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Original Article

Assessing the Impacts of Climate Change and Variability on the Livelihoods of Pastoralist Communities in Bagamoyo District, Coastal Tanzania

Moson Koika Moti^{1*} & Dr. Emma Teresa Liwenga, PhD¹

¹ University of Dar es Salaam, P. O. Box 35097, Dar es Salaam, Tanzania.

* Author for Correspondence ORCID ID: <https://orcid.org/0009-0001-7475-8274>; Email: mosonmoti@yahoo.com

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The objective of this study was to assess the impact of climate change on the livelihoods of pastoralist communities in Bagamoyo District, Tanzania. To collect sufficient information, 10% (880) of the total pastoralists' households were randomly selected for structured interviews. Other methods employed include field observation, Key Informants Interview and Focus Group Discussions with purposively selected respondents. Descriptive statistics and content analysis were used to analyse the data collected. The findings reveal that approximately 74% of respondents believe climate change has harmed livestock quality. The ongoing decrease in rainfall and rising temperatures have heightened the vulnerability of pastoralists. This shift has led to a decline in both the quality and quantity of livestock, resulting in food shortages and increased poverty. In response, pastoralists have adapted by diversifying their livelihoods, changing food sources, selecting different livestock breeds, reducing herd sizes, and migrating. The study recommends modernising local adaptation strategies to enhance the resilience of pastoralist communities in the face of climate change challenges.

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INTRODUCTION

Climate change and variability have garnered significant attention globally as they pose numerous challenges to climate-sensitive sectors. Climate change is one of the most significant challenges facing the world in the 21st century. There is a strong consensus that climate change is primarily driven by the increased emissions of greenhouse gases, such as carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O), among others (IPCC, 2013). The Intergovernmental Panel on Climate Change (IPCC) has established a consensus that climate warming is "unequivocal", supported by rising global and sea temperatures, the melting of snow and ice, and significant increases in global sea level (IPCC, 2007). Research indicates that more than 90% of global warming is attributable to human activities that emit greenhouse gases into the atmosphere. Activities such as the combustion of fossil fuels for industrial purposes and changes in land-use practices have contributed to an increase in atmospheric CO₂ concentrations. Consequently, the global average temperature has risen by approximately 0.76°C since pre-industrial times, and it is projected to increase by 1.8°C to 4°C unless significant measures are implemented to curb greenhouse gas emissions (Collier et al., 2008; IPCC, 2007). The Intergovernmental Panel on Climate Change (IPCC) estimates that if the current trajectory of global warming persists, the temperature could reach 1.5°C between 2030 and 2052 (Hoegh-Guldberg et al., 2018; Leung et al., 2019).

Since the Industrial Revolution, a clear link has been established between greenhouse gas emissions and rising temperatures, which contribute to global warming (IPCC, 2012, 2019). Developing countries, particularly those in Africa, South Asia, and Latin America, are projected to be

disproportionately impacted by the consequences of climate change. Since 1950, observable changes in temperature and precipitation patterns have been documented across the African continent (IPCC, 2013; Pauline and Grab, 2018). Climate change and its impacts are expected to significantly affect a large number of people living in arid and semi-arid regions, which cover about two-thirds of the African continent (Galvin et al. 2001). These regions are characterised by varying precipitation patterns and extreme weather events, including droughts, storms, and floods (IPCC, 2007, 2013). In sub-Saharan Africa, approximately 386 million people, including pastoralists, rely on natural resources for their livelihoods (Conway, 2009; Adhikari et al., 2015; IPCC, 2015). However, vulnerabilities and responses to climate change and variability differ across communities, influenced by factors such as time, social status, economic conditions, environmental circumstances, and regional location (Niang et al., 2014). Additionally, the impacts experienced can vary significantly from region to region. While some communities may have benefited from these changes, others have faced catastrophic consequences (Rowhani et al., 2011).

Pastoralism is one of the most vulnerable activities to climate change and variability across various regions of the world, highlighting the urgent need to enhance the resilience of pastoralists to safeguard their livelihoods. The rise in climate change and variability may lead to reductions in herd sizes due to increased mortality rates and diminished reproductive performance among animals (Addison et al., 2012). Pastoralism is widely practised in various regions, primarily in grassland areas, covering approximately a quarter of the world's land surface (Follett and Reed, 2010). Approximately 200 million households worldwide, including agro-pastoralists, nomads, and pastoralists, rely on pastoral livestock for their livelihoods (Aberra and

Abdulahi, 2015). In East Africa, climate variability and changes will be severe, including water resources, food security, disease prevalence, natural resource productivity, sea level rise, and desertification. In Kenya, pastoralist communities mainly reside in the ASALs (Arid and Semi-Arid Lands) in the country's north, east, and south. These areas comprise 36% of the total population of 14 million (GoK, 2014; Ameso et al., 2018). The sector is central to the livelihoods of rural Tanzania, particularly for pastoralist communities whose livelihoods depend directly on livestock (MLDF 2012, 2015). Pastoralists raise a large number of animals and rely on them for their daily sustenance. Their food consumption mainly consists of milk, meat, and blood obtained from livestock, along with other food acquired from the market after selling their animals (Sellen 1996 and Galvin 1992).

Tanzania, like many other countries, is facing the impacts of climate change and variability. Significant changes include fluctuations in temperature and unpredictable rainfall patterns, which have led to extreme events such as floods, droughts, and rising sea levels. These events pose threats to critical sectors, including agriculture, livestock, water resources, energy, human health, ecosystems, and infrastructure (USAID, 2018). The majority of rangeland is unsuitable for livestock farming due to factors such as the presence of tsetse flies, unpredictable rainfall, and a lack of available water. These challenges complicate both cattle grazing and human habitation (URT, 2007; Maleko and Koipapai, 2015). These challenges heighten the vulnerability of sectors already facing various non-climate-related issues, such as inadequate advisory services, technology, markets, and infrastructure, which directly impact the livelihoods of pastoral communities (Maleko and Koipapai 2015; Magita and Sangeda 2017). Livestock serves not only as an economic asset but also holds social, cultural, and spiritual significance that shapes the community's identity. These values are often preserved when the community adheres to the customary practices of a particular ethnic group (Gaiballah and Abdallah,

2016). Moreover, pastoralists maintain a large number of animals for various purposes, including fulfilling household needs, upholding cultural traditions that require livestock, fostering respect within their community, and sharing livestock with friends (Oba and Lusigi, 1987; Liwenga, 2016).

The coastal region of Tanzania has experienced climate change (CC) and variability, as evidenced by a decrease in both annual maximum and minimum temperatures, which are linked to changes in rainfall patterns (Kashaigili et al., 2014; Liwenga et al., 2013). The Bagamoyo district, in the Coastal region (Pwani), is particularly affected by these changes, facing issues such as rising temperatures, floods, and drought. Increased rainfall variability in the district has led to recurrent and prolonged dry seasons, as well as more severe droughts, which in turn diminish the availability of water and pastures for livestock (URT, 2012). Despite various interventions aimed at mitigating the effects of climate change in Tanzania, the district remains inadequately prepared to tackle both current and future impacts of climate change and variability. Pastoralists in the area lack reliable information on these climate issues, possess a low adaptive capacity, and do not have effective adaptation strategies. As a result, their livelihoods are increasingly threatened. Previous studies (Lyimo et al., 2013; Liwenga et al., 2013; Kashaigili et al., 2014) have focused on how coastal communities have responded to the impacts of climate change and variability on tourism, agriculture, and industries. However, there has been little attention given to the pastoralist communities regarding climatic stresses in the coastal area. Despite the increasing recognition of the impacts of climatic stressors on various communities, a significant gap remains in the literature concerning the specific challenges faced by pastoralist communities in coastal regions. This oversight limits our understanding of how these communities adapt to environmental changes and underscores the need for targeted research that explores their unique vulnerabilities and resilience strategies in the face

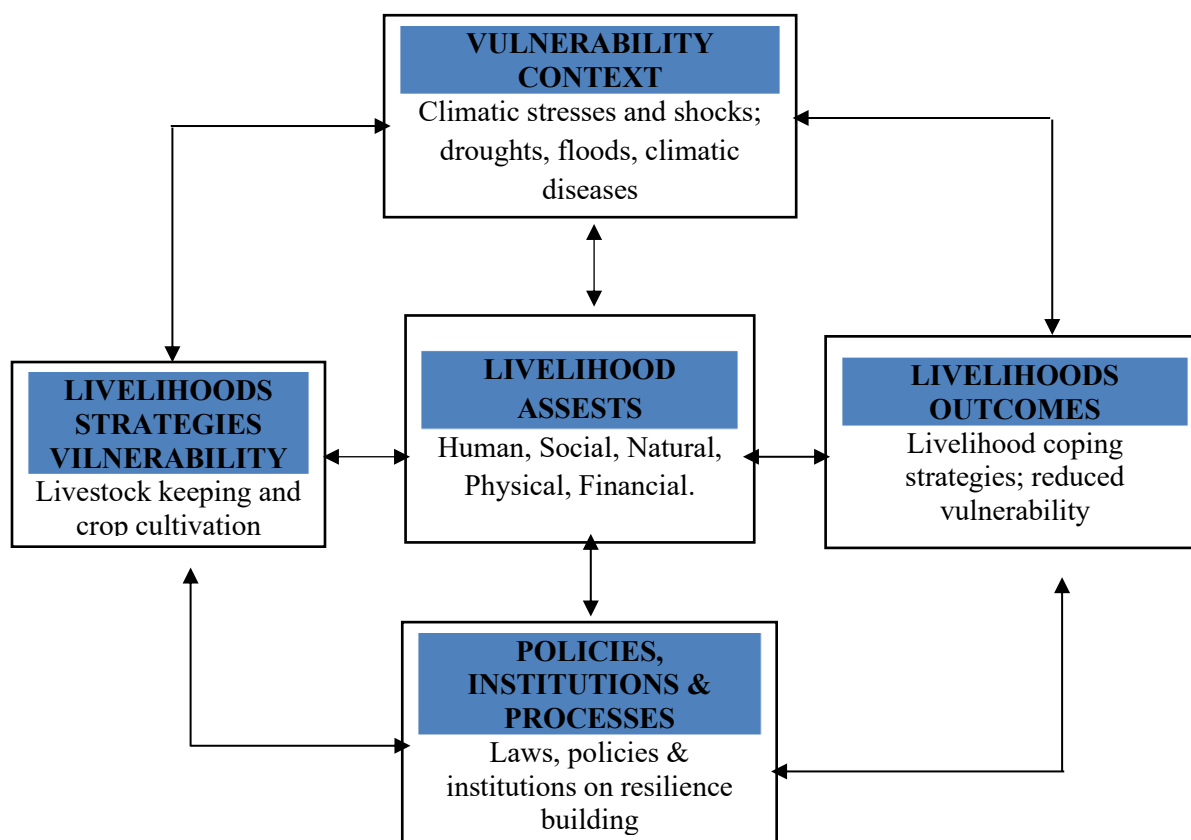
of climatic shifts. Addressing this research gap is essential for developing effective interventions and policies that support pastoralist livelihoods and ensure their sustainable existence in coastal areas.

Conceptual Framework

This study adopts and modifies the Sustainable Livelihoods Approach as established by DFID (2001). The Sustainable Livelihood Framework is essential for understanding poverty, vulnerability, and adaptability (Chambers & Conway, 1992). This framework provides valuable analytical and empirical insights into how adaptability links livelihood assets to adaptation, thereby enhancing its relevance in discussions surrounding climate change. It is constructed around four key components: livelihood outcomes, livelihood assets, livelihood strategies, and the institutional

context (Fig. 1). The presence or absence of capital significantly impacts the ability of vulnerable populations to withstand shocks and pressures stemming from both climate-related and non-climate-related changes (Scoones, 2009). Successful capital is primarily driven by adequate policies, robust local institutions, and various processes (DFID, 2001). Supportive policies and dynamic local institutions are essential for ensuring sustainable adaptation. All four elements are situated within a context of vulnerability, which is influenced by climatic shocks and stresses. This study examines explicitly household vulnerability and adaptation strategies about external factors. The vulnerability context is primarily addressed by focusing on the climatic stresses that affect pastoralists, such as droughts, floods, and diseases.

Figure 1: Sustainable Livelihood Framework



Source: Adopted and modified from Chambers & Conway, 1992.

METHODOLOGY OF THE STUDY

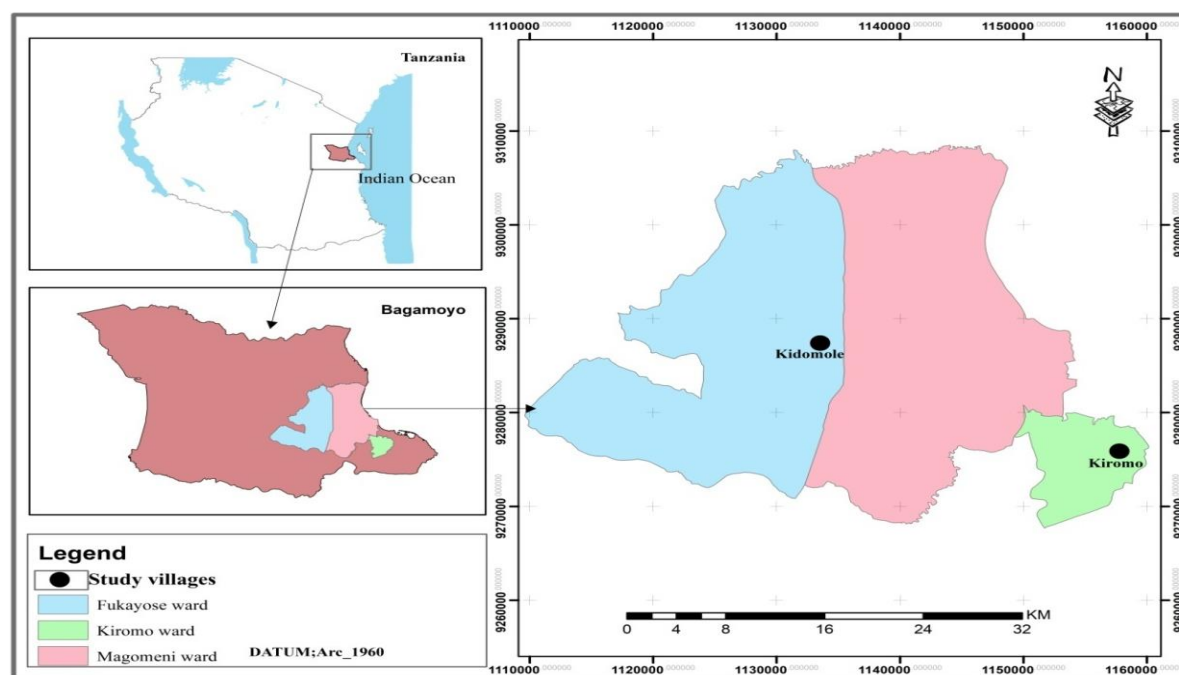
Study Area

The study was conducted in two villages, Kidomole and Kiromo, in the Bagamoyo district of the coastal region (Pwani) in Tanzania (Figure 2). The district is situated 75 km north of Dar Es Salaam on the coast of the Indian Ocean. Geographically, it is located at 6°26' South of the Equator and longitude 38°54' East of Greenwich, at an altitude of 1 meter above sea level (UNHSP, 2009, Bagamoyo District Profile, 2009). It is bordered by the Mvomero, Kilindi, and Handeni districts on the North, the Indian Ocean on the east, the Morogoro district to the west, and the Kinondoni and Kibaha districts to the South. The district experiences a modified type of equatorial climate. The climate is generally hot and humid throughout the year, with a seasonal average temperature ranging from 28°C to 30°C, averaging 30.5°C annually, and humidity levels reaching 98% (EPMS, 2006; TMA, 2008). Rainfall exhibits bimodal patterns, ranging from 800 to 1200 mm annually (TMA, 2008). The short rainy season (Vuli) starts from October to December (OND), while the prolonged rainy season (Masika) starts from March to May (MAM) (Bagamoyo District, 2006; Andrew, 2009). The driest months are June to September, with monthly rainfall generally less than 50 mm per month.

The 2022 national census report indicates that the Bagamoyo district has a population of 205,478, comprising 101,827 males and 103,651 females (NBS, 2023). Covering an area of 9,842 sq. km, the

district features 8.7% (or 855 sq. km) of water, primarily from the Indian Ocean, while dry land accounts for 91.3% (or 8,987 sq. km). Administratively, the district is currently organised into two divisions, 11 wards, 8 villages, and 174 hamlets. This study focuses primarily on two villages: Kiromo and Kidomole. Kidomole village is situated in the northwest of Bagamoyo District, specifically within the Msata Division of Fukayosi ward. These two villages are located in distinct areas, as illustrated in Figure 2. The level of vulnerability varies between them; Kiromo, being closer to the Indian Ocean, is less susceptible to drought compared to Kidomole, which is further inland.

Bagamoyo district was chosen for the following reasons. First, it faces significant climatic vulnerability, characterised by erratic rainfall, droughts, and coastal floods that impact pastoralist communities. Second, the district is home to both settled and semi-nomadic pastoralists, whose livelihoods are directly tied to livestock and are thus particularly susceptible to the effects of climate change. Third, there is a strong dependency on natural resources for livelihoods, as livestock grazing relies heavily on local water and pasture availability, both of which are sensitive to climate fluctuations. Finally, land use conflicts are on the rise, with increasing competition for land resulting from agriculture, urban expansion, and conservation efforts, which exacerbates the vulnerability of pastoralists to climate-induced resource scarcity.

Figure 2: Map Showing the Location of the Study Area

Source: GIS La-University of Dar es Salaam, 2022

Sample Size and Sampling Procedure

The study utilised both purposive and random sampling methods to select the wards, villages, households, and participants. Wards and villages were purposefully chosen based on their socioeconomic activities, the presence of pastoralist communities, and their sensitivity to climate change. The Kiromo and Kidomole wards were purposively selected due to the predominance of pastoralist communities in the area. Village leaders, elders, ward officers, Ward Livestock Officers, and prominent pastoralist community leaders (referred to as Ilaigwanack in the Maasai language) were deliberately selected for interviews to provide valuable insights. A random sampling technique was used to select participants from households for focus group discussions. Additionally, a representative sample of heads of families was selected from each study village to respond to the questionnaire. As recommended by social science researchers, a sample size of 10% was used, based on the representative unit for rural populations (Kothari, 2004). The study sample consisted of 88

randomly selected pastoralist households from the two wards out of a total of 880. Out of 88 pastoral households selected, 28 respondents were from Kiromo, and 60 respondents were from Kidomole.

Methods of Data Collection

A mixed approach was used to collect quantitative and qualitative data (Kothari, 2004). Within the mixed design, a descriptive research design was employed to assess the implications of climate variability and change on the livelihoods of pastoral households. The design answers questions on how, what, when, and where, and an explanatory research design answers the “why.” The use of this method helps to understand a research problem better. The study utilised primary and secondary sources of information and employed a range of data collection methods. Primary data were collected through field observation, household survey, key informant interviews, and focus group discussions. Various sources were utilised to collect secondary data, including published and unpublished reports, government publications, technical and trade journals, as well as documents from the Bagamoyo

District Council's Library and the University of Dar es Salaam Library. Annual rainfall and temperature data were collected from the Tanzania Meteorological Association (TMA) for a 30-year period, from 1989 to 2018. The data was obtained from the Kibaha TMA station, as there was a lack of data for the Bagamoyo district.

Household Survey (Questionnaire)

The study utilised a household questionnaire to collect information, with a particular focus on primary data from respondents. A combination of closed and open-ended questions was employed during face-to-face interviews with 88 selected pastoralist households. The head of each household was primarily responsible for answering the questions; alternatively, another eligible family member could respond in the head's absence. The questionnaire gathered various types of information, including demographic data, socio-economic characteristics of the region, pastoralists' perceptions and awareness of climate change and variability, the impacts of climate change on livestock, and the response measures taken by pastoralist communities to mitigate the adverse effects of climate change.

Key Informant Interview (KII)

Key informants are typically knowledgeable individuals who possess a deep understanding of the local context relevant to the study. This technique involves conducting in-depth interviews between the researcher and respondents who are well-versed in the issues being addressed. The primary aim of key informant interviews is to gather insights from a diverse array of individuals with specialised knowledge or experience pertinent to the subject matter. A semi-structured interview approach was utilised to interview five key informants, including: Village Elders (Ilaigwanack in the Maasai language), the Ward Livestock Officer, the Ward Executive Officer, the District Environmental Officer, and an officer from the Tanzania Meteorological Agency.

Focus Group Discussions (FGDs)

A focus group discussion is a type of group interview where a small group of 10 to 12 people engages in a loosely structured dialogue led by a moderator. The aim is to gather insights from participants' personal experiences, beliefs, and perceptions on a specific topic (Hayward, Simpson, and Wood, 2004). In this study, one focus group discussion was held in each village, with sessions comprising 12 members, six men and six women, selected during village meetings led by the chairman in Kiromo and Kidomole. The focus group discussions involved individuals aged 45-60 years with long-term experience of the village's history, as well as those with expertise in climate change and variability issues, and those who had lived in the town for at least 40 years. Participants were chosen based on their awareness of climate change, willingness to engage, knowledge, and relevant experiences. The findings revealed that women felt less comfortable speaking in mixed-gender groups. Therefore, two groups were formed to discuss the topic differently, allowing each group to have room to discuss freely, particularly women, so that they could provide information that differed when combined with the information from the other group.

Field Observation

Field observation was conducted within the study area to gather data related to livestock and assess their conditions, as well as their market prices, particularly at the Livestock Market in Fukayosi Ward, which takes place every Tuesday. This observational approach allowed the researcher to cross-check the information obtained from household questionnaires, thereby validating the findings. Kothari (2004) posits that direct observation involves the investigator collecting information through their own observations, without conducting interviews with respondents. The data gathered through direct observation pertains to current occurrences and is not influenced

by respondents' past behaviours or future intentions and attitudes.

Data Processing and Analysis

Data collected through various methods and techniques were systematically organised and coded into distinct themes. The quantitative data were analysed using descriptive statistics, while the qualitative data underwent narrative analysis. The quantitative data were coded, edited, and entered into IBM SPSS Version 20 software for further analysis. Percentages, frequencies, and cross-tabulations were calculated, with the results presented in the form of tables, charts, and graphs. The computed percentages facilitated the interpretation and formulation of conclusions. Additionally, temperature and rainfall data were analysed using Microsoft Excel, employing linear trend lines to illustrate the trends in both rainfall and temperature.

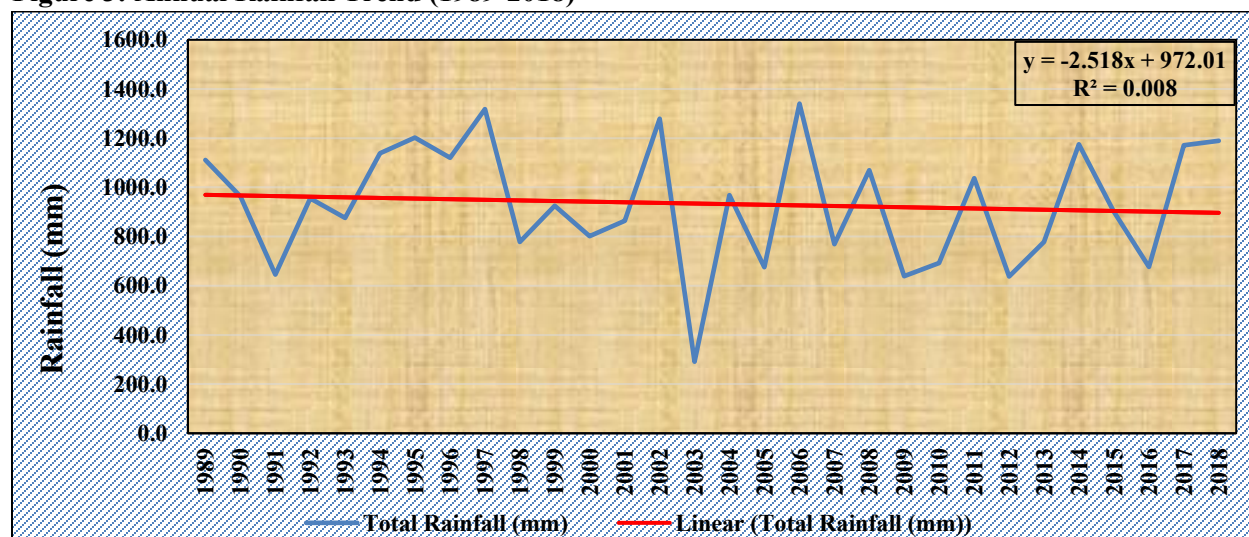
RESULTS AND DISCUSSIONS

Rainfall Trends and Change

Results from Key informant interviews and focus Group Discussions (FGDs) were validated using 30 years' rainfall and temperature data from 1989 to 2018. Results indicated that rainfall patterns have

exhibited significant variability in recent years, particularly notable in the years 2012, 2015, and 2016, with observable changes occurring at the onset of the rainy season. The results indicate a significant inter-annual variability in total rainfall. Certain years, such as 2003 and 2009, show a decline in rainfall, while others, including 1996, 2006, and 2013, experienced notable peaks (Figure 3). Additionally, the linear trend line reveals a slight negative slope, suggesting a gradual decline in rainfall over time, represented by the equation: ($y = -2.518x + 972.0$). This implies that annual rainfall is decreasing at a rate of approximately 2.52 mm per year. The Coefficient of Determination ($R^2 = 0.008$) indicates that only 0.8% of the variation in rainfall can be accounted for by the linear trend. This signifies a very weak or negligible linear relationship over the observed period. The rainfall patterns in the study area exhibit considerable variability from year to year, demonstrating no discernible trend in either direction. The negative correlation coefficient of approximately -0.089 indicates a very weak downward trend in annual rainfall. These findings suggest that, although climate variability is apparent, there is no statistically significant long-term change in total rainfall over this period.

Figure 3: Annual Rainfall Trend (1989-2018)



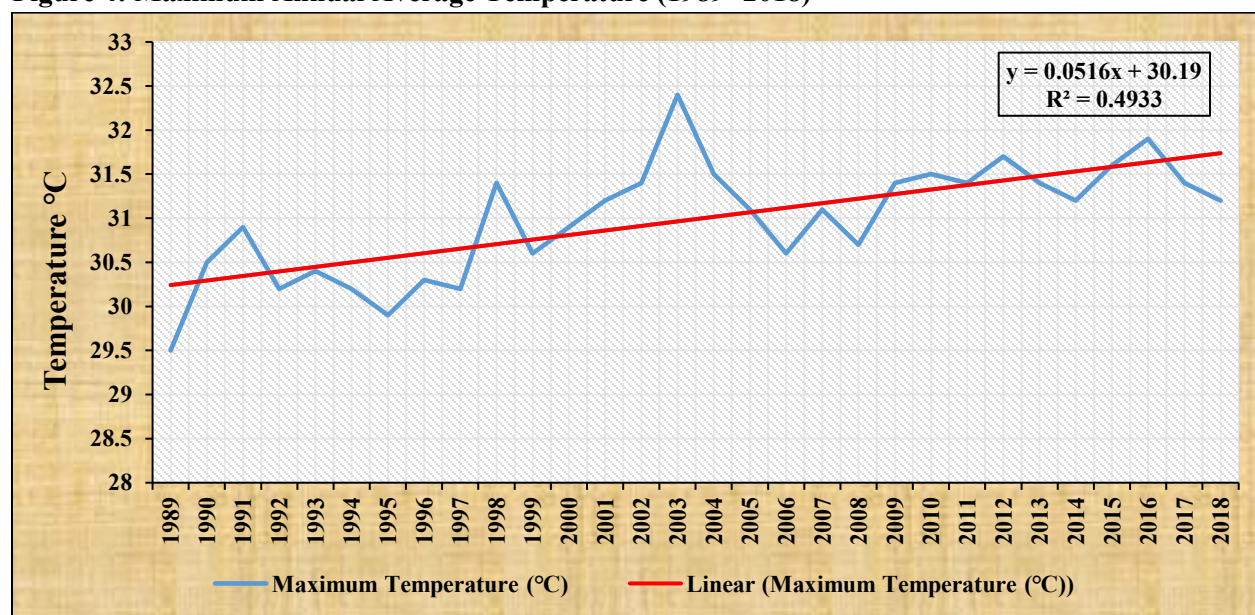
Source: Tanzania Meteorological Authority (2020).

Temperature Trends and Change

The average maximum temperature has exhibited an upward trend from 1989 to 2018. The equation of the trend line is given by $y = 0.051x + 30.19$, indicating an increase of approximately 0.051°C per year. The coefficient of determination ($R^2 = 0.493$) reveals that 49.3% of the temperature variation can be explained by this linear trend, suggesting a moderate positive correlation (Figure 4). Notably, there is significant inter-annual variability, with several peaks, particularly around 2003 and 2016,

as well as some dips. The correlation coefficient is approximately 0.70, reflecting a moderate to strong positive correlation between the year and the maximum temperature. The findings indicate that the average maximum temperature in Bagamoyo has increased significantly over the past 30 years. The positive trend and moderate R^2 value support the conclusion that climate change is contributing to the regional warming. This trend may have critical implications for agriculture, water resources, and livelihoods, particularly for pastoralist communities.

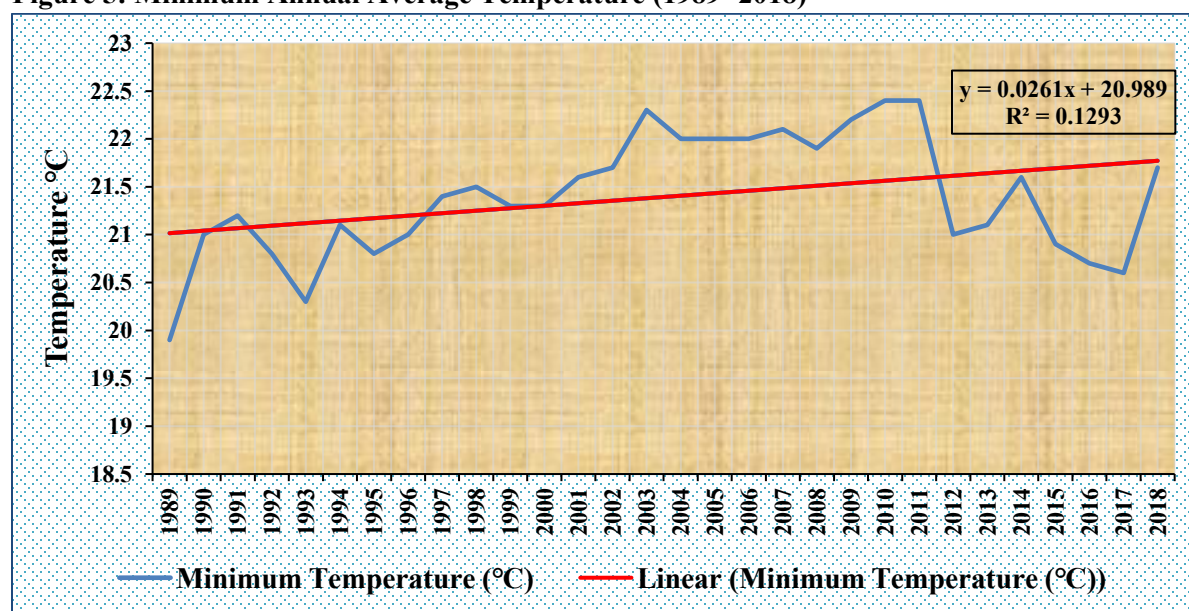
Figure 4: Maximum Annual Average Temperature (1989 -2018)



Source: Tanzania Meteorological Authority (2020)

Minimum temperatures exhibit a discernible linear trend over time, as demonstrated by the accompanying regression line. The derived equation, $y = 0.0261x + 20.989$, indicates that minimum temperatures are increasing at an average rate of 0.0261°C per year (Figure 5). Moreover, the R^2 value of 0.1293 is relatively low, suggesting a weak but positive linear relationship between time and the increase in minimum temperatures. Rising minimum temperatures lead to warmer nights,

which negatively affect livestock health, especially for species accustomed to cooler conditions. This can increase heat stress during dry seasons, reduce milk production in cattle, compromise meat quality, and threaten food security, ultimately impacting the incomes of pastoralists. Warmer nights may also facilitate the spread of vector-borne diseases, such as those transmitted by ticks and mosquitoes, posing risks to both livestock and humans.

Figure 5: Minimum Annual Average Temperature (1989 -2018)

Source: Tanzania Meteorological Authority (2020).

The Impacts of Climate Change and Variability on Pastoralist Communities

Pastoralism is the primary source of income in the study area, with pastoralists relying on livestock to sustain their livelihoods. According to Gaiballah and Abdalla (2016), livestock provide essential resources such as milk, meat, and blood, which are sold in markets to meet various basic needs, including clothing, school fees, and food, particularly maize. For pastoralists, raising animals holds great significance, as they have relied on livestock products, including hides and manure, since childhood. In alignment with Mung'ong'o and Yanda (2016), livestock play a crucial role in fulfilling various needs within pastoralist communities, serving not only practical purposes but also cultural rituals and symbolising the status of the pastoralist. The effects of climate change and variability are notably severe in the study area. The findings indicate that climate change has resulted in several adverse impacts, including a decline in the quality and quantity of livestock, increased livestock diseases, reduced livestock production, and longer distances required to access pastures and water.

Reduced Livestock Production

Based on the perspectives of pastoralists from the two study villages, climate change has significantly impacted livestock production, with 87% of respondents indicating that livestock are the most vulnerable animals to the effects of climate variability and change. These implications directly affect local livelihoods, as livestock are struggling to produce sufficient milk due to reduced pastures and an increase in animal diseases associated with drought, such as foot-and-mouth disease and Babesiosis. This situation has led to a decline in cattle values in the market (Plate 1). During a transect walk, a researcher visited a well-known market within the ward, specifically the Kidomole/Fukayosi market. The most effective methods used were field observation and a limited number of interviews to evaluate the quality of livestock about market prices. During interviews, one of the respondents said

“... We are selling now on March/April because their body condition is good now and we are getting money, depending on the size of a cattle, big one range from (450,000 to 700,000/=), but

the medium size the price range from (350,000 to 450,000/= Tanzanian Shillings), when it reach to June/July the price become down so

that you can sell up to three cattle's once to pay school fees" (A pastoralist: In Kidomole Market 2020)

Plate 1: Livestock in Kidomole Market



Source: Field Survey (2019)

The Increase in Livestock Diseases

The study indicates that incidents of certain animal diseases have risen over the past decade, including East Coast Fever (ECF), also referred to as “theileriosis” (known as Ndikana Kali in the Maasai language). This disease is prevalent in drought-stricken areas and is caused by the protozoan parasite “*Theileria Parva*.” Additionally, cases of Anaplasmosis have been reported in the region, which has increased due to climate change. In the Fukayosi ward (Kidomole village/Vihagata), foot-and-mouth disease has also been documented. Heartwater disease has been observed in both Kiromo and Kidomole villages. Furthermore, Babesiosis and Trypanosomiasis have been reported in Kiromo Village; these diseases are notably recognised by the pastoralist community known as “Ndorobo” and typically occur during the dry season. One of the respondents said that.

“Trypanosomiasis disease (Ndorobo in Maasai language) is more pronounced in the study area

between July and September and during this time livestock keeper migrate temporary from Kidomole to Wami basin searching for pastures and water for their livestock, and this happen when one charcoal dam known as Rambo la Fukayosi dry, livestock keeper has no alternative to continuo living there, rather than migrating to near Wami River basin” (Livestock Office: Kidomole Village 2020)

Reduced the Quantity and Quality of Livestock

The findings indicate that climate change and variability have a notable impact on the quality and quantity of livestock in the region. Approximately 74% of respondents reported that climate change has negatively impacted livestock quality due to ongoing fluctuations in rainfall patterns. Drought has emerged as a significant challenge for pastoralists in the Bagamoyo district. For instance, in the years 2005, 2009, and 2016, drought conditions led to a decline in both the quantity and quality of livestock. The effects of climate change

and variability have diminished the value of livestock keeping, primarily due to the increasing frequency of recurrent droughts, prompting pastoralists to migrate in search of better conditions. Unfortunately, during these migrations through drought-prone areas, many livestock do not survive the journey to new settlements (Yanda et al., 2011). Likewise, research by Koipapai et al. (2015) revealed that climate change and variability negatively impact livestock quality, leading to weakened animals that are often unsellable at high market prices. This situation directly affects pastoralists, who rely on livestock as a critical source of income. During the Focus group discussion, one of the respondents said that:

“The phenomenon of recurrent severe droughts occurring every one to two years significantly contributes to a decline in livestock populations. This reduction adversely impacts the income levels of pastoralist communities, thereby exacerbating poverty within these groups” (A pastoralist; In Kidomole Village, 2020).

The Increased Distance to Access the Pastures.

Table 1: The Distance to Access Pastures in the Study Villages

Changes	Kilometers	Frequency	Percentage
The distance for the pastoralists to reach the grazing areas	2-3	17	19.3
	6-8	42	47.7
	8-10	29	33
	Total	88	100
Is there any difference in the distance to walk in the past 10years?	YES	86	97.7
	NO	2	2.3
	Total	88	100
Is there an increase in Distance over the past ten years?	YES	81	92.0
	NO	7	8
	Total	88	100

Source: Field Survey (2020)

The Increased Distance to Access Water.

The study highlights that the distance to access water for both domestic use and livestock has increased significantly. Approximately 54.5% of respondents indicated that the distance has grown for domestic purposes, resulting in women spending

The study revealed that pastoralists are required to travel considerable distances and spend numerous hours reaching areas with available pasture. Approximately 97.7% of the respondents indicated that the distance to access pasture has increased compared to ten years ago, with many now walking between eight and ten kilometres to reach grazing areas, particularly in Kidomole village (Table 1). Additionally, 47.7% reported that they must walk between six and eight kilometres to access these areas. Conversely, 92% of respondents noted noticeable differences in the distances livestock keepers had to travel to reach grazing locations. During the focus group discussion, the respondent added that:

“There is a difference in past 10 years because most of the pastoralists are migrants, they migrated from other area like Morogoro especially 2017 due to droughts and now are here, therefore the needs for grazing areas increased, because in the past 10 years the pastoralists were few in this area, hence the number of livestock was small” (A pastorlist elder: Kidomole Village 2020)

more than an hour to reach water sources. Simultaneously, they are purchasing water, with 20 litres costing 1,000 Tanzanian Shillings (Tshs 1,000). For livestock, the distance to water sources is now between 6 and 8 kilometres (Table 2). Increased rainfall variability has caused a

community-constructed dam, known as ‘*Rambo la Fukayosi*,’ to run dry, forcing pastoralists to migrate from Kidomole to the Wami area in search of adequate water supplies for the entire dry season. Unfortunately, the available water sources in the region are not strategically located, making it

difficult for everyone to access water within a few miles. As a result, people often share water from the dams with livestock, which poses significant health risks due to the open nature of these sources, making contamination likely.

Table 2: The Distance to Access Water

Distance	Frequency	Percentage (%)
2-5 km	14	16.0
6-8km	48	54.5
10-12km	24	27.3
No Change	2	2.3
Total	88	100.0

Source: Field Survey, 2020

Adaptation Strategies for Climate Change and Variability Among Pastoralist Communities

Pastoralist communities are experts in traditional methods of adapting to unpredictable weather conditions caused by climate change and variability (Mung’ong’o, 2019). Pastoralists rely on adaptation strategies to mitigate the adverse effects of climate change. According to a study by Gaiballah (2016), pastoralist communities are better equipped to cope with the harsh conditions of arid and semi-arid areas, which are more vulnerable to the impacts of climate change. The study also found that the extent of adaptation depends on the pastoralists' location and vulnerability level. Through household questionnaires and focus group discussions, respondents reported that climate change has numerous impacts on livestock, leading them to develop alternative measures to cope with these impacts.

Seasonal Migration

Many pastoralist communities employ migration as their primary adaptation strategy to climate-related disasters, including droughts, floods, diseases, and high winds. According to a survey, nearly 47.6% of respondents stated that nomadism, the temporary movement of pastoralists with livestock in search of pastures and water, has been more effective than other methods of livestock management.

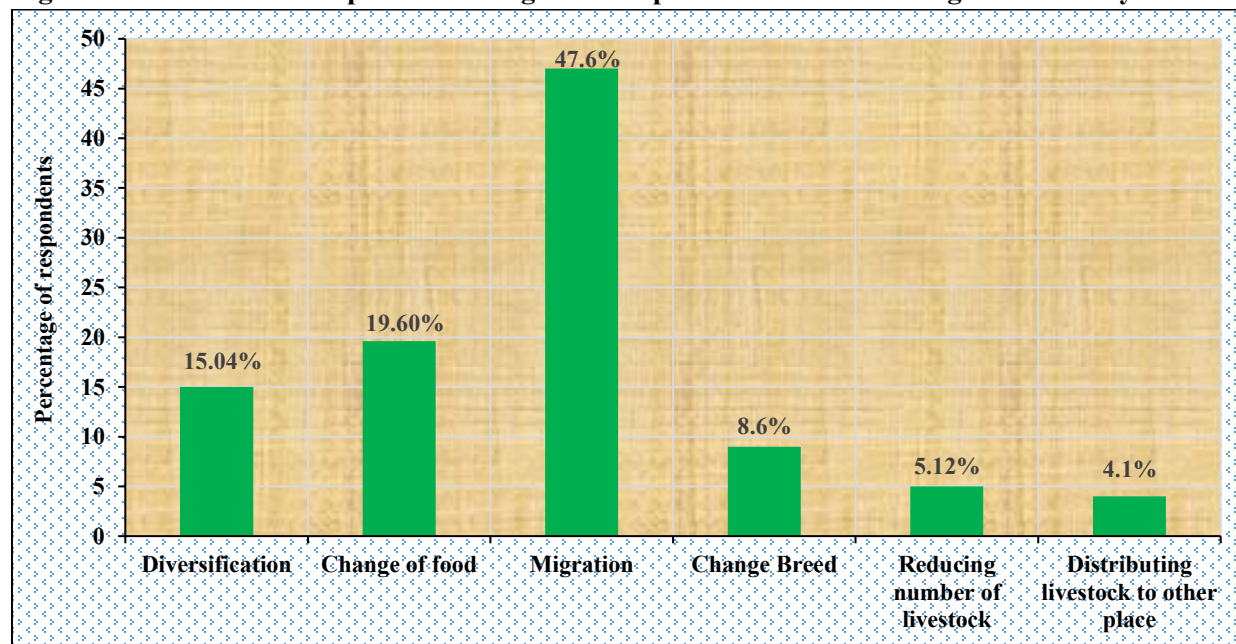
Pastoralists whose ways of life depend on mobile livestock herding are also known to employ migration to cope with varying rainfall and find pastures. Similarly, Liwenga (2016) contended that pastoralists are individuals whose way of life primarily relies on mobile livestock herding. Consequently, the migration of livestock keepers is linked to the seasonal movements of pastoralists, who migrate to specific areas based on the patterns of seasonal rainfall; this typically occurs between September and December during the short (vuli) rains.

Severe drought has forced pastoralists to migrate to the Ramset area with their livestock, where there is enough pasture and water. The findings indicate that the migration of pastoralists, particularly into areas engaged in different economic activities such as agriculture, leads to significant conflict between pastoralists and smallholder farmers. The study reveals that village leaders often demand payments from pastoralists in exchange for permission to graze their livestock. This has resulted in serious confrontations between pastoralists and farmers in the district, leading to the loss of both livestock and human lives. A notable example occurred in June 2016 in Bagamoyo District, specifically in Makurunge Village, where four individuals were injured (Ngarabali, 2016). During the key informant Interview, the respondent narrated that:

"Some village leaders request money from us and allocate us the pastoral areas for grazing. However, after a few days, farmers complained

that the area belonged to them, where the conflicts started" (A pastoralist elder, 45 years old, from Kiromo Village in 2020).

Figure 6: Pastoralists' Adaptation Strategies in Response to Climatic Change in the Study Area



Source: Field Survey (2020)

Change of Traditional Food

Recent research has shed light on the dietary practices of pastoralists, revealing a historical reliance on livestock-derived products, including milk, meat, and blood, as their primary sources of sustenance. This trend persisted until the 1980s. These findings are consistent with those reported by Galvin et al. (2001), who noted that the traditional diet of pastoralists was predominantly composed of meat, milk, and blood sourced from cattle. The study found that 19.6% of respondents in the surveyed villages have adjusted their diets in response to the impacts of climate change and variability affecting their regions. Notably, it has been observed that there has been a significant transition in the primary food sources of pastoralists, moving from a singular dependence on livestock products to a more diversified diet that incorporates both livestock products and

agricultural produce, particularly maize and its derivative products, such as maize flour, which is utilized for the preparation of cereals and Ugali (*Argali in Maasai language*). This statistic suggests a noteworthy transition among pastoralists from traditional pastoralism toward agro-pastoralism, highlighting an evolving food system influenced by both environmental factors and market dynamics (Plate 2). These findings were supported by respondents' views during focus group discussions, who argued that;

"Due to unpredictable seasons, our diet has shifted from traditional food to a mix of crops and purchased agricultural products like rice, bananas, and cabbages from the market. This means that we cultivate some crops and sell our livestock to support our dietary needs (A pastoralist in Kiromo Village, 2020)"

Plate 2: Pastoralists (Mang'ati) eating Ugali with Milk and Ghee in Kiromo village

Source: Field Survey (2020)

Livelihoods Diversification

Results revealed that livestock keepers are increasingly adopting livelihood diversification as a strategic response to the challenges posed by climate change and environmental variability. A recent survey indicates that approximately 15% of respondents have observed pastoralists engaging in a range of alternative livelihood activities. These activities encompass agricultural practices, seeking employment opportunities in urban areas, operating motorcycles as a means of transport or income, and the sale of traditional medicinal products. This shift towards diversified income sources mitigates their dependence on livestock alone, thereby enhancing their resilience to the adverse effects of climate change and variability on their livelihoods. Respondents narrated that:

"Currently, we cultivate crops like maize and beans on a small scale due to the unpredictability of rainfall. This approach allows us to have some food available when it rains, helping us avoid selling our livestock to purchase food, particularly maize." (A

pastoralist elder aged 40 years in Kidomole Village, 2020).

Change of Livestock Breed

The responses gathered from the participants indicate that the introduction of new livestock breeds is perceived as a strategy to adapt to the direct impacts of climate change and variability. However, only 8.6% of the surveyed individuals acknowledged changing the livestock breed as an effective adaptation measure employed by the pastoralist community in the region. The findings further reveal that economic considerations drive the pastoralists' interest in altering livestock breeds (Plate 3). Certain new breeds exhibit greater resilience to adverse climatic conditions, such as drought, and possess enhanced marketability compared to traditional local cattle. Despite these potential benefits, the adoption of new livestock breeds, such as Boran cattle, is met with resistance among pastoralists. This reluctance can be attributed to two primary factors: firstly, the high cost associated with purchasing these breeds makes them inaccessible for many; secondly, the intensive

care and standardised treatments required for their management, including regular vaccinations, are often beyond the financial capacity of most pastoralists in the study area. Respondents supported these findings during the focus group discussion, added that:

"We have discovered a new breed of livestock that is superior to our local breed. As a result,

we plan to purchase a bull to breed with our current livestock and improve the quality of our herd. However, the new breed is quite expensive, and only a few of us can afford to buy it. Therefore, we are importing the breed from Kenya (A village elder aged 60 years in Kidomole, 2020)"

Plate 3: New Livestock Breed Mixed with the Local Breed in Kidomole



Source: Field Survey (2020)

Reducing the Number of Livestock-keeping

A study revealed that only 5.12% of the pastoralists interviewed indicated that reducing their livestock was among the strategies they adopted to cope with the effects of climate change and variability. The respondents cited several reasons for decreasing their herds, including limited grazing areas, water scarcity, and the increasing prominence of alternative economic activities such as farming and petty trade. The study posits that reducing livestock numbers could help alleviate the impact of climate change. However, not all pastoralists concur with this approach, as a larger number of animals is often viewed as a symbol of respect and plays a vital role in cultural practices. Respondents supported these

results during focus group discussions and argued that:

"Reducing the number of livestock within pastoralist communities is challenging. This is because selling livestock is often seen as a sign of approaching poverty. Additionally, owning a large number of livestock is considered a sign of wealth and prestige. However, due to the lack of rainfall and pastures to sustain many livestock, it has become increasingly difficult for pastoralists to maintain their herds (A pastoralist elder aged 55 years in Kidomole village, 2020)."

Distribution of Livestock to Different Places

The study's findings indicated that approximately 4.1% of the respondents identified the distribution of livestock across various locations as a primary strategy employed by pastoralists in the study area to mitigate the impacts of climate change and variability. This adaptive strategy aims to safeguard portions of their herds during periods of severe drought, particularly by dispersing livestock to regions less affected by adverse climatic conditions. The study highlights that climate change and variability have necessitated this practice among pastoralists, mainly due to the increased frequency of drought events, which significantly impact livestock production in the region. Supporting this observation, Galvin (2009) posited that the pressures exerted by climate change and variability compel pastoralists to implement precautionary measures, including relocating their livestock to areas with reduced susceptibility to prolonged drought conditions. Moreover, these findings were supported during focus group discussions with respondents who narrated that:

“Due to the irregular rainfall pattern, we relocate our livestock to different places, especially to our relatives who live in less affected regions. Additionally, the short rainy season (vuli) does not occur uniformly in all areas. Therefore, we transport weakened livestock to areas that receive early short rains, especially in highland regions, to enable them to recover and regain their body condition (A pastoralist elder aged 50 years in Kidomole Village, 2020).”

CONCLUSION AND RECOMMENDATIONS

This study aims to examine the implications of climate change and variability on the livelihoods of pastoralist communities in the Bagamoyo District of Tanzania. A thirty-year climatic trend analysis has revealed significant alterations in both temperature and precipitation patterns within the study area. The findings suggest that climate change has led to an

increase in average temperatures and a decrease in overall rainfall. Furthermore, the onset and cessation of rains have become increasingly erratic, complicating traditional predictive practices for pastoralists. The observed shifts in rainfall and temperature patterns have led to an increase in the frequency and intensity of severe droughts, as well as unstable and unpredictable precipitation patterns. These climatic changes have adversely impacted livestock quality and quantity, highlighting the detrimental effects of climate variability on pastoral livelihoods. The unpredictability of rainfall, coupled with changes in its onset and duration, has significantly undermined livestock production, contributing to an increase in livestock diseases within the region. In contrast, the priorities of pastoralists regarding climate change adaptation and enhancing community resilience have been significantly hindered by several critical factors. These include the irregular vaccination of livestock within the study area, persistent conflicts among pastoralist groups, insufficient knowledge about effective adaptation strategies, and a notable lack of timely weather forecasting information from the Tanzania Meteorological Agency (TMA).

Recommendations

It is crucial to adopt an integrated approach that combines policy reform, institutional support, and community-based initiatives. National and local governments should incorporate pastoralist concerns into climate adaptation policies and land use planning, ensuring the protection of grazing corridors and water resources while promoting climate-resilient livestock practices. It is imperative that the government, in collaboration with the Tanzania Meteorological Agency (TMA), non-governmental organisations, and the Livestock Department in Bagamoyo District, initiate systematic campaigns, training programs, and knowledge-sharing initiatives aimed at equipping pastoralist communities with effective adaptation techniques.

Educational and awareness campaigns are essential for bolstering the adaptive capacity of these communities in the face of climate-related challenges. At the community level, it is vital to enhance access to localised climate information and early warning systems, support traditional coping strategies, and promote livelihood diversification. Institutions must be strengthened through capacity building, improved resource governance, and investments in infrastructure, such as water harvesting and fodder storage. Increasing access to financial services, including micro-insurance and climate risk financing, will provide essential safety nets against climate-related shocks.

Additionally, ongoing research is necessary to monitor long-term climate impacts, integrate Indigenous Knowledge Systems, and encourage participatory vulnerability assessments. A multi-stakeholder and inclusive approach, involving government, research institutions, NGOs, and pastoralist communities, will be essential for the effective implementation of these strategies.

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