represented in Table 14.

Table 12. Sources of support

Supporting Institution	Frequency	Percentage
NGOs	74	58
Government Department	51	40
No support	2	2
Total	**127**	**100**

Table 13. Nature of support given by government departments

Nature of Support	Frequency	Percentage
Relief-Food Voucher, Cash relief, Nutritional Supplements	124	98
Destocking and Vaccination	49	39
Animal feed relief	42	33
Non-Food Items-utensils	12	9
Sponsorship of students in education	18	14

Table 14. Possible future strategies for reducing the impact of climate change

Strategy	Frequency	Percentage
Migrate out of the area	8	6
Abandon pastoralism	5	4
Diversify within pastoralism	20	16
Diversify economic activities	47	37
I don't know	47	37
Total	**127**	**100**

The responses depict, owing to the number of respondents unsure what to do (37%), that the community has probably been pushed beyond the limit or with very few options. The same number envisions diversifying their economic activities, but their options seem slim due to an unfavorable environment and poverty. A small number even indicate their despair at the thought of abandoning pastoralism. However, diversification within pastoralism was an option seen by those yet to despair at 16% of the respondents. Some ways suggested for diversification are adding more livestock species, separating the herd, and increasing the herd's mobility. The researcher is also very interested in those who wish to diversify their economic activities to survive the vagaries of the weather. Some options given included seeking casual employment, engaging in petty trade, and some unfavorable means like brewing chang'aa and burning charcoal. They thought these activities might help them survive. Still, the health issues and the acceptability of the chang'aa option were unresolved, while the environmental sustainability of charcoal burning in desert environments that have been degraded may not be feasible.

Suggestions on external intervention

The respondents were asked to indicate what they thought could be done to help them cope with climate change. In their response, they mentioned several suggestions, which include the establishment of stable livestock markets, restocking, enhancement of development activities for casual laborers, creation of more opportunities for casual employment, support education for their children, creation of awareness, especially on environmental conservation, continuous and adequate relief for both animals and people, the provision of water for animals in the areas with pasture and lack of water and awareness creation and capacity building on ways of coping with weather changes. Furthermore, now that mobility is part of the respondents' lifestyle, there were suggestions of support for mobility and continuous peace-building and conflict resolution among the communities.

Discussion

This section presents an interpretation of some of the remarkable findings of this study and its comparison with the limited data available in the area. The section is organized into four thematic areas based on the key research questions of the patterns and trends of rainfall and temperature, the effect of variability in climate parameters on livestock population, coping strategies employed by pastoral households, and an examination of their sustainability.

The gender respondents' composition may have some implications in understanding the nature of strategies used to cope with adverse climate changes. The study established that there were more male than female respondents. That may be influenced by the community's culture, where the male is the family head and is the official spokesperson on every matter, especially if the information seeker is an outsider. Since the pastoralists tend to their livestock as a family unit, however, the respondent's gender may not have much influence on the responses given in other sections. However, it is significant in the research community that illiteracy is overwhelmingly high among adults, consistent with the data from the Kenya Bureau of Statistics (Thornton et al. 2009). Therefore, it is worth recognizing that the level of education influences an individual's understanding of issues and access to information, including options available for adaptation and climate information to adverse climatic changes.

The predominant occupation of the respondents as expected was livestock rearing. However, that could be influenced by several factors, primarily the nature of the environment of the study site. Maikona sub-location is in the heart of the Chalbi desert. That makes farming and other livelihood activities difficult owing to the low precipitation, the rocky nature of the soil, high temperature, and soil salinity levels.

The respondents confirmed that there were changes in the rainfall pattern in the study area, and almost all of those respondents agree that the reduction is the changing pattern. However, the minority who responded to the changes manifested in an increase in the amount of rainfall cited as an example the rains in late 2011, a time which was actually outside the study period, which may be due to the barrier in the interpretation of time since the community uses a different calendar and unable to comprehend the instruction on the study time frame. Also, the persistent drought occurring every two years was cited as an indicator of changing rainfall patterns. This finding is consistent with the IPCC (2007) prediction. However, the respondents were oblivious to what caused the changes they experienced. This ignorance was an indicator of the community's poor awareness of the climate change issues that the world is grappling with, which could be attributed to a lack of exposure beyond their community boundary, the high illiteracy levels, and little understanding of the dynamics of climatic patterns, coupled with heavy reliance on nature and strong cultural ties. Indeed, the metrological data of rainfall obtained from the Marsabit Metrological station collaborated with the community's perception, showing a declining rainfall in the area though marginally. However, due to the lack of such services in Maikona, the data relied upon were collected about 100 km away, and it was believed that it could indicate the trend in the whole County.

According to a study by Witsenburg and Roba (2004) covering the period of 1920-2001, Marsabit and Moyale stations, from the long-term mean of 81 years, registered an annual rainfall deviating at least 75%. The study illustrates that Marsabit station registered a sharp fall in the annual rainfall during the last 40 years or so of the study period. Regarding the decadal differences, the rainfall between 1960 and 2001 shows a more proportionate decrease (relative decrease of 8.7% per year) than a marginal increase between 1919 and 1960 (at a relative rise of 2.5% per year), which would suggest a high possibility of reduced annual rainfall during the last 20 years relative to the similar earlier periods. The mean annual rainfall for Marsabit is 11 % below the overall average during the last decade. This decade also had the lowest average rainfall

compared to the other decades. Witsenburg and Roba (2004) concluded that Marsabit experienced lower average rainfall over 30 years than the previous 30 years during their study period of 1920-2001. Their study also concluded that the risk of adverse precipitation over the last 30 years was twice as high as over the previous 50 years. This result confirms respondents' popular view that: 'nowadays droughts occur more frequently" and/or "these days it rains."

The respondents clearly indicated that the rainfall change negatively influenced their livelihoods. The most outstanding effects were its reduction of pasture production, which affected livestock health, crashing the community's livelihoods. Distance to water points was reported to increase with each drought, increasing tracking distance for livestock and humans, affecting their health. Livestock dies during droughts, thus reducing their numbers and productivity. Moreover, livestock breeding is disrupted during droughts, and the numbers dwindle. That plunges the community into poverty and causes resort to relief dependency as the last recourse in the cycle. Witsenburg and Roba (2004) concluded that while the human population constantly grew between 1920 and 2001, the rainfall data and livestock numbers depict similar downward trends over time, especially during the last decade of that period, which collaborates with the finding of this study.

On the other hand, the respondents could not tell a temperature change because they could not physically detect changes in temperature patterns. It is possible that without an instrument, one may not tell a slight temperature change correctly. However, a whooping majority of those who thought to have noticed some changes claimed the temperatures were increasing, which collaborated with the notion of global warming, where the temperature was thought to be rising. The data from Marsabit Metrological Station also slightly validated the increasing temperature on average. However, the average minimum temperature has increased tremendously, which means indicated by the respondents, the area was becoming hot throughout.

However, the respondents could not tell what caused the temperature changes but alluded to reasons like drought, increase in sunshine, degradation, and people abandoning their culture hence being punished by God, indicating a low level of awareness about the climate change phenomenon. Generally, the respondents report experiencing negative impacts of increased temperature, though some of which were disruption of livestock feeding pattern or disruption of grazing, particularly during hot days, miscarriage, especially in small stocks, premature births, and even death of lamb and young kids during migrations. Scientifically, warming is thought to alter heat exchange between animals and the environment, and mortality, growth, reproduction, feed intake, maintenance, and production are all potentially affected (Thornton et al. 2009). Moreover, scientific records show that increased temperature has been linked to livestock mortality and reduced productivity (Thornton et al. 2009). It has also been shown that physical livestock activities decline during unusually high temperatures, including feed intake (Thornton et al. 2009). In addition, high temperatures and reduced feed intake put a ceiling on milk yield irrespective of feed intake, and in the tropics, this may be between half and one-third of the potential of modern cow breeds. Moreover, increased energy deficits may decrease fitness, fertility, and longevity (King et al. 2006).

As thought, the effect of rainfall on the livestock population was direct in the study area. Residents reported milk and meat production as one such direct relationship. It was also reported that livestock dies during prolonged dry spells and multiplies during favorable seasons. As established in the study area, the reduced rainfall pattern has caused a net decline in livestock numbers due to decreased forage. Livestock also did fetch poor prices during the frequent drought cycles reported. Consequently, it was revealed that the population of the three priority livestock has declined over the study period, with sheep and camel being the most affected. When livestock numbers declined, directly related to their production, it affected the pure pastoralists' livelihoods, affecting food availability and other needs. Therefore, it collaborated with the respondents' responses in the study area that changes in climatic variables have negatively impacted their livelihoods and that the quality of their lives was decreasing. Considering that the population in the area was increasing and that of their livestock was decreasing, therefore, it means that the residents were becoming poorer. This finding complies with existing known facts that precipitation reduces and temperature increases crop and reducing pasture yield. Rising temperatures and changes in rainfall patterns directly affect pasture yields (IFPRI 2009). The availability and quality of pasture directly affect livestock production in pastoral areas where the livestock purely depends on a range of resources.

Furthermore, to survive, it was established that residents devised several coping mechanisms with three top most important priorities: seeking relief food, buying food on credit to be paid when the drought ends, and selling productive livestock herds, including lactating ones. Unfortunately, the respondents were uncertain about how long they may continue using the strategies, and some of their top priority options seemed unsustainable. It is impossible to tell because they can't tell how long they may continue getting food on credit, or providing relief food may not be in their control. Even environmentally speaking, the residents could not tell the impact of what they were doing; all they did was just to survive by all means. That indicates a community with poor environmental awareness levels and/or a lack of viable means of survival. Indeed, the main impediments to adopting strategies were identified as lack of opportunities, lower education, decreasing livestock, persistent drought, financial capital, unreliable relief, and the general uncertainty of the weather conditions.

This study has revealed that the present coping strategies affected the target community's ability to adapt in the future in terms of an increase in poverty as sources of livelihoods diminish due to the sale of productive livestock, separation of the family when livestock move far away as well as the inaccessibility of the livestock products due to

distance. Furthermore, as nomadic pastoralists were settling near market centers/water points to access relief and water, nomadism was at risk leading to the high concentration of sedentary people around those centers, thereby causing environmental degradation. Furthermore, borrowing food on credit plunges households into the cycle of debts and erodes family wealth as families incur bad debts for the small kiosk owners. Moreover, since the majority rely on relief food as a strategy, breaking down the community's livelihood system due to creating dependency.

On the flip side, settling around the market centers to access water and relief offered the residents a chance to take their children to school, which secured the future of those children and the extended family. Also, diversification of livestock herds was helpful to sustain their livelihoods because different species were affected differently; since they relied on the remaining type of livestock when one was affected by the droughts, increased mobility of the herd was able to save some herds during extended droughts.

With the overwhelming effect of drought cycles, it was clearly established that there was external support from the government and NGOs. The main support identified included relief supplies, nutritional supplements, veterinary services, NFIs, and student scholarships. However, it was unclear how sustainable those supports were, especially with the dependency syndrome setting in. On their own, the community appeared with very few options or pushed beyond its limit. A sizeable number was unsure of what to do and required animation and propositions of well-researched options. A similar number envisions diversifying their economic activities, but their options seem slim due to unfavorable environments and poverty. A small number even thought of abandoning pastoralism, an indicator of despair. Some of the ways suggested for diversification within pastoralism included; adding more species of livestock, separating the herd and further increasing the mobility of the herd. The researcher also took a keen interest in those who wish to diversify their economic activities to survive the vagaries of the weather. Some options given included seeking casual employment, engaging in petty trade, and some unfavorable means like brewing chang'aa and burning charcoal. They thought these activities might help them survive. Still, the health issues and the acceptability of the chang'aa option are unresolved, while the environmental sustainability of charcoal in an already degraded desert environment may not be feasible.

The community had suggested some options like the establishment of stable livestock markets, support education for their children, creation of awareness, especially on environmental conservation, restocking, development of infrastructure, continuous and adequate relief for both animals and people, awareness creation and capacity building as some of the ways of coping with climate vagaries and the provision for water for animals in the areas with pasture and lack water. Now, mobility is part of the respondents' lifestyle, and there were suggestions for mobility support. On a similar note, in its AR4 report, IPCC suggested livestock insurance schemes, credit schemes, and income diversification opportunities as possible viable adaptation options (IPCC 2007).

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