CLIMATE VARIABILITY KNOWLEDGE AND RESPONSE STRATEGIES AMONG ORMA PASTORALISTS OF TANA RIVER COUNTY, KENYA

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DECLARATION

Declaration by Candidate

This thesis is my original work and has not been submitted to any other examination body. All the sources of materials used for the work have duly been acknowledged.

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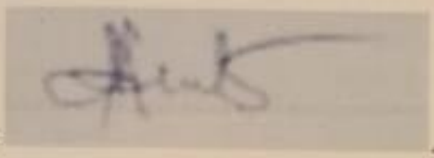
Signature  ..... Date 30/05/2024

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We confirm that the work reported in this thesis was carried out by the candidate under our supervision.

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DEDICATION

This work is dedicated to my wife and children; they shaped my vision and passion to give my best to this work. I accord you all my unconditional love, thank you.

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Thanks to Almighty God for the gift of health and well-being that enabled me to undertake this work. I do not take this for granted. The grace and guidance God bestowed on me enabled me to overcome many obstacles to get this far.

My sincere gratitude goes to my supervisors, Dr. James Koske and Dr. Daniel Manguriu, for their patience, firmness, persistence, and meticulous guidance throughout the course of my study.

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ABSTRACT

Enhanced climate variability has been recognized as one of the major 21st century global challenges. Although these challenges are global in nature, the impacts are more pronounced in certain regions of the world, threatening primary livelihood sources. The African continent is experiencing these challenges, manifesting as frequent extreme weather events like floods and droughts, which are significantly threatening agricultural production. Kenya has been contending equally with the effects of enhanced climate variability, with flooding and drought being the most common. Though these effects are common across the country, arid and semi-arid counties are the most severely affected. Tana River County stands out as one of the most affected counties. Despite the global challenges and impacts, knowledge documented and shared, localized knowledge evaluation, and assessment of implications on livelihood support systems have not received much attention. Investigation of awareness and response strategies is particularly scanty in Tana River County, Kenya, and more so among Orma pastoralists, hence the need to conduct this study research. The study was conducted in Assa and Kipao, which are predominantly occupied by Orma pastoralists. It was guided by three objectives, which were to analyze the variability of climate components (temperature and rainfall) in Tana River County from 1988 to 2018, to determine what Orma pastoralists know about enhanced climate variability, and to analyze Orma's pastoralist indigenous knowledge of climate variation and its application to livestock management practices. A descriptive research design and sampled 400 respondents, who were Orma pastoralists. Various data collection tools were used to collect information on enhanced climate variability knowledge and response strategies. Other data utilized included the vegetation condition index, historical temperatures, and rainfall averages of the county. Statistical analysis was done using the statistical package for social sciences, and the results were presented in the form of graphs, tables, and charts, which were interpreted and discussed. The study found that the level of climate variability awareness was quite high, with 86.34% (n = 278) of male respondents and 76.92% (n = 60) among females. Year-to-year enhanced seasonal variability of rainfall performance was demonstrated by increased spread from the mean seasonal rainfall as $\sigma = 64.45$mm. Further, there was a significant association between male respondents' awareness of enhanced climate variability and change in management practices, as $x^2 = 4.003108$, $df = 1$, and $p = 0.045416$. The study, therefore, rejects the null hypothesis and accepts the alternative hypothesis. The same was true for female respondents, as the association between level of awareness and adaptation of news practice was $p = 0.031686$, less than 0.05 set as the significance level of the test. Despite adapting some new practices, Orma pastoralists' changes in livestock management practices are not adequate for coping with the enhanced climate. It is therefore recommended that the government of Kenya and the county government of Tana River continue to create awareness of enhanced climate variability and support the diversification of livelihood sources. As climate change impacts men and women differently, deliberate efforts should be made by development actors to support projects that empower women.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF ACRONYMS AND ABBREVIATIONS

ASAL	Arid and Semi-arid land
CDEV	Community Development
CIDP	County Integrated Development Program
DRR	Disaster Risk Reduction
FAO	Food and Agricultural Organization
FGD	Focus Group Discussion
GOK	Government of Kenya
IPCC	Intergovernmental Panel on Climate Change
KALRO	Kenya Agriculture and Livestock Research Organization
KI	Key Informant Interview
NDMA	National Drought Management Authority
NGO	None Governmental Organization
PDNA	Post Disaster Needs Assessment
TRCG	Tana River County Government
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
VCI	Vegetation Cover Index
WMO	World Meteorological Organization

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Climate change has dominated the global agenda for scientists, academics, the general public, and policymakers, and it is acknowledged as one of the major global issues of the twenty-first century, according to Klein *et al.* (2014). There is widespread agreement that climate has changed, which the World Meteorological Organization (WMO) defines as statistically significant variation in either the mean state of climatic components or their variability over a long period of time (decade or more) (WMO, 2019). Climate variability, which is the subject of this study, is characterized as discrepancies in temporal and spatial scales for the mean state of climate components. Unlike climate change, which focuses on long-term shifts, variability refers to short-term fluctuations in precipitation, temperature, and other climate features that occur seasonally or year after season (WMO, 2019).

Understanding and monitoring the enhanced variability of climate components are essential for predicting short-term weather patterns and assessing potential effects. Further, Thornton *et al.* (2014) underscored the importance of understanding the impacts of enhanced variability on various aspects of the community production system. According to Thornton *et al.* (2014), climate variability has a greater impact in some places where weather anomalies affect primary production. Furthermore, locations with high variability have been observed to experience extreme wet and dry weather patterns (IPCC, 2014).

Further, Makonnen *et al.* (2021) highlighted how increased climate variability has production in Africa. The African continent is one of the regions experiencing increased climatic variability, which has resulted in frequent extreme weather risks such as floods

and droughts (UNFCCC, 2007). According to Kogo *et al.* (2021), Kenya is witnessing the advanced impact of climate change and unpredictability, resulting in food insecurity for vulnerable groups in the country's arid and semi-arid regions. Rainfall performance is poor in most places, but particularly in Arid and Semi-Arid counties, and flooding is occurring in numerous areas (UNDP, 2012). Furthermore, climate variability has a greater influence on Kenya's arid and semi-arid areas, where drought and flash floods are more common (NDMA, 2019).

Tana River County was part of the former coast province and shared a boundary with the former north-eastern province. The county's northern region is covered in shrubland and grassland. The hot and humid areas along the River Tana and the ocean are where the majority of crop output occurs (MoALF, 2016). The county was divided into three livelihood zones: pastoral, mixed agricultural, and marginal mixed farming, as illustrated in Plate 6 (page 86). The zoning was intended for needs assessment and development planning by county development units and partners, considering the community's primary economic activity (GoK, 2008). Mixed farming livelihood zones include places near the coastline and delta; marginal mixed farming zones are along the Tana River; and pastoral livelihood zones are hinterland areas away from the river and coastline. The pastoral livelihood zone is more arid than the other two, and nomadic pastoralism is the primary economic activity (TRCG, 2013).

The county has a bimodal rainfall pattern, with long rains occurring from April to June and short rains falling between October to December (TRCG, 2013). Rainfall varies across livelihood zones. The mixed farming livelihood zone is long rain-dependent, while the

marginal mixed farming and pastoral livelihood zones are short rain-dependent (MoALF, 2016). The mean annual rainfall ranges from 220 to 500 millimetres in pastoral and marginal mixed farming zones and 750 to 1250 millimetres in mixed farming livelihood zones (TRCG, 2013).

Orma pastoralists live in the pastoral livelihood zone, which is sparsely inhabited and allows for communal use of pasture and water (MoALF, 2016). Within the zone, Orma pastoralists distinguish between wet-season and dry-season grazing regions (Oba, 2012). Plate 2 (page 82) depicts the wet season grazing zone, which includes water sources such as an earth pan from which animals can receive water. Traditional grazing management is gradually being adapted to accommodate movements between these two extremes; they settle in the hinterland and relocate to the Delta during severe droughts. However, due to increased climate variability, the hinterland environment can no longer support year-round cattle production; rainfall is decreasing and temperatures are rising (NDMA, 2019).

Historically, Orma pastoralists acquired and maintained grazing pastures collectively through conquest, while restricting access to water for those deemed outsiders (Ensminger, 1992). The approach of community water and pasture management strengthened their resilience and reduced overgrazing. Raiding and conquest, on the other hand, broadened geographical reach (Oba, 2012). Conquest and raiding fall under the rule of law, and the Constitution encourages peaceful cohabitation (GOK, 2010). However, communal management is under threat as diverse communities now use the same set of resources while not always agreeing on common traditional practices. Climate variability exacerbates Orma pastoralist grazing management, reducing pasture and water availability (Oba, 2012).

The pastoral livelihood zones predominantly occupied by Orma pastoralists in the county have been ranked as high priorities for emergency relief food aid since 2004 (NDMA, 2014). The zone is mostly characterized by dried earth pans and households struggling to access water from shallow wells, as shown in plates 3 and 4 (pages 83 and 84), respectively. This implies that Orma pastoralists, who formerly persisted in the tough terrain of what is now Tana County, are victims of climatic and environmental conditions. Relief food being a significant source of food confirms their increasing vulnerability to the effects of enhanced climate variability (NDMA, 2014).

Similarly, Houghton (1997) stated that any large shift in the averages of climate components will put more stress on the afflicted community's livelihood system. Sweeney *et al.* (2005) reiterated these centuries, stating that increased precipitation variability in a specific location will undermine the livelihood system, rendering impacted communities more vulnerable. According to Uddin *et al.* (2020), pasture and water are essential elements in cattle productivity, with availability and quality being heavily influenced by rainfall performance. If rainfall is widespread and lasts at least three weeks, the regeneration of quality pasture is dependent on its distribution in time and place. The importance of timing was elucidated by Cossin and Upton (1987), who argued that rainfall distribution within a season is more crucial for pasture growth than the amount of rainfall received. In other words, the period from the onset of rainfall to cessation should be long enough to support pasture growth.

Most African countries' rangelands are degrading. Mintzer (1993) relates this to increased seasonal rainfall variability and a general reduction in precipitation. Pasture growth and

regeneration are dependent on the pasture's maturity to blossom and produce seeds; reduced precipitation has been insufficient during the growing period. As a result, pasture conditions in Kenya's rangelands are deteriorating, and pastoralists, who rely heavily on healthy rangeland, are becoming increasingly vulnerable to drought and other climate-related shocks (GOK, 2010).

The condition of pasture in Tana River County is declining. Pastoralism, as practiced today by the Orma pastoralists, is under pressure from the effects of enhanced climate variability. The community is facing frequent droughts, flash floods, and episodes of violent conflict, as explained by Mohamed (2015). Due to decreasing range land conditions in their rainy season grazing area, pastoralists frequently overstay in the Delta area (dry season grassing area), refusing to migrate until the area floods. Forced to flee, they try every available escape route, as depicted in Plate 6 (page 86).

1.2 Statement of Problem

Increased seasonal unpredictability has become a serious challenge that governments, development workers, and community people must address. While seasonal patterns are normal, recent increases in seasonal variabilityhave created huge problems. Orma pastoralists in Tana River County rely significantly on natural resources such as pasture and water for their livelihoods; the availability of these resources is heavily controlled by seasonal rainfall patterns. While average rainfall is frequently observed, the timing, distribution, and intensity of rainfall over the seasons have a significant impact on these resources. Well-distributed rainfall, for example, encourage grassland rregeneration and water recharge.

It is critical to assess season performance comprehensively, including onset and distribution in time and location, because well-spread rainfall will result in appropriate soil moisture to enable grass regeneration and runoff to recharge water sources. Enhanced seasonal variability causes uncertainty for Orma pastoralists, making it difficult to forecast migratory timetables. Oba (2012) emphasized the importance of seasonal performance, stating that pasture and water rely heavily on seasonal rainfall performance. Such study is crucial for developing sustainability strategies and adapting pastoral lifestyles. Such research is critical for the development of strategies to promote sustainability and the adaptation of pastoral ways of life.

Oba (2012) emphasizes the importance of Orma pastoralists' indigenous knowledge in managing their livestock and adjusting to their environment, particularly seasonal movements determined by rainfall patterns. While Orma traditional livestock management has successfully adapted to natural climate variability (Oba, 2012), determining their ability to cope with increased seasonal variability is critical. While the importance of seasonal rainfall performance for pastoral systems is well established, limited research exists on how recent increases in variability of rainfall patterns (duration, intensity, and frequency) impact the climate of Tana River County and the livelihoods of the Orma community. This study sought to bridge this gap by understanding the impacts of enhanced climate variability on the pastoral system, identifying vulnerabilities and capacity gaps, and proposing feasible solutions.

1.3 Research Questions

The research was guided by the questions listed below:

i. How have the seasonal rainfall variability (long rain and short rain) and temperatures been for Tana River County from the year 1988 to 2018?

ii. What is the extent of Orma pastoralists' knowledge regarding enhanced climate variability in the study area?

iii. How do Orma's pastoralists utilize their knowledge of climate variability in their livestock management practices?

1.4 Objectives of the Study

The broad purpose of the study was to assess climate variability trends and their impact on Orma pastoral livestock management practices and evaluate the community's indigenous coping strategies. The specific objectives of the study were:

i. To analyze the seasonal variability of climate components (temperature and rainfall) in Tana River County from 1988 to 2018.

ii. To determine the extent of understanding among Orma pastoralists regarding enhanced climate variability within the study area

iii. To examine indigenous knowledge of Orma pastoralists concerning climate variability and its application to livestock management practices

1.5 Hypothesis

This research was guided by the following hypotheses.;

i. Ho_1: There is no relationship between Orma pastoralists' awareness of enhanced climate variability and observed seasonal rainfall performance trends from year to year within the study area.

ii. Ho_2: There is no relationship between Orma pastoralists' awareness of enhanced climate variability and changes in their livestock management practices to cope with extreme weather events.

1.6 Significance of the Study

The significance of this study lies in its potential to contribute valuable insights and information on pastoral production systems to various stakeholders, including policymakers, development agencies, researchers, and pastoral communities. By assessing climate variability trends and their impact on Orma livestock management practices, this study can provide insights for the formulation of effective policies and strategies for adaptation to reduce pastoral community vulnerability.

The study has generated a blend of indigenous and scientific knowledge of climate variability, which will contribute to existing knowledge and also form a platform for further research. In other words, the study's findings can contribute to the existing body of knowledge on climate variability, indigenous knowledge systems, and livestock management practices in pastoralist contexts. This can help fill research gaps and provide a basis for further studies on similar topics in other regions or among different pastoral communities.

The study documented the effects of enhanced climate variability on pastoral livestock management practices, which provided better insight into Orma pastoralists' level of adaptation. This will inform the formulation of pastoral livelihood adaptation policy guidelines at the county and national levels.

1.7 Conceptual Framework

The Orma community of Tana River is strongly reliant on cattle production, which is primarily accomplished through nomadic pastoralism. Oba (2012) underlines the importance of herd and herder mobility as the primary management method in this system. Securing access to pasture and water remains critical for both humans and animals, and includes both routine and seasonal operations. However, mobility is more than just finding vital resources. It also serves the strategic objective of providing access to the finest quality grazing and browsing available at any given time in order to maximize productivity or assure survival during times of scarcity. When resources are ample, mobility focuses finding the highest quality options. During times of shortage, movement becomes a key tool for survival, with the goal of keeping the herd going until the next rains arrive.

Indigenous knowledge is critical to sustaining the Orma community's livestock management practices. Orma herders, known for their expertise, use their traditional knowledge and skills to handle the environmental issues presented by uneven rainfall distribution. However, the delicate equilibrium is jeopardized by increased climate variability. The deterioration of natural resources has a direct influence on the Orma's principal source of income: livestock. This study looks into the impact of climate variability on their knowledge systems and how it has changed traditional practices. Notably, while general knowledge is widely shared, precise insights into seasonal performance frequently require the input of respected elders.

Successful livestock production, as measured by improved milk output and healthy animal body condition, is strongly reliant on seasonal rainfall patterns. Indicators of poor rainfall

performance include a high frequency of livestock diseases, frequent and irregular migration patterns, decreased livestock prices, and, tragically, increased animal mortality. This study investigates how awareness of climate variability affects the Orma community's cattle management practices. The variable summary includes both qualitative and quantitative aspects, demonstrating the study's multidimensional investigation into the interactions between nomadic pastoralism, indigenous knowledge, climate variability, environmental conditions, and livestock management practices in the Orma community.

Overall, the conceptual framework depicts the dynamic interplay between nomadic pastoralism, indigenous knowledge, climate variability, environmental conditions, and livestock management practices in the Orma community, with the goal of elucidating the factors that influence their resilience and sustainability in the face of changing climatic conditions. Figure 1.1 illustrates the possible outcome of interaction with increased variability.

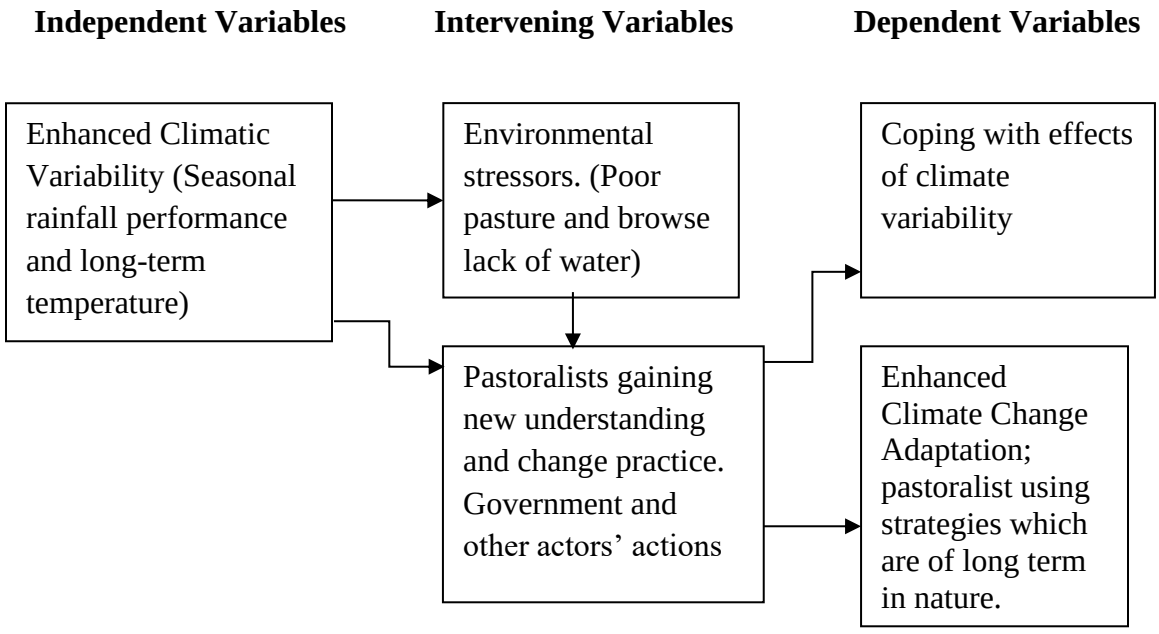

Figure 1.1: Orma Pastoralist Response to Climate Variability

CHAPTER TWO: LITERATURE REVIEW

2.1 Enhanced Climate Variability and Change

This chapter reviews the literature relevant to this investigation, with a focus on increased climate variability and climate change. Furthermore, it examines how increased climate variability affects livestock productivity under pastoralism, as well as pastoralists' knowledge, coping, and adaptability.

There is universal agreement that the climate has altered, and the consequences are extensive, as detailed by Godde *et al.* (2020) and Stuart *et al.* (2015). Furthermore, Stuart *et al.* (2015) suggested that the voices of climate change doubters are dwindling as the effects of the changes become more visible, manifesting as extreme weather occurrences. Increased observations of global average air and ocean temperature have made global warming clearer and more certain (IPCC, 2007). The United States Environmental Protection Agency (2014) also presented additional evidence of climate change, indicating that the earth's average temperature has risen by 0.60 °C over the previous century and is anticipated to grow; the changes, however slight, translate to a large and potentially dangerous shift in climate and weather. (IPCC, 2007)

Ackerman and Knox (2005) define climate as the condition of the atmosphere over many years. Temperature, moisture, wind, pressure, clouds, visibility, and precipitation are all observed as long-term averages. Thus, the Intergovernmental Panel on Climate Change (IPCC) defines climate change as statistically significant changes in the mean or variability of its attributes (IPCC, 2007). Climate variability is an essential component of climate change, as described by the World Meteorological Organization (WMO) as inconsistencies

in the temporal and spatial scale of the mean state of climate components (WMO, 2007). Climate variability is also defined by the IPCC as short-term fluctuations in precipitation, mean temperature, and other climate variables that occur from season to season or year to year. (IPCC, 2014). Year-to-year or season-to-season fluctuation is what this study focused on: the short-term changes felt by pastoralists compared to long-term shifts in climate.

Solar radiation, greenhouse gases (GHGs), land cover, and aerosols all contribute to natural climate change. As with the carbon cycle, the natural mechanism is self-regulating and balancing. Plants absorb carbon dioxide produced by animals in the carbon cycle, and vegetation cover serves as a major carbon sink (Smith *et al.*, 2006). Human activities are linked to increased greenhouse gas emissions, including carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O). Human activities that produce greenhouse gas emissions are classified as anthropogenic sources of global warming (IPCC, 2007). Anthropogenic activities such as fossil fuel burning, deforestation, and some agricultural practices are the primary causes of global warming, which raises atmospheric temperatures (IPCC, 2007).

Carbon dioxide is the most significant human greenhouse gas, emitted mostly through the combustion of fossil fuels (IPCC, 2007). Furthermore, Houghton (1997) emphasized the significance by linking rising global temperatures to an increase in atmospheric carbon dioxide. In other words, when CO2 emissions increase, so does global temperature. When the pre-industrial revolution carbon dioxide concentration (278 parts per million (ppm)) was compared to 379 ppm in 2005, the anthropogenic cause of increased atmospheric CO2 became clear (IPCC, 2007). Anthropogenic activities either limit natural systems' ability to absorb carbon dioxide from the atmosphere or increase greenhouse gas emissions, which leads to increased warming (Houghton, 1997). Similarly, the average global temperature

rose by 0.740 °Cover the same period, amplifying the relationship between warming and increased emissions (IPCC, 2007).

Africa is dealing with the consequences of increased climatic variability, with one-third of its population living in drought-prone areas and extreme weather events documented in other sections (Makonnen, 2021; UNFCCC, 2007). Poverty, inadequate infrastructure, and a lack of technical progress further erode the continent's population's ability to adapt with increased climate variability. Makenzi *et al.* (2013) found that seasonal and yearly rainfall variability has a major impact on agricultural output in the Lower Tana basin. Furthermore, Makenzi *et al*. (2013) reported that the return period for extreme climate events (droughts and floods) has been shortened from 4 to 5 years to 2 years prior to the year 2000.

2.2 Awareness of Enhanced Climate Variability

Climate change has dominated the global agenda for scientists, academics, the general public, and policymakers, and it is recognized as one of the most significant global concerns of the twenty-first century (IPCC, 2009). Scientists have improved their observation and modeling, resulting in a greater knowledge of climate change. Furthermore, scientists share their findings with policymakers and other audiences around the world via the International Panel of Climate Change Assessment Reports (IPCC, 2007). Furthermore, IPCC reports inform global, regional, and national activities to address climate change concerns (UNFCC, 2007). Ochieng and Koske (2013) explain that the public is informed through mass media, government departments, and development players (civil society and non-governmental organizations). Pastoralist communities face increased climate variability through interaction with their environment (Herrero *et al*., 2016).

The Tana River's ormas have indigenous knowledge about changes in their environmental conditions, and they alter their management strategies to maximize gains while minimizing losses from advanced weather patterns (Oba 2012). Other research agreed that there should be more awareness of growing climate variability. For example, Ajuang et al. (2016) found that more than 80% of Nyakatch, Kisumu County locals were informed. Mutunga et al. (2017) confirmed this finding, estimating 74% awareness among small-scale farmers. Marty et al. (2023) suggested that traditional societies, such as the Maasai of Kenya, are now valuing modern knowledge through their elites in dealing with rising difficulties. However, whether increased knowledge has resulted in a better understanding of adaptability to environmental changes has received less attention.

2.3 Impacts of Climate Change

There is widespread agreement that if business as usual continues, the effects of climate change will result in significant losses and damages (IPCC, 2007). According to the IPCC (2013), the evidence of climate change impacts is far more convincing. Natural disasters caused by extreme weather events are becoming more common, threatening the economic and social well-being of people around the world (IPCC, 2007). Climate change affects vary by geography and intensify over time. Though no region of the world is immune, more affects are already being felt in Sub-Saharan Africa, portions of Asia, and the Caribbean islands (UNFCC, 2007).

Climate change impacts are growing, with the global average temperature rising by 1.1 °C since the pre-industrial revolution. Impact as described by IPCC (2007), IPCC (2013), UNFCC (2007), and WMO (2019). Some locations have experienced higher rainfall as a result of increasing sea levels caused by the melting of ice sheets and glaciers. According

to the World Meteorological Organization, global sea level has risen by an average of 5mm per year between 2014 and 2019. Rising sea levels have had a significant impact on coastal towns, with indications of seawater incursion into farmlands. Coastal settlements are also impacted by seawater erosion on land. The impact of the sea eroding into the land was very high throughout the Kenyan coast, particularly in the Tana River, as shown in Plate 1 (page 81).

Extreme natural disasters, such as droughts, floods, hurricanes, storms, wildfires, and strong winds, are becoming increasingly common. According to Makenzi *et al.* (2013), extreme weather events are getting more common, which explains why agricultural output rates are declining. Mutunga *et al.* (2017) also discussed how extreme weather events have influenced the output capability of small-scale farmers and livestock caretakers. Houghton (1997) went on to say that increased climate unpredictability and frequent extreme weather events threaten community coping capacity.

Water scarcity and degrading pasture fields are two major effects of increased climate variability on livestock output, according to Kimaro *et al.* (2018) in their study of Northern Tanzania's rangelands. Kimiti *et al.* (2018) described a similar situation: degradation of pasture and browse conditions in Amboseli rangelands, resulting in a drop-in herd numbers among pastoralist populations. Furthermore, Kimiti *et al.* (2018) linked inadequate range conditions to increased climate variability and competing land-use types such as habitation and crop cultivation.

2.4 Pastoralist Knowledge and Practice of Livestock Management

Grazing and obtaining water for animals are among the most important tasks that every pastoralist learns from childhood. Clarence *et al*. (2011) emphasize the value of traditional ecological knowledge acquired via engagement with the environment. The knowledge enables the local community to continue producing despite environmental obstacles and to deal with environmental challenges caused by fluctuations in weather patterns (Clarence *et al.,* 2011). Understanding seasonal trends and settings allows the local population to use relevant skills and knowledge in the livestock management system (McCarthy et al., 2004). Traditional ecological knowledge is localized, meaning it is limited to a certain community within a specified area. Clarence et al. (2011) highlighted that, despite the knowledge not being developed using current science, it contributes to a better understanding of the localized impacts of variability.

Warren (1995), underlined the relevance of pastoralist indigenous knowledge, defining pastoralism as a flexible social structure that adapts to environmental conditions and natural shocks such as drought. Warren (1995) went on to explain that pastoralism is an adaptive system that allows people to continue their produce even in the harshest environments on the planet. However, numerous experts have expressed concern about whether indigenous knowledge is adequate to help communities cope with the effects of increased climate variability. For example, in Kenya, pastoral livestock production is mostly conducted in dry and semi-arid regions that are unsuitable for other production methods such as crop production (GOK 2012). Pastoralists used to cope with a scarcity of pasture and water by banking on their flexible management practices, which change depending on environmental factors. The frequency of extreme weather events has

increased in arid and semi-arid regions of Kenya; this has led to the loss of lives and damage to critical facilities (GOK, 2012).

Pastoralist groups' traditional knowledge and practices are being swamped by the effects of increased climate unpredictability, yet there is room for adaptation through a shift in behaviors. Climate change adaptation, defined by Smith and Wandel (2006) as efforts taken by people or organizations to lessen sensitivity to climatic circumstances, can be accomplished by changing production techniques. Pastoralists employed a variety of ways to deal with changes in their environment. McCarthy *et al.* (2004) described the procedures, which included herd separation, migration, consensus-building and decision-making, proper animal watering restrictions, and rangeland scouting, among others. Furthermore, McCarthy *et al*. (2004) highlighted that herd separation is an effective environmental management approach that minimizes strain on grazing space. Dry animals (cows without calves, bulls, and castrates) are moved far from settled areas to access far-off pasture resources and milking herds remain close to villages.

Categorization of grazing lands as wet season and dry season grazing has been another pastoralist management strategy. According to Cossin and Upton (1988), transferring herds from one zone to another based on seasons and rainfall performance is an important adaptation strategy for pastoralists to offset regional variance in rainfall distribution. Moving from one grazing zone to another promotes pasture regeneration since not all pasture areas are used at the same time. Tana River Orma Pastoralists employ zoning to separate dry and wet season grazing regions as an adaptation method. Each zone has its own sort of water source, as illustrated in plates 2, 3, 4, and 5.

Water access is a key part of a pastoralist production system; once a herder has it, he or she gains access to grazing land (Oba, 2012). Water supplies in dry-season grazing zones are forbidden during the wet season to prevent encroachment, according to Oba (2012). Traditional natural resource management institutions lack mission and authority in modern state governance. Climate variability and a lack of remuneration from the state jeopardize their ability to manage their environment. As a result, more research is needed to determine the efficiency of indigenous knowledge and behaviors for dealing with climatic variability.

According to UNDP (2007) and Care (2012), pastoral communities have historically successfully adapted to environmental problems caused by recurring droughts and irregular rainfall. Furthermore, Nyong *et al.* (2007) reiterated these comments, stating that the capacity to scout for ideal pastures and make the proper decision about when and where to migrate is one of the management methods that have enabled pastoral communities to cope with climate unpredictability. However, the increased frequency and severity of enhanced climatic variability disasters, like as the 2008-2011 drought, have tested the pastoralist community's indigenous ability to respond. The post-disaster needs assessment (PDNA) following this drought revealed significant losses and damages in the livestock sector (700,000 million) (GOK 2012). McCarthy *et al.* (2004) reported similar findings, outlining that the increased variability of climate has constrained East African pastoralist coping strategies.

In summary, pastoral communities have historically demonstrated resilience and adaptation to environmental fluctuations. However, the intensifying impacts of enhanced climate variability present new challenges that may be beyond their traditional coping mechanisms. Addressing these challenges may require understanding and documentation

of traditional knowledge while also implementing new strategies to enhance resilience in the face of a changing climate.

2.5 Climate Variability and its Impacts on Pastoralism

Global temperatures have risen, as recorded in the Intergovernmental Panel on Climate's 5th assessment, which painted a clear picture of warming. Communities that rely heavily on nice weather are the most vulnerable to climate variability (Herrero *et al*., 2016). Furthermore, the United States Environmental Protection Agency (2014) stated that the global average temperature has risen by 0.60 °C over the last century and is expected to climb further. According to the IPCC assessment from 2007, the statistic may appear insignificant, but in the climate component, it represents a major and potentially disastrous shift in climate and weather patterns.

Global warming has resulted in a variety of modifications in climate components, including seasonal variation in terms of onset, temporal distribution, and highly variable averages (Houghton, 1997). Climate change and short-term weather patterns both have an impact on the ecosystem. According to Ellis (1995), significant levels of fluctuation in ecosystems in mainly sub-Saharan Africa may be connected to increased climate variation. Ellis (1995) goes on to demonstrate that seasonal rainfall performance has a substantial impact on breeding and herbivore growth. Climate variability has an impact on plant development, which in turn affects different levels of the food chain in the ecosystem.

Cossin and Upton (1987) describe the effects of the seasonal distribution of rain in the Borana pastoral grazing system. They explained that well-distributed rainfall promotes greater pasture and browse regeneration than high, uneven rainfall. On the other hand, a

failure of the rainfall season has negative consequences such as reduced calving and increased calves' death. Furthermore, climate change has resulted in more frequent calamities such as flooding, droughts, and wildfires than it did four years ago. Roncoli (2006) emphasized the need of focusing on seasonal fluctuations and their impact on productivity. Despite its importance, nothing has been done to highlight the effects of seasonal variability on livestock production in a pastoral setting.

Pasture and water are key components of cattle productivity; seasonal rainfall patterns influence the quantity and quality of pasture and water. Quality pasture regeneration is determined by rainfall distribution across time and space, i.e., if there is adequate geographical coverage and it has rained for at least three weeks. Cossin and Upton (1987) contended that rainfall distribution within a season is more important for pasture growth than the average quantity of rainfall received each season. In other words, the time between the commencement of rainfall and its termination should be sufficient to enable pasture growth.

Most African countries' rangelands are degrading; Mintzer (1993) links this to increased seasonal rainfall variability and a general decrease in precipitation. Pasture growth and regeneration are dependent on pasture maturity, which includes flowering and seed production. lowered precipitation has lowered the amount of soil moisture required throughout the growth season (GOK, 2010). The status of pasture in Kenyan rangelands is worsening, and pastoralists, who rely heavily on healthy rangelands, are becoming increasingly exposed to drought and other climate-related shocks (GOK, 2010).

2.6 Seasonal Forecast

The rainy season is made up of months that correspond to when a country or region receives rainfall. East Africa has two seasons: long rains and short rains (Nicholson, 2017). The long rains (referred to as "Gann" by Ormas pastoralists) were historically significant to the community as a period of abundance, highlighted by several days of heavy rainfall. Kumar (2010) explains that knowing the rainfall occurrence period is significant in decision-making. However, an examination of historical rainfall trends reveals a depression in long rains. Tierney *et al.* (2015) also reported on the depression of long rains, stating that nations in the Horn of Africa are experiencing decreases in March-April rains (long rains) and an increase in short rains (October–December period). This could provide a hit of limitation to Orma Pastoralists' season performance prediction.

Several operational and research centers have produced seasonal climate predictions and weather outlooks (Kumar, 2010). Kenya's meteorological bureau, for example, gives both a daily and a seasonal weather outlook (GoK, 2010). Despite the generation of outlooks and forecast timetables, the trustworthiness of weather-related information has not received the attention it deserves. Kumar (2010) claimed that the economic value of using seasonal forecast information in decision-making is yet unknown and needs to be investigated further. Farmers' information requirements and available seasonal forecasts do not coincide; farmers are interested in the timing of initiation, distribution, and cessation (Troccoli, 2010).

Pastoralism relies heavily on seasonal forecasting since water and pasture availability have a substantial impact on the production system and migratory decisions. Migration is an important coping strategy in pastoral grazing management, governed by experience-based decisions. According to Luseno *et al.* (2003), pastoralists make seasonal migratory decisions based on their experiences and indigenous climatic projections. However, Luseno *et al.* (2003) questioned the indigenous methodologies' trustworthiness in light of rising climate variability. As a result, the effectiveness of these management approaches must be examined against the backdrop of increased climate unpredictability.

2.7 Research Needs for Pastoralist Enhanced Climate Change Knowledge and Response Strategies

Credit goes to scientists. Credit is due to scientists. Climate change is becoming more understood globally as a result of enhanced observation and modeling. The Intergovernmental Panel on Climate Change documents and shares peer-reviewed understandings of climate change. However, Mahinda *et al.* (2021) contend that there is still a vacuum in cascade observations for assessing localized consequences, particularly in Africa. This was also noted by Boko *et al*. (2007), who contributed to the fourth assessment report and identified research gaps in understanding communities' knowledge of their vulnerability to increased climate unpredictability and consequences. Furthermore, the IPCC (2014) identified information gaps in measuring vulnerability to climate change at the local level in Africa, urging further action in research. One of the goals of this study was to determine the Orma pastoralists' understanding of climate variability. The information gathered on their grasp of climatic variability will help to determine their capability level, thereby reducing the knowledge gap. Furthermore, extension workers and

other service providers will use the data to package messages about climate variability and change.

The study documented Orma pastoralists' application of climate variability knowledge in livestock management practices. Kimaro *et al*. (2018) forwarded the importance of more research to enhance knowledge about communities' understanding of weather patterns for indigenous forecasting. Good seasonal forecasting facilitates better grass management decision-making. In addition, Kimaro *et al.* (2018) explained that there exists a gap in better understanding pastoralists adaptive capacity to climate change. The documented knowledge identified adaptation practices that will contribute to the understanding of pastoralists' adaptations and limitations, which require actions to address. Further, the knowledge generated will inform the design of livestock sector interventions for developmental and emergency response purposes.

The study also identified strategies employed by the community to cope with climate variability. Identification of indigenous coping strategies will add to existing knowledge of climate change adaptation options. In addition, knowledge of the strengths and constraints of coping strategies will provide immediate advice to development partners engaged in supporting communities to cope with climate change. From the literature review, the following gap is about evidence of climate variability in Tana River County and the extent to which communities' indigenous knowledge is coping with the pace of variability.

CHAPTER THREE: METHODOLOGY

3.1 Study Area

Tana River County is one of the six counties in the Coast region of Kenya. It borders Kitui County to the west, Garissa County to the northeast, Isiolo County to the north, Lamu County to the southeast, and Kilifi County to the south. The county is located between latitudes 0° 0'53" and 2°0'41" south, and longitudes 38°25'43" and 40°15" east. The county has an average population of 240,075 people, a total area of 38,862.2 km2, and approximately 35 kilometers of coastal strip (TRCG, 2013). The county is divided into three subcounties: Bura, Galole, and Tana Delta. These were former districts carved out of the broader Tana River district, which formally gained its name from the River Tana that traverses the county from Tharaka County in the north to the Indian Ocean in the south, passing through the Tana Delta and covering a stretch of approximately 500km. A map illustrating the location of study areas is shown in Figure 3.1.

The county is traversed by various seasonal rivers, known as "lagas," in addition to the Tana River. These rivers normally run west-east from Kitui County, eventually draining into the River Tana and then into the Indian Ocean. Although the riverbeds of these seasonal rivers provide critical sustenance for livestock, they are also ideal locations for shallow wells, pans, and sub-surface dams. The "lagas" are, nonetheless, substantial bottlenecks in road transport, cutting off road networks during rainy seasons (NDMA, 2019).

The county experiences low, bimodal, and unpredictable convectional rainfall, ranging from 300 to 500 mm. April and May are the months with the most rain, while October and

November have the least. The county's proximity to the ocean adds to its high humidity and average yearly temperature (TRCG, 2013).

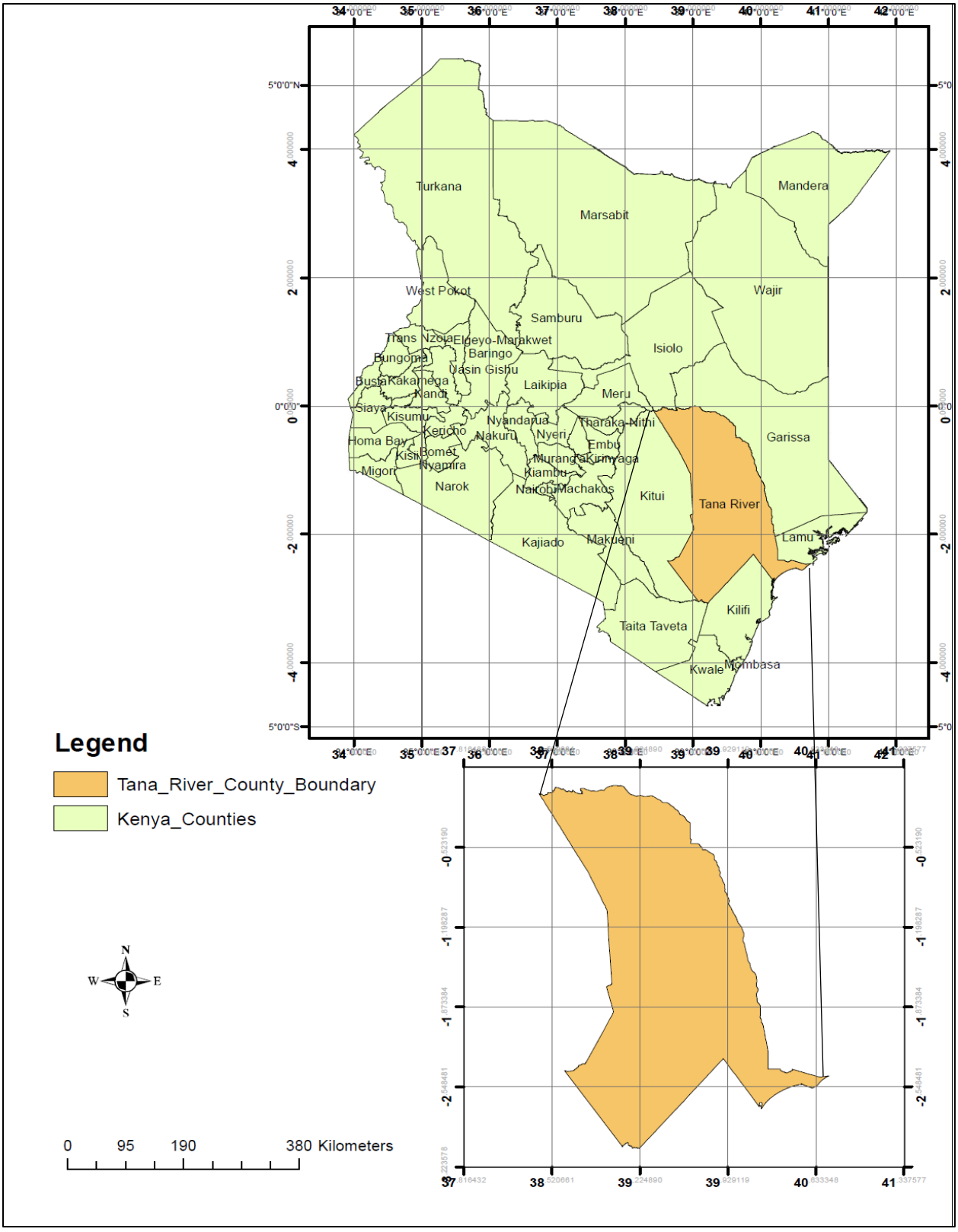

Figure 3.1: Tana River County Map and its Position in Kenya

3.2 Research Design

The study utilized a descriptive research design, a method adapted as it fit with the study's objectives. Denscombe (2010) defines the descriptive approach as studying phenomena without affecting the variables. According to Kothari (2010), descriptive design entails gathering data through interviews, questionnaires, and literature reviews in order to gain a deeper knowledge of the subject under inquiry. A descriptive survey's core purpose is to allow the researcher to analyze the existing situation and predict possible trends.

The design allowed the researcher to probe and expound on climate variability knowledge and response methods among Tana River's Orma. The results are consistent with Denscombe's (2010) explanation that a research design should support the achievement of the study's aims. The choice of research strategy is critical for providing insight and knowledge of increased climate variability and response strategies among Orma pastoralists.

3.3 Population

The study's target population were Tana River County's Orma pastoralists. The county has a population of 240,075 people, including 119,853 male and 120,222 female (GoK, 2009). The Orma community is one of the county's three largest ethnic groups, accounting for around 35% of the total population, according to the County Development Planning Department (TRCG, 2013).

3.4 Sampling Procedure

Purposive and simple random sampling techniques were used in the study to choose a representative sample of the population. First, Tana River County was chosen specifically

for the study's objectives and the Orma First, Tana River County was selected purposefully based on the objective of the study and the Orma community, which is domiciled in the county. The county's location in an area that borders the Arid North of Kenya and coastal land provided an opportunity to generate information about the Orma community's grazing management practices across diverse environmental conditions.

Second, the Tana Delta sub-county was also purposefully selected out of the three sub-counties to enable the researcher to carry out the study in two grazing zones, i.e., dry season and wet season grazing areas. Kipao, a wet season grazing area, and Assa, a dry season grazing area, were chosen for the study as classified in the Tana River Integrated Development Plan (TRCG, 2013).

Third, subjects for the study were selected using simple random sampling technique within the two regions. Households were selected at random from a pre-prepared list provided by the chief's office. An adult male or female who was deemed the head of the family at the time of the interview took part in the interview. The targeted individual was deemed mature enough to interact with their environment and other senior tribal men and women. Because the group is very homogeneous, their perspectives can be extrapolated to apply to other populations in comparable situations. Furthermore, key informants were recruited both within and outside of these two places to provide in-depth information on the subject matter.

3.5 Sample Size

The formula below was used to attain the desired sample size. To get the desired sample for a population of more than 10,000 the following formula applies the Yamane Tore

formula. The formula was also explained by Kothari (2010) paying more attention to the margin of error and confidence levels. $\frac{z^2pq}{d^2}$

Where: n= desired sample size, z = standard variate at required confidence level, and p = proportion in the target population. q = 1-p and d = margin of error allowed.

Therefore;

z = is at a 95% confidence level the value is 1.96 in a normal distribution and p = 0.5 this is the value of the most conservative sample (considering the highest level of variability).

q = (1-0.5) and d = Margin of allowed error is at $\pm$5% or 0.05$\frac{1.96^2 0.5(1-0.5)}{0.05^2}$= 384.16

Therefore, a sample of 400 persons was selected from the entire population, 200 from each of the two sites. Two Focus Group Discussions (FGD) and Key informant interview also enriched the process.

3.6 Research Instrument

A questionnaire served as the primary method for gathering information from pastoralists. This instrument allowed us to measure pastoralists' perceptions and knowledge of climate variability. It also revealed critical details regarding the Orma community's adaption techniques.

The research instruments utilized were pre-tested and then tweaked to get the desired results. The pre-testing took place in an area with a similar setting to the actual study site. To test the instruments, a random sample of 12 people from Wayu Duka were recruited and interviewed. The pretesting was conducted in a different place with identical characteristics to ensure that people who took part in the pre-testing were not included in

the actual survey. The pre-tested questionnaires were critical for gathering reliable and accurate data from Orma pastoralists.

In addition to the instruments listed above, the study used semi-structured questions for focused group discussions and key informant interviews. Observation forms were also used to document key observations made throughout the field activities. The combination of data gathering tools offered the foundation for a comprehensive grasp of the research issue, as well as components for thorough analysis and interpretation of the findings. Furthermore, the selection of data collection tools was critical for ensuring the accuracy and validity of the research findings.

3.7 Data Collection

Household questionnaires were administered to the household heads through face-to-face interviews by the researcher. A face-to-face interview was conducted in the local dialect, ‘afaan Orma', because a majority of the respondents were not literate. These were in line with Orodho's (2012) recommendation of considering the age and literacy level of the target population in determining appropriate data collection instruments. The questionnaires contained both closed-ended and open-ended questions. As explained by Mugenda and Mugenda (1999), close-ended questions are focused and save time. On the other hand, open-ended questions enabled the respondents to provide details that were not provided by closed-ended questions.

Household questionnaires were used to capture respondents’ particulars in section (I), respondents’ knowledge of climate change in section (ii), and indigenous responses to climate variability in section (iii). Using this instrument, it was possible to establish the

current situation and get opinions of how climate elements (rainfall and temperature) were for the period they could recall. In addition, the instrument also provided information about the impact of enhanced climate variability and how the community was coping with it.

Second, to supplement the household questionnaire, additional data was collected through focus group discussions (FGD), where two FGD were conducted in each of the target areas, one dedicated to women and the other two to men. Semi-structured questions were used to guide the discussion; rich information was obtained at each of the discussions. The information gathered from the FGD included aspects such as livestock management systems in different seasons, seasonal mobility practices, and areas that are grazed during the wet season and dry season. Further, emerging livestock management practices were identified and discussed. Despite the 1-2 hours planned for each FGD, the discussion extended to 2-3 hours was utilized to enable understanding and collect more significant information.

Third, key informant interviews were conducted involving "jars *aargaa dhageeti"* (knowledgeable elders) who are well-known and respected in the community. Their past experiences regarding communal management of livestock, grazing areas, climate variability, and coping strategies provided invaluable information. Other key informants interviewed included retired civil servants who served in the livestock sector.

Data about the study area was also accessed from existing government records available within county offices and also at the national archives. Weather information was obtained from the head office meteorological department in Nairobi. The rainfall and temperature data received was a monthly summary of readings from various stations across the county. In the national archives, various monthly reports are handed over from the district

commissioners, which detail grazing conditions and community grazing arrangements. This showed how grazing management has changed over the years. Secondary data, household questionnaires, focus group discussions, and key informant interviews provided a better insight into Orma community perceptions, practices, and response strategies to enhanced climate variability.

3.8 Reliability of Instruments

The questionnaires were pre-tested in Wayu, a community with similar characteristics to the communities sampled for the study. Further improvement of the tools was done based on the outcome of the test interviews. The questionnaires utilized for the study were then refined and developed. During the study, interviews were conducted at the household level, and a respondent who at the time was head of the household was involved.

Identifying the head of the household was made possible through the utilization of information gathered during questionnaire pre-testing and interaction with the community. It was observed that when one visits a household in the Orma community and exchanges greetings, all occupants of the house respond to the greeting. However, when the visitors make a further inquiry, only the head of household (mostly men) responds. The rest of the family members then give room for the visitor and head of household to discuss, unless called upon by the head to provide information. By understanding and respecting cultural practices and norms, the researcher and respondents can better collect data.

3.9 Data Analysis

The acquired data was methodically organized, cleaned, and coded based on attribute similarity, and then evaluated using statistical tools. According to Kothari (2010), the

analytical procedure comprised manipulating gathered data to determine whether there were any correlations between different factors. The systematic methodology ensured that the conclusions drawn were accurate and reliable.

The data was summarized using descriptive statistics such as the arithmetic mean and percentages. Additional analysis was carried out to investigate relationships, with chi-square used for comparison and assessment. To determine correlation, the Pearson correlation ecoefficiency, specifically the coefficient of determination (R2), was used to compare the degree of relationship between variables. In addition, a standard deviation was employed to calculate the dispersion away from mean. A weighted score was used to categorize respondents as having less knowledge, moderate knowledge, or very knowledgeable. These knowledge categories were used to assess respondents' degree of comprehension. Respondents were interviewed to assess coping capacity and changes in livestock management techniques, and their replies were scored on a Likert scale. The scale used placed values like strongly agree, agree, disagree, and strongly disagree where a value was attached to each of the scores.

The methodology of evaluating statements was based on a Likert scale, as expounded by Kothari (2010), involving assigning scores as follows: a score of 5 indicates strong agreement with a positive statement, while a score of 1 indicates strong disagreement with the same statement. Similarly, a score of 1 was given for strongly agreeing with a negative statement and a score of 5 for strongly disagreeing with a negative statement. The same scoring was applied to a correct and an incorrect statement. The continuum scale used was as follows: strongly agree (5), agree (4), don’t know (3), don’t agree (2), and strongly don’t

agree (1). The approach enabled effective capture of levels of understanding across a broad spectrum within the study population.

The attribute of highly knowledgeable was assigned to respondents who scored between 4 and 5 on both positive and negative statements, demonstrating a better understanding of enhanced climate variability. Respondents in this category also responded appropriately and effectively distinguished between correct and false statements. The second category was moderately knowledgeable: respondents who provided mixed responses in both directions of positive and negative statements but scored less than 4 and above 2. The third category was given the attribute less knowledgeable; this is respondents who could only score 2 or 1. To evaluate the knowledge category, 10 sets of statements, including both positive and negative, were used. A score ranging from 63 to 70 was classified as highly knowledgeable, while a score above 35 but below 63 was categorized as moderately knowledgeable, and respondents who scored below 35 were categorized as less knowledgeable.

3.10 Ethical Consideration

Following the obtaining of a letter to conduct the study from Kenyatta University and subsequent approval by the National Council of Higher Education, the researcher made a cover letter and presented it to the offices of the County Commissioner and County Director of Education. An explanation was given to all respondents, assuring them of confidentiality and the sole purpose of gathering information. All efforts humanly possible were made to abide by the guidance and code of conduct of Kenyatta University and NACOSTI.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.0 Introduction

The study's overarching goal was to analyze the amount of climate variability awareness in the Orma pastoralist community and assess the impact of this information on livestock management practices. Three questions were developed to drive the research, as described in Chapter 1. The investigation was carried out in two locations, Assa and Kipao, which are primarily inhabited by Orma pastoralists. The study also looked at increased climate variability trends in Tana River County, focusing on rainfall performance, temperature, and vegetation condition. The chapter presents the results and discussion of the findings.

4.1 Respondents' Characteristics

The demographics of respondents are presented in the subsequent sections:

4.1.1 Gender of Respondents

The results in Figure 4.1 indicate that majority of household questionnaire respondents were men, accounting for 80% (n = 322) of the total respondents, while 20% (n = 78) were female. There were disproportionately more men than women, despite the fact that Tana River County has a 1:1 male-female ratio, according to GOK (2009). The method of interviewing the head of the home at the time of the interview may have contributed to this. As stated in Section 3.7, household members respond to greetings, but when more information is required, only the leader of the home responds. Because the majority of the households studied were led by men, more men may have responded to questionnaires.

The Orma community is patriarchal within the family structure, with men taking up leadership positions and communicating on behalf of other members (Ensminger, 1992).

Women are more preoccupied with their domestic responsibilities than with their social interactions. Furthermore, Kratil and Swift (2014) described the polygamous aspect of a pastoral household, in which one male might represent multiple women. In order to amplify the voice of women, concerted efforts were made to include more females in all focus group discussions across all sites.

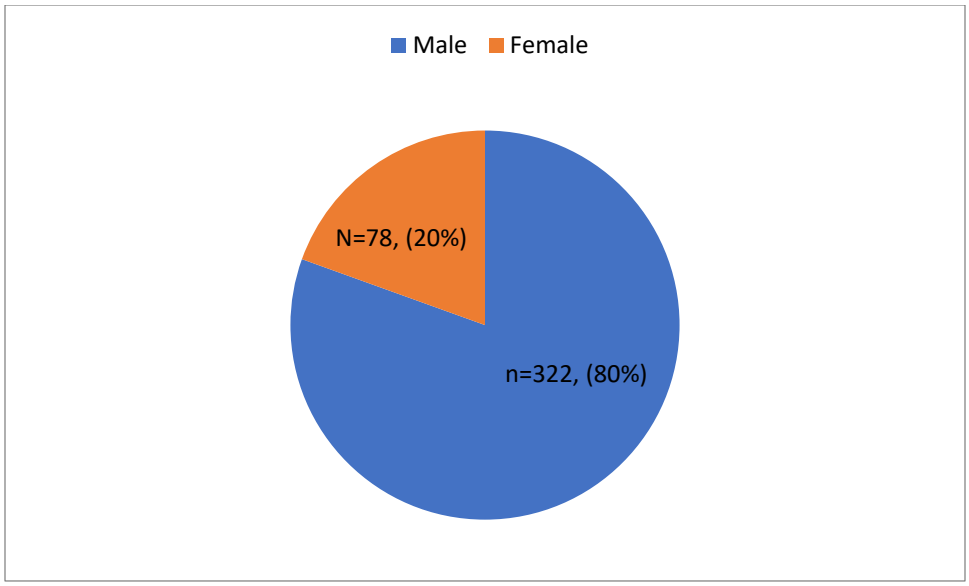

Figure 4.1: Gender of Household Questionnaires Respondents

4.1.2 Age Distribution of Respondents

The majority of the respondents were aged between 36 and 67 years old, making 64.5% (n = 258) of the total respondents. The age bracket of 36–67 years old is classified as those with wide experience in livestock management practices among the Orma pastoralists. As shown in Table 4.1, the 36-43 age bracket was 20% (n = 80), the 44-51 age bracket was 20% (n = 80), 52-59 were 12.57% (n = 51), and 60-67 were 11.75% (n = 47). The second significant group of respondents were aged above 67 years, i.e., 15.5% (n = 64) of the total who belong to the category of wise elders according to Orma Pastoralists. The third

category, which is 19.5% (n = 78), was below 36 years old. These groups are active herders among the Orma pastoralists, depended upon by the community.

The age distribution of respondents provided a rich information, with a blend of experiences from active youth to wise elders. A significant number of respondents had lived long enough to observe patterns of climate component changes. Contribution from all age categories was important in one way or another, offering an opportunity to acquire information that can be generalized to the experience of Orma pastoralists.

Table 4. 1 Respondent Age Distribution

Age Bracket	Frequency	Percentage (%)
20-27	27	6.75
28-35	51	12.75
36-43	80	20
44-51	80	20
52-59	51	12.75
60-67	47	11.75
68-75	26	6.5
76-83	32	8
84-91	6	1.5
Total	**400**	**100**

4.1.3 Households' Main Sources of Income

When respondents were asked about their main source of income, livestock and livestock products featured prominently. The majority of respondents, which is 72% (n = 288) of households, depended on livestock and livestock products as their main source of income, as shown in Figure 4.2. The high reliance on livestock is also supported by county planning

documents such as the integrated development plan (TRCG, 2013). Assa and Kipao are considered pastoral livestock keepers' livelihood zones. Furthermore, the livelihood zoning map of County Assa and Kipao classifies them as pastoral livelihood zones, where livestock production is the primary source of income, as indicated in Plate 6 (page 86).

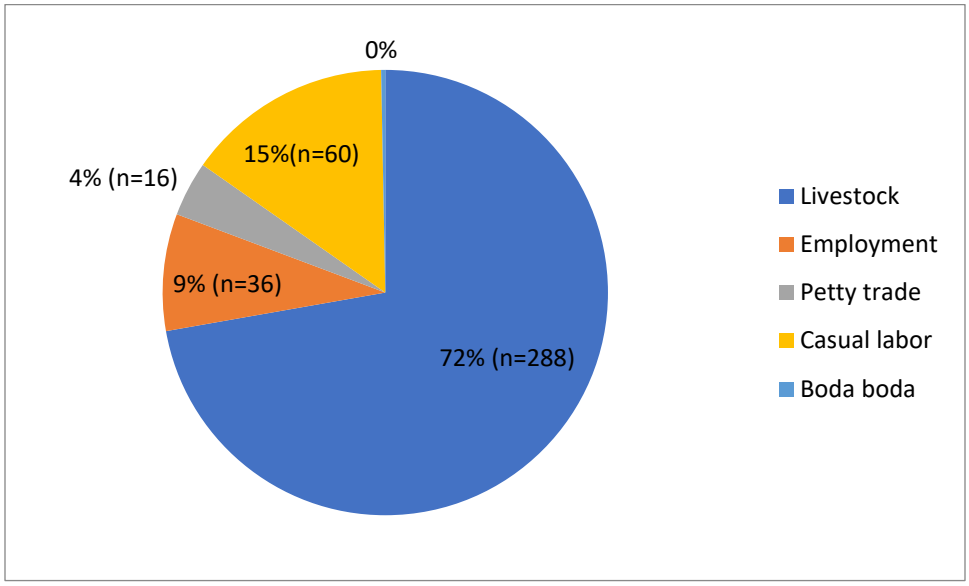

Figure 4. 1: Main Source of Income

4.1.4 House Hold Cattle Herd Size

Livestock, as discussed in 4.2.3, is the primary source of revenue; the number of livestock held provides insight into a household's economic situation. When asked how many livestock they had, most respondents were unable to provide specific numbers. A phrase like "about or not less than" a specific quantity was popular. Various pastoral communities feel that children and livestock are not counted, hence they do not provide an accurate herd size. Kratli and Swift (2014) also noted a lack of real herd size, highlighting the challenge

in determining the economic worth of pastoralist herd size for planning. To compensate for the lack of precision, a range was used to cluster classes.

A majority of 66.5% (n = 266) of the respondents fall in the class 0-29 category, as shown in Table 4.2. This implies that most households require other sources of income to meet their family needs. Among the Orma Community, this is also true for Muslim households with less than 30 herds of cattle, which are considered poor.

Table 4. 2: Number of Cattle Households Currently Own

Number of cattle	Frequency	Percentage (%)
0 – 29	266	66.5
30 – 59	67	16.75
60 – 89	32	8
90 – 129	24	6
130 – 159	7	1.75
160 and above	4	1
Total	**400**	**100**

The other economically important domestic animals in the family are goats and sheep, reared together as one group. Orma community herds and houses goats and sheep together, a practice that is observed to increase the effective utilization of range resources (Oba, 2012). Drier and warmer weather has led to less pasture regeneration, which has affected cattle more than goats and sheep. Herrerro et al. (2016) explained that browsers, which are species that feed on shrubs and other trees, are more tolerant to enhanced climate variability. This is so because pasture, which is the main feed for grazers like cattle, decreases faster and regenerates slowly. Probably varying levels of impact on pasture and browsing explain the increased loss of cattle and families opting for small stocks, which

are goats and sheep. A majority of respondents, 59.25%, indicated that they own more than 40 goats, as shown in Table 4.3, while 40.75% reported owning less than 40 goats.

The increase in households keeping smaller stocks, which require fewer feeds, and the decline in the number of households keeping cattle were reported by the by the livestock department (TRCG, 2013). Further, according to one of the key informants interviewed (the Sub-County Livestock Production Officer), their department is currently encouraging families to engage in keeping small stock. He explained that goats are more tolerant to drought situations and utilize a wider variety of range resources as compared to cattle, which are grazers. In addition, in one of the focus group discussions held at Assa, former senior chief Omar Bonaya narrated an Orma saying that echoed the importance of small stocks: "*When you fall, our elders say hold what is close to the earth."* This implies that if individuals' circumstances are not favorable (issues about the source of income), small animals are rapidly maturing and demand less from the keeper.

Table 4. 3: Number of Goats Owned by the Household During the Study

Number of Goats	Frequency	Percentage (%)
0 – 39	163	40.75
40 – 79	117	29.25
80 – 119	68	17
120 – 159	23	5.75
160 – 199	5	1.25
200 and above	24	6
Totals	**400**	**100**

The majority of respondents reported owning less than 40 sheep as shown in Table 4.3, The population of sheep appears to be reducing as they are more vulnerable to changes in the environment.

Table 4.4: Number of Sheep Owned by the Household During the Study

Number of Sheep	Frequency	Percentage (%)
0 – 39	388	97
40 – 79	10	2.5
80 – 119	2	0.5
120 – 159	0	0
160 – 199	0	0
200 and above	0	0
Totals	**400**	**100**

From the findings, the recommendation to keep more small stock, and of climate change-related impacts has led to more households keeping goats. Which is also demonstrated by low number of households keeping sheep, where only 2.5 % of respondents reported to have more than 40 sheep as shown in Table 4.4.

4.2 Tana River County Climate Variability Trends

One objective of the study was to determine whether there was enhanced seasonal variability in climate in Tana River County from 1988 to 2018. This aspect of the analysis aimed to establish whether there was indeed enhanced variability in climate elements observed over this period.

4.2.1 Rainfall Performance Long Rainy Season

To establish whether there has been enhanced climate variability, the average rainfall estimate was one of the climate elements analyzed. This was achieved using rainfall data obtained from the meteorological department. Tana River County experiences long rain seasons occurring during the months of March, April, and May, referred to as MAM rainfall. An analysis of average seasonal rainfall data was generated by getting a mean monthly rainfall estimate for the season as shown in Fig. 4.3.

There was enhanced year-to-year variability of rainfall for the long rain seasons (MAM), as shown in Figure 4.3. In addition, there was a reduction in average long rainfall from 150 mm in 1988 to 80 mm in 2018. There was a low relation on a linear model of year against mean rainfall, as $r^2 = 0.0823$. Despite there being a negative correlation (r = -0.287), only 8.23% of the variance can be attributed to the progress of time, and more than 90% of the variation is due to other factors. The year-to-year enhanced seasonal variability of rainfall performance was demonstrated by increased spread from the mean seasonal rainfall (σ = 64.45 mm).

The measure of dispersion confirmed the high variability of MAM season rainfall from one year to another, making prediction much more difficult to support decision-making.

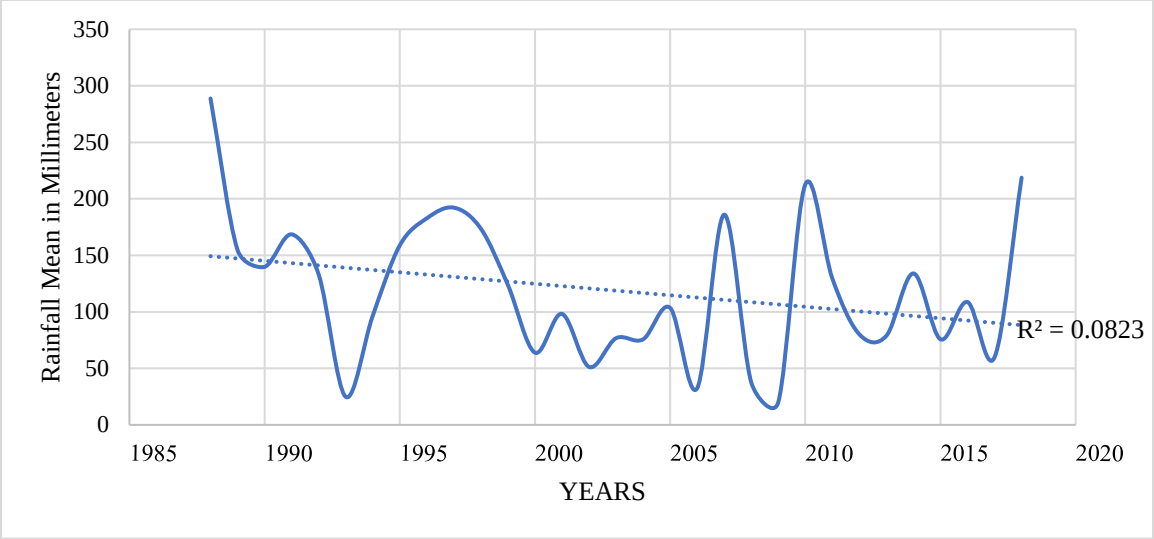

Figure 4.2: Tana River County Average March, April, and May (MAM) Rainfall

Similar findings indicating a depression of rainfall during the March, April, and May rainy seasons (long rain) in East Africa were reported by Nicholson (2017). The long rain season, known among Orma pastoralists as '*Gann'*, symbolizes a time of plenty, highly dependent on for livestock production. However, since 1980, according to participants in focus group discussions and key informant interviews, it has become less reliable. They further outlined that rainfall has reduced in amount and there has been an increased frequency of drought. These results were also corroborated by Tierney et al., explaining that there was a drastic depression of MAM rainfall in the Horn of Africa in the year 1980.

4.2.2 Rainfall Performance Short Rainy Season

Short rains fall between October and December in Tana River County, as indicated by a summary of the focus group discussion. This period of occurrence of short rains in Kenya was also reported by Nicholson (2017) and Tierney et al. (2015), falling on similar months. From the analysis of rainfall data for short rainfall seasonal performance for October, November, and December, there was evidence of an increase from 212 mm in 1982 to 225

mm in 2018. There was a slight increase in the average mean over the years, as shown in Figure. 4.4.

There was a low positive relationship on a linear model as $R^2 = 0.0009$, which demonstrates a weak positive association between change in time and an increase in short rainfall performance. While there was a decrease in the long-term seasonal rainfall average, there was a slight increase in average short rainfall performance. Further, equally enhanced variability from year to year was noted as $\sigma = 37.6$ mm. This implies that the traditionally held belief that long rainfall was a season of plenty is slowly becoming less applicable. Information on the performance of long rains and short rains was also corroborated by Nicholson (2017), who explained that there has been a drastic reduction in long rains and an increase in average rainfall during short rains in October, November, and December (OND) over the East African region.

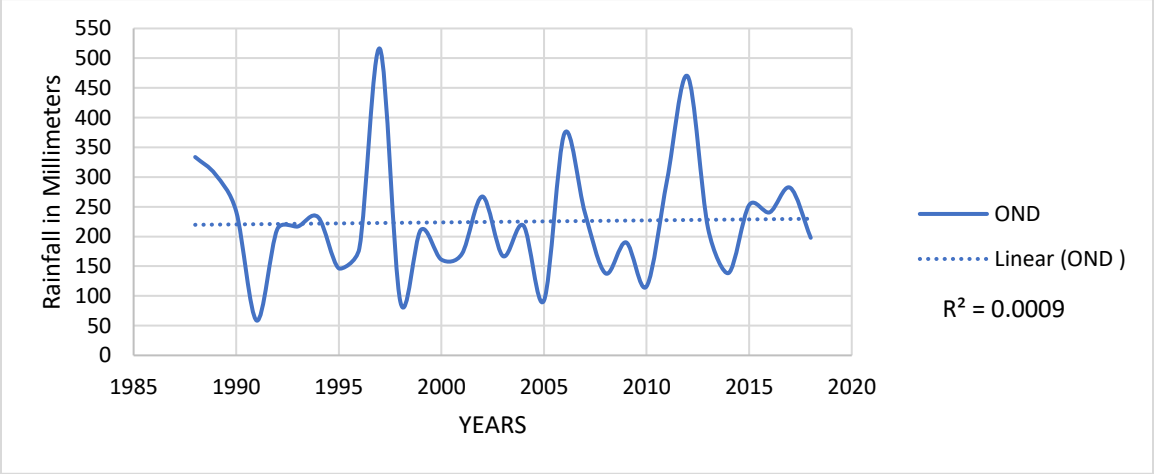

Figure 4.3: Tana River County Average October, November, and December (OND) Rainfall

4.2.3 Long-term Temperature of Tana River County

The county becoming hotter and drier was a common complaint raised by a majority of those interviewed, both as key informants and participants in focus group discussions. This

was also reported by a majority of household interview respondents: their area is becoming hotter, as shown in Table 4.6.

Enhanced variability and an increase in mean temperature over some time were also shown by the analysis of temperature readings, as shown in Figure. 4.5.

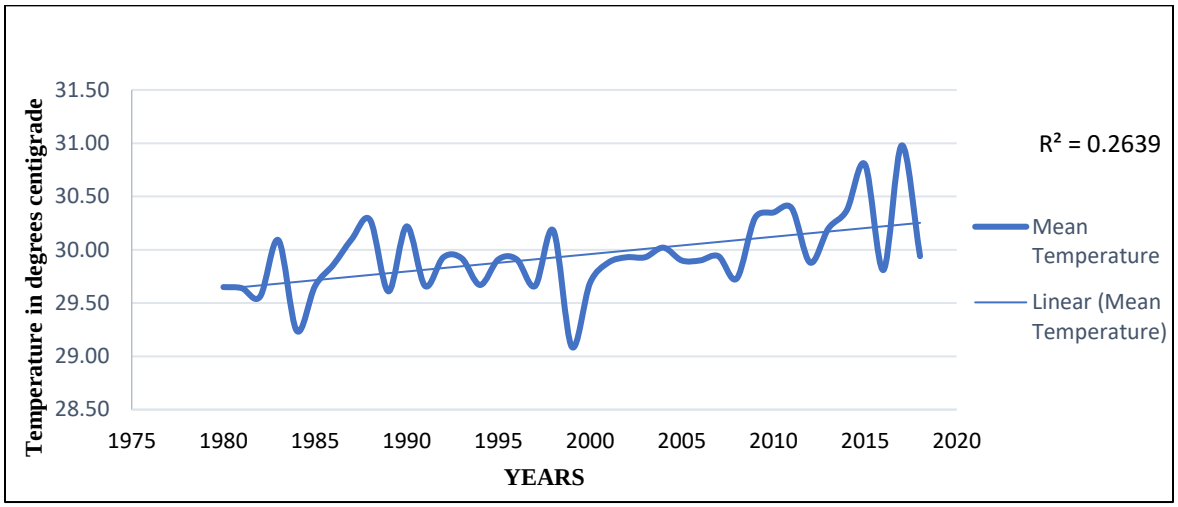

Figure 4. 4: Tana River County Mean Annual Temperature

There was a slight increase in temperature over the years, about 0.4 $^{\circ}C.$ Though minimal, this has had a great impact on livestock production. It will lead to increased evaporation of water and enhanced drying of pasture and browse.

The linear model analysis demonstrated that $R^2 = 0.2639$, which implies that only 26.4% of changes can be predicted with an increase in years. In other words, the model can predict an increase in temperature at a future point with 26.4% accuracy. This confirms year-to-year enhanced variability and a gradual increase in temperature in Tana River County. Similar findings were reported by Ongoma et al. (2017), explaining that some parts of Kenya are becoming wetter and hotter while the northern part of Kenya is drier and hotter.

4.2.4 Tana River County Monthly Vegetation Condition

Pastoralists depend on rainfall to support pasture regeneration for their herd production. Because of its significance, Orma pastoralists continuously scout the grassy area to evaluate pasture condition. It was evident from the household questionnaire results that the pasture condition was deteriorating, as shown in Table 4.10. Additional data to get a clear picture of vegetation condition was generated by analyzing the monthly vegetation condition index generated by the National Drought Management Authority. The National Drought Management Authority monitors drought using the vegetation condition index (VCI). Monthly and three-monthly VCIs are produced by NDMA in collaboration with BOKU University, as explained by Klisch and Atezberger (2016). They further explained how Moderate-Resolution Imaging Spectroradiometer (MODIS) data are downloaded from NASA and processed for use in drought management decision-making.

Tana River County VCI (2001–2018) data was analyzed and indexed using VCI guidelines as shown in Table 4.4. The vegetation condition categorized as ‘normal’ (35%–50%) was observed to be reducing over the years, being surpassed by the 'moderate’ category (20%–35%) by the year 2010. On the other hand, the category ‘poor’ (20%–30%) increased over time, as shown by the linear range of 20%–35% in Figure 4.6. The decline in vegetation greenness is significant in assessing pasture and browse status in the county, as it is used to guide drought response by various actors. In addition, it was evident that the trend of moderate vegetation deficits was increasing.

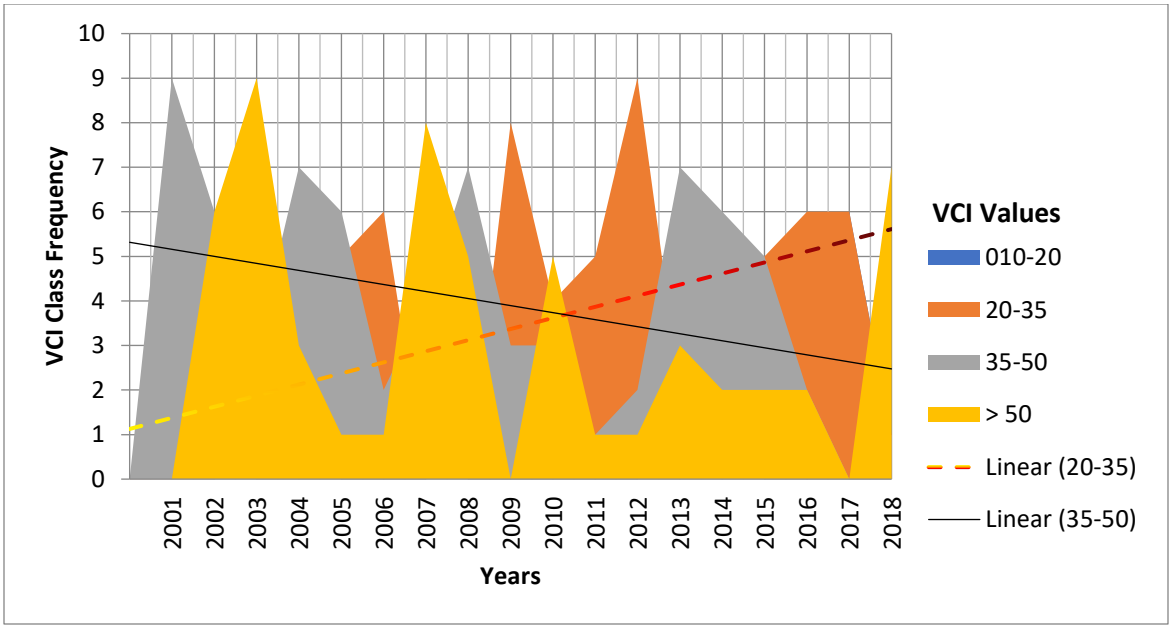

Figure 4. 5: Tana River County Vegetation Condition Index

Table 4. 4: Summary of VCI Interpretation

VCI 3 Monthly in %	Vegetation Condition
≥ 50	Vegetation Greenness above Normal
35 to 50	Normal Vegetation Greenness
21 to 34	Moderate Vegetation Deficit
10 to 20	Severe Vegetation deficit
<10	Extreme Vegetation deficit

Adapted from NDMA Drought Management Response Guide (2020)

4.3 Orma Pastoralist Knowledge of Enhanced Climate Variability

The second objective of the study was to determine Orma Pastoralists' knowledge of enhanced climate variability. To assess Orma pastoralist knowledge of enhanced climate variability, the following knowledge components were considered: awareness of climate

change, experience of variability, and a comprehensive understanding of assessing possible causes and effects.

4.3.1 Awareness of Enhanced Climate Variability

One of the tools used to achieve the objective of the study was household questionnaires. When asked whether they know or have heard about climate change generally, the responses indicated that the majority are aware. The level of awareness was quite high among male respondents, as shown in Table 4. The majority, i.e., 76.92% (n = 60) of female respondents and 86.34% (n = 278) of male respondents, respectively, affirmed that they had heard or knew about climate change. Global warming was mentioned more frequently in key informant (KI) interviews and focus group discussions. The majority of respondents involved in KI used the terms global warming and climate change interchangeably.

Female respondents were not as aware as their male counterparts; further analysis was done to find out whether there is an association between respondents' gender and level of awareness. From the results, there appears to be an association between gender and level of awareness, as $x^2 = 4.247135$, $df = 1$, and $p = 0.039317$. Males perform tasks and roles requiring greater movement away from the homestead, contrasting with females, whose main tasks and roles are close to the homestead, according to FGD and key informant interviews. This implies that men have more opportunities to expand their knowledge. On the other hand, women depend on the information available around the homestead.

The significance level of the test, also referred to as the alpha value (p) for the study, was 0.05 at a *p-value* of.039, which demonstrates the statistical significance of the test. Therefore, based on the analysis, there is a strong possibility that gender plays a role in influencing the level of awareness of enhanced climate variability.

Significantly high awareness of climate change was also observed in other studies. For example, Ajuang et al. (2016) reported that awareness of climate was above 80% among residents of Nyakatch, Kisumu County. This fact was also corroborated by Mutunga et al. (2017), who reported that 74% of small-scale farmers in Makueni County were aware of climate change.

Based on the findings of household interviews, a summary of key informant interviews, and a literature review, there was a significantly high level of climate change awareness. However, whether the high level of awareness of climate change contributes to better understanding or action has to be established. What appears to be of more concern to respondents involved in the study was the impact of extreme weather events and the underperformance of seasonal rainfall. On the other hand, the majority of respondents equate climate change with negative impacts, and those with formal education among the respondents and key informants have a limited understanding of the climate change concept. Key informants in government departments (livestock and administration) mix reduction of the ozone layer with an increase in greenhouse emissions.

Table 4. 5: Respondent Awareness of Climate Change

Category of attributes	No of female respondents (n=78)	Percentage of total female respondent	No of male respondents (n=322)	Percentage of total male respondent
Yes	60	76.92%	278	86.34%
No	18	23.08%	44	13.66%
Totals	78	100%	322	100%

4.3.2 Experience of Enhanced Climate Variability

Households were asked whether they had noticed changes outside of what they perceived as normal seasonal variation from 1988 to 2018. The focus was for respondents to compare year-to-year seasonal rainfall performance changes. For example, respondents could compare the long rainy season of recent years with other years before. A majority of respondents explained that there has been significant variation in seasonal rainfall performance. Observations by Orma pastoralists were also corroborated by the analysis of rainfall data from the meteorological department, as shown in Figures 4.3 and 4.4, i.e., average seasonal rainfall performance.

4.3.2.1 Experience of Season-to-Season Rainfall Variation

Enhanced variability in seasonal rainfall performance was also reported by a majority of respondents. When comparing year-to-year rainfall performance, the majority, i.e., 87.89% (n = 283) of male respondents and 78.21% (n = 63) of female respondents, reported that rainfall is becoming less predictable and there are fewer rainfall days, as shown in Table 4.6. Further analysis demonstrated an association between gender and understanding of enhanced climate variability as $x^2 = 4.88979$, $df = 1$, and $p = 0.027016$.

Figures 4.3 and 4.4 outlined an increase in variation in yearly seasonal rainfall performance, which corroborates the findings of respondents' experiences. In addition, the reduction of average long rainfall performance was also highlighted in FGD and KI, similar to what was shown in Figure 4.3. Long rain was reducing in average amount and also becoming more and more unpredictable.

Table 4. 6: Onset, Cessation, and Performance of Rainfall From 1988 to 2018

Category of attributes	No of female respondents (n=78)	Percentage of total female respondents (%)	No of male respondents (n=322)	Percentage of total Male respondents (%)
Highly predictable, onset, Cessation and performance	17	21.79	39	12.11
Highly Unpredictable, onset, Cessation and performance	61	78.21	283	87.89
Totals	**78**	**100.00**	**322**	**100.00**

Tana River County experiences two rainfall seasons, i.e., the long rain seasons of March, April, and May. According to remarks generated during FGDs, it was reported that MAM rainfall historically has been a time of good rainfall and better vegetation regeneration. However, currently, it has become more unreliable and not adequate to support pasture regeneration. This information is also corroborated by the analyzed rainfall data shown in Figure 4.3, which shows a gradual reduction over the years. The second season is the short rain, which during FGD was reported to be historically a time of less rainfall. This is now changing, and the short rain in October, November, and December (OND) is now increasing over time, though it has remained unreliable.

The majority of respondents agreed that there has been significantly high variability in temperature and rainfall performance from season to season. Changes in season-to-season rainfall performance and temperature formed the reference for expressing their knowledge among a majority of respondents.

The first objective of the study was to establish whether there is enhanced climate variability in Tana River County. Rainfall average and temperature readings were used, and it was evident that, as shown in Figures 4.3 and 4.4, there has been enhanced variability, which was observed to be more than what was previously experienced, as shown in Table 4.6. Further, based on data received from the Meteorological Department, OND rainfall is equally highly variable but shows an increase in average seasonal rainfall, as shown in Figure 4.2.

4.3.2.2 Experience with Temperature of their Area

In response to the questions about the temperature of their location between 1988 and 2018, the majority of males, i.e., 63.35% (n = 204), and the majority of females, 65.38% (n = 51), agreed that their location is becoming hotter, as shown in Table 4.7. Generally, all respondents agree temperature has been increasing. 34.62% (n = 27) of females and 36.65% (n = 118) of males further qualified the increase by adding increased fluctuation with more hot episodes, as shown in Table 4.7.

The respondents' experience of their location becoming hotter was also corroborated by temperature readings by the Meteorological Department during the same period, which outlined an increase from 29.70 degrees centigrade (°C) average mean in 1980 to 30.50 °C average mean temperature in 2015, as shown in Fig. 4.5. Northern Kenya becoming hotter was also reported by Ongoma *et al.* (2017). Their location becoming hotter and dryer has negative implications for Orma livestock production, which depends on pasture and water.

Table 4. 7:Temperature Changes During the Last 30 Years (1988-2018)

Category of attributes	No of female respondents (n=78)	Percentage of total female respondents (%)	No of male respondents (n=322)	Percentage of total Male respondents (%)
It is becoming hotter	51	65.38	204	63.35
There has been a frequent fluctuation of temperature but there have been more hot episodes	27	34.62	118	36.65
Totals	**78**	**100**	**322**	**100**

4.4 Understanding of Enhanced Climate Variability

Most of the respondents are aware of climate change, as shown in Table 4.5; in other words, a significant number of respondents know or have heard about enhanced climate variability and change. These findings, though in agreement with other studies by Ajuag *et al.* (2018) and Mutunga *et al.* (2017), raise the fundamental question of which dimension or component of climate change knowledge the community possesses. The study adopted climate change knowledge assessment perceptions as outlined by Shi *et al.* (2015), where climate change knowledge was classified into three categories: interpreting relevant terms or concepts, causal factors, and knowledge about the impacts of enhanced climate variability.

The study documented Orma pastoralists' application of climate variability knowledge in livestock management practices. Kimaro *et al.* (2018) emphasized the importance of more research to enhance knowledge about communities' understanding of weather patterns for

indigenous forecasting. Effective seasonal forecasting facilitates better grass management decision-making. In addition, Kimaro *et al.* (2018) explained that there exists a gap in understanding pastoralists adaptive capacity to climate change. The documented knowledge identified adaptation practices that will contribute to the understanding of pastoralists' adaptations and limitations, which require actions to address. Further, the knowledge generated will inform the design of livestock sector interventions for developmental and emergency response purposes.

4.4.1 Description of Enhanced Climate Variability

To assess Orma Pastoralists 'level of understanding of climate variability, a description of the concept was considered. Based on the findings of focus group discussions, household questionnaire responses, and key informant interviews, it was found that respondents' understanding of climate change was limited. It was evident that when asked what they understood about enhanced climate variability or change, the majority focused on the consequences or impacts of the changes. Where 76.92% (n = 60) of females and 84.47% (n = 272) of males, respectively, explained climate change as increased frequency and severity of drought as outlined in Table 4.8. Meanwhile, 16.67% (n = 13) of female and 11.18% (n = 36) of male respondents explained climate change as increased frequency of flooding, and only 0.62% (n = 2) of males explained enhanced climate variability as long-term change in the weather pattern.

Tana River County, in the recent past, has been facing frequent and more severe drought (MoALF, 2016). This reality could have influenced respondents's perceptions about climate change. Additionally, Weber (2010) explained that the general public's perception of climate change is more focused on weather, which affects them directly, than long-term

issues. Respondents have heard about climate change, and their experience with frequent and prolonged droughts influenced their knowledge. Based on the findings of household interviews, a summary of key informant interviews, and a literature review, there was a significantly high level of climate change awareness.

However, despite a high level of awareness, there is a gap in understanding of climate change. A majority of respondents equate climate change with the negative impacts of extreme weather events like drought. A significant number of key informants interviewed referred to climate change as '*mabadiliko ya hali ya anga.'* Further, they explained that they have noticed changes in weather patterns in their area, and they have been affecting livestock and crop production. Similar findings about climate change perception were forwarded by Stuart *et al.* (2015), who argued that changing meteorological conditions may influence public perception. Therefore, this implies that, in the absence of better scientific understanding, individuals perceive climate according to how it affects them.

Table 4. 8: What Respondents Understood About Climate Change

Category of attributes	**No of female respondents (n=78)**	**Percentage of total female respondents (%)**	**No of male respondents (n=322)**	**Percentage of total male respondents (%)**
Long-term shift in weather pattern	0		2	0.62
More frequent and severe drought	60	76.92	272	84.47
Increased flooding	13	16.67	36	11.18
Increased temperature	2	2.56	10	3.11
I don't know	3	3.85	2	0.62
Totals	**78**	**100**	**322**	**100**

4.4.2 Causes of Enhanced Climate Variability/Change

The second component of knowledge about climate change assessed was causal factors, it was evident that the majority of respondents have limited information about causes of climate change.

When asked causes of Climate Change about 50 % (n=39) of female and 54.04 % (n=174) of male respondents, believed that it was due to Nature or God ‘s wishes as shown in Table 4.9. Similarly, opinions summarized from Focus Group Discussion supported this belief. For example, Mzee Adan Dara of Kipao village argued that climate change is punishment for mankind’s sins stating that; “*What do we expect when Killing of the innocent is increasing, people are not helping the needy and respect for parents are waning*”.

Second, a good percentage of respondents that is 35.9% (n=28) female and 31.36% (n=101) of male respondents admitted they did not know the cause. The community’s belief likely influenced their understanding of climate change causal factors. Weber (2010) corroborated the fact that values and believe system influences individuals interpretation and perception about phenomenon like climate change. He further argued that strongly held cultural values and other beliefs tend to influence how interpret changes they encounter shaping their course of response.

Third, 6.41% (n=5) Female and 4.66% (n=15) male the respondent outlined human activities like overstocking livestock and increased population as probable causes.

Table 4. 9: Opinion of Respondent About Causes of Climate Change

Category of attributes	No of female respondents (n=78)	Percentage of total female respondents (%)	No of male respondents (n=322)	Percentage of total male respondents (%)
Human Activities	5	6.41	15	4.66
Gods' wishes	39	50	174	54.04
I don't know	28	35.9	101	31.36
Others	6	7.69	32	9.94
Totals	**78**	**100**	**322**	**100**

4.4.3 Effects of Enhance Climate Variability

The third component assessed was about the effect enhanced climate variability, where respondents outlined various impacts they observed over time. According to the findings of this study, there are several impacts experienced by Orma Pastoralists of Tana River County as a result of enhanced climate variability. Orma pastoralists have experienced frequent and more severe weather events, especially drought. During the last drought (which was during the year 2017) respondents reported a loss of cattle about 12 per household in Assa on average as shown in Figure 4.7.

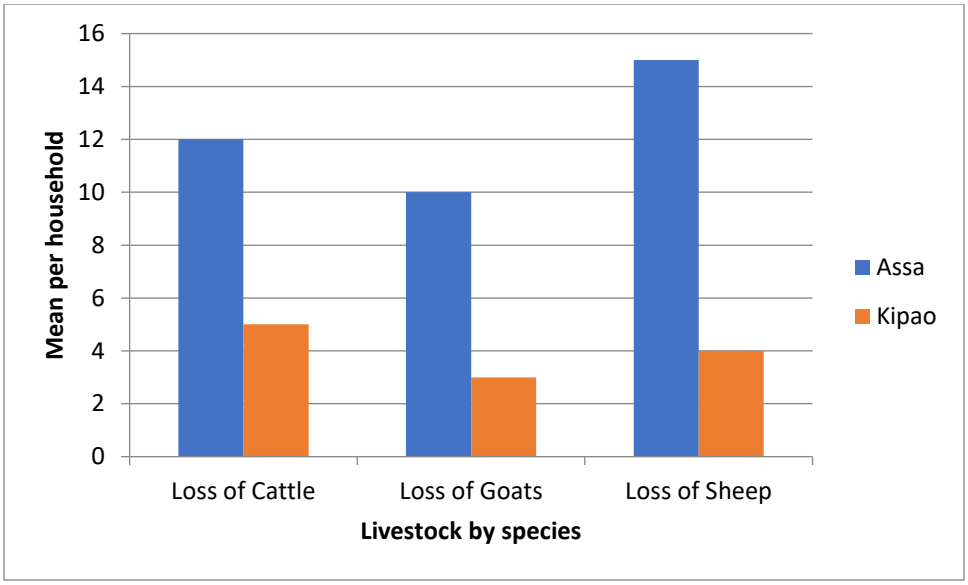

Figure 4. 6: Average Loss Of Cattle and Goats During the Drought Of 2017

4.4.3.1 Effects of Enhanced Climate Variability on Seasonal Rainfall Performance

Comparing the year-to-year performance of rainfall, the majority of respondents reported that rainfall is becoming less reliable with fewer rainy days, as shown in Table 4.6. Similarly, findings by Gundula *et al.* (2018) outlined that rainfall seasons used to be more consistent in occurrence and performance, but now they are unpredictable.

Forecasting seasonal performance facilitated migration decision-making among the Orma pastoralists. Wise elders were consulted about the coming season; they observed various indicators, triangulated, and agreed on a possible scenario. One of the key informants interviewed, Elder Kuni Dhadho (78 years older), explained, “Nature is cheating now; it says one thing and the outcome is another. I observe the behaviors of birds, animals, and the position of stars at night; nothing is consistent currently.” Salite (2019) echoed the argument forwarded by the elder: that enhanced climate variability and subsequent changes in the environment have made traditionally dependable indicators less precise.

Respondents are concerned with seasonal rainfall performance as they are experiencing changes in time and coverage.

4.4.3.2 Effects of Enhanced Climate Variability on Pasture and Browse

The majority of respondents, comprising 64% (n = 50) of women and 57.14% (n = 184) of men, affirmed that pasture regeneration was affected to a very great extent, as shown in Table 4.10. The percentage of women in this case is higher than that of men. This disparity may be attributed to women's role in collecting pasture for young and weak animals, making them more observant of the significant effects. It is vital to acknowledge that climate change impacts are not gender-neutral; they affect men and women differently (WMO, 2019). It is important to note that livestock production under pastoralist management entirely depends on rainfall (Oba, 2012). That is pasture generation, and the recharging of water sources entirely is rainfall, which are key resources needed for production.

Focus group discussions and key informant interviews further reinforced respondents' remarks about effects, with the majority outlining the scarcity of pasture. In addition, women expressed particular concern about diminishing pasture, forcing them to travel far distances beyond the reach of young girls. For example, Hadija Garbo from Assa, during a focus group discussion, noted that during their childhood, it was their responsibility to collect fodder ('Okha') for the vulnerable herd; this task was not done by their mothers. However, she explained that under current circumstances, the collection of 'okha' is beyond the capacity of girls, as it involves going the long distance from homesteads to get pasture and fodder trees.

Table 4. 10: Effect of Enhanced Climate Variability on Pasture Regeneration

Category of attributes	No of female respondents (n=78)	Percentage of total female respondents(%)	No of male respondents (n=322)	Percentage of total male respondents (%)
Very great extent	50	64	184	57.14
Great extent	25	32.1	128	39.75
Minimum extent	3	3.9	10	3.11
Totals	**78**	**100**	**322**	**100**

4.4.3.3 Effects of Enhanced Climate Variability on Water Availability

Respondents were particular concerned about the effects of enhanced climate variability on water availability. When asked about the extent to which water availability was affected, majority indicated that it is affected to a very great extent. With 85.9% (n=67) female and 83.54% (n=269) male affirming that indeed water availability has been affected to a very great extent as shown in Table 4.11

Table 4. 11: Impact of Enhanced Climate Variability of Water Availability

Category of attributes	No of female respondents (n=78)	Percentage of total female respondents (%)	No of male respondents (n=322)	Percentage of total male respondents (%)
Very great extent	67	85.9	269	83.54
Great extent	10	12.8	50	15.53
Minimum extent	1	1.3	3	0.93
Totals	**78**	**100**	**322**	**100**

4.4.3.4 Categorization of Enhanced Climate Variability Knowledge

As shown in Figure 4, 8 knowledge categories were scaled into 3 attributes, which were ‘highly’ knowledgeable, 'moderately", and ‘less’ knowledgeable. This was based on responses to 12 sets of statements about the interpretation of terms or concepts about enhanced climate variability, the cause of enhanced climate variability, and the impacts of enhanced climate variability. Scoring was done as outlined in Chapter 3.

The knowledge category was signed by respondents based on their scores on a Linkert scale. The ‘Highly’ knowledgeable category are respondents with good mastery of enhanced climate variability phenomena, i.e., can explain basic facts like causes, impacts, the role of human beings in cause and mitigation, and differentiating cause from impacts of enhanced climate variability. Respondents in the category ‘highly’ knowledgeable were a minority, accounting for only 0.6% (2) males.

The second category was 'moderately' knowledgeable, and respondents in this category demonstrated some level of knowledge of concepts. However, their responses were mixed, such as agreeing with an otherwise negative statement or disagreeing with a positive statement. As shown in Figure. 4.8–25.6% (n = 20) females and 34.8% (n = 112) males were in the category 'moderately knowledgeable'.

The majority of respondents, comprising 74.4% (n = 58) males and 64% (n = 208) females, were in the category of 'less' knowledgeable. Respondents in this category, despite being aware of enhanced climate variability, mainly equate it to its impact, saying it is a severe and recurrent drought. This implies that the majority of respondents, despite being aware of and experiencing the impacts of enhanced climate variability, have limited knowledge about the underlying concepts of enhanced climate variability.

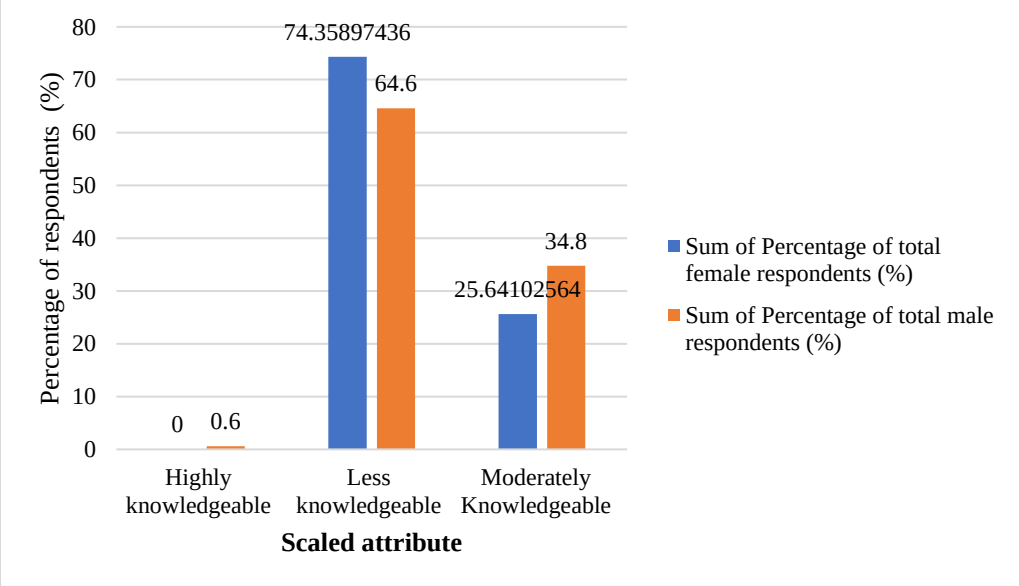

Figure 4.8: Respondent's Level of Enhanced Climate Variability Knowledge

There exist many gaps in their knowledge to mitigate and also cope with the level changes in their environment. Shi *et al.* (2015), similarly explained despite experience and awareness other critical elements of enhanced climate change knowledge remained a gap among community members.

4.5 Management Practice Used to Cope with Extreme Weather Events

From the findings, it was evident that there are numerous gaps in their knowledge to mitigate and also cope with the level of changes in their environment. Shi *et al.* (2015) similarly explained that despite experience and awareness, other critical elements of enhanced climate change knowledge remained a gap among community members.

To investigate whether Orma pastoralists are using knowledge of enhanced climate variability to modify their livestock management practices, respondents were asked about measures they used during the last extreme weather event. As outlined in Chapter 1, livestock management practices were categorized into two groups. The two categories were traditional practices that are indigenous and formed part of their tradition and emerging practices that were practiced to cope with increased changes in their environment. The practices referred to in this section are emerging practices that are assumed to be in response to the effects of enhanced climate variability.

According to the study, there was evidence that Orma pastoralists adopted coping strategies to minimize losses to extreme weather events. As shown in Table 4.13, various management practices were used to cope with the impacts of enhanced climate variability. The majority of respondents, comprising 90.30% (n = 294) males and 89.74% (n = 70) females, reported that their household used a new practice to cope with extreme weather events, which was prolonged drought. The most common practice reported by most

respondents was movement outside their traditional grazing area. Mobility as a strategy for utilizing natural resources is an old practice. However, moving beyond the traditional grazing zone—more than two days' journey by herders and their herd—is recognized as a new practice. Other studies also agree with the increased frequency and distance of migration. For example, Adger *et al.* (2003) outlined that migration as a strategy for resource utilization is becoming more pronounced to cope with an extreme weather event. The use of supplementary livestock feeds, which included cereals, hay, tubers, and acacia pods, was identified as a practice that is slowly being adapted, as elaborated in FGDs and KI interviews conducted. Further, study findings reported that the main cereal used was sorghum, which was provided by the World Food Program as relief food for households, as expressed in most of the focus group discussions.

One of the null hypotheses (Ho) suggested for the study was that there is no relationship between Orma pastoralists's awareness of enhanced climate variability and changes in their livestock management practices. The study was pursued to investigate whether there are changes in livestock management practices by the Orma pastoralists attributed to enhanced climate variability. Further investigation involved assessing changes in livestock management practices in response to the scarcity of pasture and water attributed to enhanced climate variability. The analysis of household questionnaires, complemented by the synthesis of focus group discussions and key informant interviews, provided evidence that, in fact, Orma pastoralists are employing innovative practices to cope with enhanced climate variability.

The awareness level among the males was particularly high, as 86.34% (n = 278) were familiar with enhanced climate variability or had heard of it. The high awareness level

could have contributed to an increase in adoption of non-traditional management practices, as 91.30% of male respondents reported applying such methods to cope with drought. There was a significant association between male respondents' awareness of enhanced climate variability and change in management practices, as $x^2 = 4.003108$, $df = 1$, and $p = 0.045416$. Accordingly, the study rejects the null hypothesis and accepts the alternative hypothesis.

Equally, among female respondents, the awareness level was 76.92%, and the report of households adapting new practices to respond to drought was 89.74%. There was a significant association between the level of awareness and adaptation of news practices, as $p = 0.031686$, less than 0.05, set as the significance level of the test.

Some of the emerging practices are the provision of supplementary feeds, a practice that is getting accepted, contrary to the belief that livestock can find their feeds solely. In addition, commercial commodities like pods and hay are creating opportunities for entrepreneurs. Acacia trees produce pods, which are traditionally collected during the stress period to feed weak animals. However, increased human activities like charcoal burning have reduced acacia trees within Tana River County, and households are forced to travel long distances to get the pods and pasture. The scarcity of acacia trees and increased demand for pods during drought seasons have created opportunities for traders from neighboring counties to fill the gap. Further, it is currently common to find traders from Ukambani selling it in local markets within Tana River County, as shown in Plate 7 (page 87).

Respondents also mentioned other forms of support that were helpful during the last drought, including drought pellets provided by NDMA and water provided by the county

government. Drought pellets are a type of livestock feed manufactured by Unga Limited using a formula developed by KALRO and NDMA distribution as shown in Plate 8 (page 88).

Table 4. 12: Livestock Management Practices During Last Drought

Category of attributes	No of female respondents (n=78)	Percentage of total female respondents (%)	No of male respondents (n=322)	Percentage of total Male respondents (%)
New management practices not traditionally used	70	89.74	294	91.30
No change of practice	8	10.26	28	8.70
Totals	**78**	**100.00**	**322**	**100.00**

4.5.1 Livestock Management Practices with Long-Term Implication

Based on household interviews and key informant interviews, it was evident that some practices that are of a more long-term in nature are emerging. For example, Ormas pastoralists who are traditionally cattle keepers, are beginning to acquire camels. Herrerro et al (2016), argued that climate changes have generated a significant shift in culture and local economies. Camel keeping was once considered a taboo among the Ormas as explained by Mzee Jarso of Assa. "*It's unbelievable to witness Orma Boma with Camels' dugs, I am now witnessing what my father never dreamed of'*. The observation of Mzee Jarso implies that despite camels being a taboo for Orma Pastoralist, climate realities are modifying their culture, leading to the adoption of camel husbandry.

The Majority of respondents, comprising of 61.54% (n = 48) female, and 58.39% (n = 188) reported to be utilizing traditional methods of migration with some modification which included the early movement to dry season grazing areas as shown in table 4.13. Changing or acquiring more drought-resilient species such as Camel was reported by 15.38% (n = 12) females and 7.76% (n = 38) males. Camel and goats are more tolerant to drought as they utilize a wider variety of pasture and can stay more days without water. In addition, poultry keeping is also emerging as an appreciated livestock for being more tolerant to drought. Herrerro et al (2016), outlined that Camels are browsers the same as Goats; utilize both pasture and shrubs, whereas Cattle and Sheep are grazers feeding mainly on grass. There was also a third group of respondents who reported no change of livestock management practices with long-term impact making comprising of 23.08% (n = 18) female and 33.85% (n = 109) male.

Female respondents reporting adaption of other species placed more emphasis on poultry, which was described as being too small to be considered by men in FGDs and KI interviews. Orma pastoralist males rarely count poultry as livestock and it is mostly managed by women. Hashora of Kipao during one of FGDs explained that; *when they migrate, they used to leave behind chicken, but this is no longer the case.* The community is now placing value on poultry learning from the problems they are facing including the loss of livestock due to drought.

Table 4. 13: Adaptation Strategies

Category of attributes	No of female respondents (n=78)	Percentage of total female respondents (%)	No of male respondents (n=322)	Percentage of total Male respondents (%)
Acquired more drought-tolerant species like camel, also Poultry	12	15.38	25	7.76
Moving to Delta timely before animals become weak	48	61.54	188	58.39
No change practice	18	23.08	109	33.85
Totals	**78**	**100**	**322**	**100**

There was an association between respondent gender and employment of different strategies to adapt to enhanced climate variability. This association was found to be statistically significant as $p = 0.041928$ less than the study-accepted level of significance of 0.05. Further, $x^2 = 6.343589$; $df = 2$ which implies that there was a moderately strong association, demonstrating a statistically significant relationship which was less likely to be as result of chance.

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

There was indeed an enhanced variability of climate elements observed in Tana River County throughout 1988 to 2018. Tana River County data from the Meteorological Department showed increased season-to-season variability of climate factors during both long and short rain seasons. In addition, average rainfall has gradually decreased during long wet seasons while somewhat increasing during short rainy seasons. Furthermore, respondents to the research reported noticing changes that differed from what they perceived as normal seasonal variation during the last 30 years. The majority of them stated that they have experienced longer dry spells and more erratic rainfall seasons.

Seasonal rainfall is becoming less reliable, and temperatures are increasing. Long rainy season (March to April) failures have been reported more frequently. Overall, the county is becoming drier and hotter; more reports of hot episodes compared to cold episodes are reported. There was an estimated increase of 0.4 $^{\circ}C$ in average temperature during the period 1988–2018.

Tana River County is experiencing increased climate variability, and respondents are well aware of this fact. In general, most respondents were aware of climate change, which they linked to increased frequency of droughts and flooding, as well as the resulting losses and damages. In other words, most respondents associate climate change with the negative consequences of extreme weather occurrences like droughts.

Despite significant awareness, it is evident that the majority of respondents have a limited understanding of climate change. The findings highlighted that awareness was mainly based on the impacts experienced by the Orma Pastoralists of Tana River County as a result of enhanced climate variability. The findings further confirmed that seasonal rainfall performance is experiencing changes in time and space.

Furthermore, enhanced climate variability has a substantial impact on pasture and browse, affecting regeneration to a large extent. The task of harvesting forage for young and frail animals is getting increasingly difficult. Reduced rainfall has resulted in low pasture production, leading to its scarcity. Furthermore, women were more concerned about depleting pasture since it caused them to go far distances that little girls could not reach. The report also emphasized the issue of water scarcity caused by recurrent and lengthy droughts.

Further, the findings show that the long rain season (March, April, and May) has traditionally resulted in adequate rainfall and vegetation regeneration. However, it has become increasingly unreliable and inadequate to support grassland regeneration. Temperature and rainfall performance varied greatly from season to season.

Additionally, traditional tactics used by Orma pastoralists to deal with seasonal variability included relocating livestock outside typical grazing regions, herd separation, and the use of supplementary feeds. Some unique methods, such as the utilization of cereals, hay, tubers, and acacia pods, have also been identified as developing livestock management practices. The primary crop used was sorghum, which was distributed by the World Food Programme as a relief food for households. Acacia pods are currently being sold in local

marketplaces by Kamba community entrepreneurs. In addition, additional reported treatments included drought pellets donated by NDMA, which were also used, and water trucking by the Tana River county administration, which proved useful.

Furthermore, the data revealed that the Orma community has embraced additional methods, such as obtaining more drought-tolerant species including camels, goats, and poultry. Other coping tactics adopted by the community include traveling to urban areas to find casual work or engaging in small trades such as selling mats and other tree products, as well as burning and selling charcoal and firewood. Some responders noted that other measures include timely migration to the Tana Delta before animals get weak, grass production and storage, and herd size control.

5.2 Conclusions

i. Tana River County is experiencing increased climate variability, as evidenced by both meteorological data and community reports. Meteorological data, supported by Orma pastoralists' observations and experience, revealed a considerable shift in both lengthy and short rainy seasons. The seasons are becoming more unpredictable and unreliable, with a significant decrease in average rainfall during lengthy rainy seasons and a little increase in average short wet seasons, the consequences of which have been realized. Furthermore, typical temperatures have risen, posing further obstacles. Orma pastoralists reported decreased pasture and grazing, as well as water scarcity, as a result of increased climate variability.

ii. Despite the high degree of awareness among Orma pastoralists, there remained a considerable gap in understanding broad features of increased climatic variability

beyond its effects on their livelihoods. The community is unable to recognize their involvement in contributing to climate change because they have a limited awareness of the causes of climate change. The Orma pastoralists had a considerable knowledge gap, which increased their vulnerability to the consequences of greater climate variability.

iii. Orma pastoralists used traditional livestock management practices to deal with variations in pasture and water availability. However, when climate variability increased, traditional livestock management practices became ineffective. To overcome livestock management inadequacies, it was clear that Orma pastoralists were using new approaches. Emerging livestock management strategies include outmigration, the use of supplemental feeds, and the acquisition of drought-tolerant animals.

iv. Despite increased awareness and evolving livestock management practices, Orma pastoralists continue to suffer losses as a result of extreme weather occurrences. The traditional improvements used in livestock management were unable to cope with the effects of increased climate variability.

5.3 Recommendations

i. The Kenyan government, as well as the Tana River county government, particularly the Department of Agriculture and Environment, should educate pastoral communities about climate variability. It is critical to increase their capacity so that they grasp anthropogenic causes and recognize their own contribution to greenhouse gas emissions. Furthermore, government personnel and other development professionals

should illustrate how the community can help to mitigate the effects of increased climatic variability. Tree planting is encouraged to provide ground cover, whereas tree cutting and overgrazing are prohibited. Furthermore, female members of the community should be intentionally targeted to improve their ability to understand increased climatic variability.

ii. The national and county departments responsible for livestock production in Tana River County should enhance the transfer of knowledge and practices needed to support pastoralist communities in adapting to enhanced climate variability. Practices that will promote increased production, harvesting, and storage of hay through rainwater harvesting should be extended. The promotion of drought-tolerant species like goats and camels should be enhanced by the livestock department and other partners.

iii. The community should collaborate with the Department of livestock to enhance livestock management methods. Controlling herd size and marketing animals prior to the onset of drought can help prevent drought losses. Furthermore, the county, national government, and other development partners should promote risk-transfer techniques such as livestock insurance to protect pastoralists from the effects of extreme weather.

iv. Tana River County government to enact legislation related to production and range resource management. Grazing management will have controlled access to range resources depending on the season; this will include zoning and enforcement for compliance. Controlling herd size and marketing of livestock before the onset of drought to reduce losses during drought. The county, national government, and other

development partners should support risk transfer practices like livestock insurance to cushion pastoralists against the impacts of extreme weather events.

5.3.1 Recommendation for Further Research

Further research is recommended in the following areas;

i. Mobility is a critical element in pastoral livestock management. Orma pastoralists depended on elders' advice, who observed various signs and patterns within their environment to make decisions. However, with the enhanced variability of climate elements, some signs are becoming less obvious to the elders, who have become more doubtful of their capacity to provide advice. Therefore, there is a need to study the effectiveness of traditional seasonal forecasting in the context of enhanced climate variability.

ii. The influence of climate information provided by government and non-governmental organizations on grazing decision-making is equally important to be assessed. This will contribute to understanding to what extent external information is integrated into traditional knowledge and practice.

iii. Nomadic pastoralism is among the few options to meet household needs in less arable areas, and it is currently facing the impact of climate change, similar to other livelihood sources. There is a need for further study to establish the climate adaptation potential of nomadic pastoralism.

iv. Various attempts, like changes in breed type, diversification of livelihood sources, and the introduction of pasture production under irrigation, are among various climate change adaptation options. Further research is required to establish the effectiveness of

adaptation options in influencing policy development and contributing to the development agenda of the government.

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APPENDICES

Appendix 1: Household Questionnaires

I am a Masters's student at Kenyatta University conducting a study on Climate Variability Knowledge and Response Strategies among the Pastoral Orma of Tana River County. The study will provide a better understanding of climate variability, assess coping strategies of the community, and recommend strategies to enhance adaption to climate variability. Your cooperation and responses will contribute to this course; in addition, data collected during the study will be treated with the confidentiality required.

Part 1: Respondent's particulars

Name…….. (Optional) Number……

Location……. Village……..

Gender……. Age……

Household members: Male…… Female……

Main Source of Income: 1. Livestock; ☐ Employment; ☐ Petty trade ☐

Casual Labor ☐

A number of livestock cattle……. Small stock…….. (Estimate)

Part 2: Awareness of Enhanced Climate Variability

Introduce climate through the use weather components like temperature, precipitation, and seasons.

1. Do you know or heard of enhanced climate variability;
   a. Yes ☐
   b. No ☐
2. How have the following climate components of your location in the last thirty years (1988-2018) been?

A. How was seasonal rainfall performance comparing one year to another?

a. Highly predictable in terms of on-set, cessation and performance ☐
b. More unpredictable in terms of on-set, cessation, and performance ☐
c. Other descriptions ☐

explain……...

……

B. Temperature:

a. It is becoming hotter ☐

b. More fluctuation with more hot episodes ☐

c. Periods of cool episodes are reducing and warm periods are increasing

d. Other observation……..

……

3: Knowledge of Climate Variability/change

1. What is enhanced Climate Variability

   a. Long-term shift in weather pattern ☐
   b. More frequent and severe drought ☐
   c. Increased flooding ☐
   d. Increased temperature ☐
   e. I don't know ☐

2. What are Causes of enhanced Climate Variability

   a. Human Activities ☐
   b. God's wishes ☐
   c. I don't know ☐
   d. Others ☐

3: Human activities are the main cause of enhanced climate variabilityI strongly agree

   a. I agree ☐
   b. I don't know ☐
   c. I disagree ☐
   d. I strongly disagree ☐

4: Human beings can play a role in reversing enhanced climate variabilityI strongly agree

   a. I agree ☐
   b. I don't know ☐
   c. I disagree ☐
   d. I strongly disagree ☐

5: Overgrazing and deforestation are among human activities that contribute to enhancing climate variabilityI strongly agree ☐

a. I agree ☐

b. I don't know ☐

c. I disagree ☐

d. I strongly disagree ☐

6: Traditional Livestock herding practices could no longer cope with changes in the environment

a. I strongly agree ☐

b. I agree ☐

c. I don't know ☐

d. I disagree ☐

e. I strongly Disagree ☐

7**:** There should be changes in livestock management practices to reduce losses to extreme weather events like drought strongly agree

a. I agree ☐

b. I don't know ☐

c. I disagree ☐

d. I strongly disagree ☐

8: Human activities are not the main cause of enhanced climate variabilityI strongly agree

a. I agree ☐

b. I don't know ☐

c. I disagree ☐

d. I strongly disagree ☐

9: Human beings have no role in reversing enhanced climate variability I strongly agree

a. I agree ☐

b. I don't know ☐

c. I disagree ☐

d. I strongly disagree ☐

10: Overgrazing and deforestation are among human activities which does not contribute to enhancing climate variabilityI strongly agree

- **a.** I agree ☐
- **b.** I don't know ☐
- **c.** I disagree ☐
- **d.** I strongly disagree ☐

11: Traditional Livestock herding practices can cope with changes in the environment strongly agree

- **a.** I agree ☐
- **b.** I don't know ☐
- **c.** I disagree ☐
- d. I strongly Disagree ☐

12**:** Without changing livestock management practices losses to extreme weather events like drought can be reduced strongly agree

- **a.** I agree ☐
- **b.** I don't know ☐
- **c.** I disagree ☐
- **d.** I strongly disagree ☐

4: Effect of Enhanced Climate Variability

a. To what extent has enhanced climate variability affected pasture availability

   a. Very great extent ☐
   b. Great extent ☐
   c. Minimal extent ☐

b. To what extent has enhanced climate variability affected water availability

   a. Very great extent ☐
   b. Great extent ☐
   c. Minimal extent ☐

5: Indigenous Response Strategies to Climate Variability

1. Can you recall any weather-related emergency event which your family experienced during the last three years? (stress period which required extra ordinary effort)
   a. Yes ☐
   b. No ☐
2. If yes to (1) above what were measures used by your family to cope with the that stress, action which is not normal management practice.
   a. Move with their herd from hinter land to delta during dry season ☐
   b. Herd separation, stronger dry animals moved away from homestead ☐
   c. Supplementary pasture and browse including falling trees and digging out of tubers
   d. Provide hay and other feeds supplements ☐
   e. No action ☐
   f. Others. ☐

      Explain……

      ……

      ……..
3. Was there loss of livestock?
   a. Yes ☐
   b. No ☐
4. If yes, how many?

   ……. Cattle. …….. Goats and ……. Sheep

   Others…….

Appendix 2: Interview Guide for Key Informant Interview (KI)

To be field by the interviewer

Introduction

I am a Masters student at Kenyatta University conducting a study on Climate Variability Knowledge and Response Strategies among the Pastoral Orma of Tana River County. The study will provide better understanding of climate variability, assess coping strategies of the community and recommend strategies to enhance adaption to climate variability. Your cooperation and responses will contribute to this course; in addition, data collected during the study will be treated with confidentiality required.

Part 1: Respondent Details

No.……

Name…….

Designation……

Location……. Department/Village……..

Gender…….

Common Sources of Income among the community: Livestock; ☐ Employment; ☐

Casual Labor ☐ Crop production ☐ Petty trade ☐

Part 2: Awareness of Enhanced Climate Variability

Introduce climate through use weather components like temperature, precipitation and seasons if necessary.

1. Do you know or heard of enhanced climate variability;
   a. Yes ☐
   b. No ☐
2. How have the following climate components of your location in the last thirty years (1988-2018) been?

A. Rainfall (inquire about seasonal performance and distribution within a season):

…….....

.....

.....

.....

.....……

……

B. Temperature (Current with 30 years ago and trend):

……

……

……

……

3: Knowledge of Climate Variability/change

a. What is enhanced Climate Variability (stimulate discussion on what participants understand enhance climate variability is, probe to find where they differentiate natural variation)

……

……....

…….

b. **What are Causes of enhanced Climate Variability**

…….

……

……

……

4: Effect of Enhanced Climate Variability

c. To what extent has enhanced climate variability affected pasture availability (*probe to get impacts and trend)*

……

……

…….

d. To what extent has enhanced climate variability affected water availability (*probe to get impacts and trend)*

.....

.....

.....

5: Change livestock management practices with possible long-term solution?

(*Probe to get fundamental changes in practices, which enable community to adapt, reducing risk associated with enhanced climate*).

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Appendix 3: Interview Guide for Focus Group Discussion (FGD)

To be field by the interviewer

Introduction

I am a Masters student at Kenyatta University conducting a study on Climate Variability Knowledge and Response Strategies among the Pastoral Orma of Tana River County. The study will provide better understanding of climate variability, assess coping strategies of the community and recommend strategies to enhance adaption to climate variability. Your cooperation and responses will contribute to this course; in addition, data collected during the study will be treated with confidentiality required.

Part 1: FGD site and participants

FGD No.……

Location……. Village……..

Number of participants…… Gender…….

Common Source of Income: Livestock; ☐ Employment; ☐ Petty trade ☐

Casual Labor ☐

Part 2: Awareness of Enhanced Climate Variability

Introduce climate through use weather components like temperature, precipitation and seasons.

1. Do you know or heard of enhanced climate variability;
   a. Yes ☐
   b. No ☐
2. How have the following climate components of your location in the last thirty years (1988-2018) been?

A. **Rainfall (inquire about seasonal performance and distribution within a season):**

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B. Temperature (Current with 30 years ago and trend):

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Part 3: Knowledge of Climate Variability/change

1. What is enhanced Climate Variability (stimulate discussion on what participants understand enhance climate variability is, probe to find where they differentiate natural variation)

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2. What are Causes of enhanced Climate Variability

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Part 4: Effect of Enhanced Climate Variability

1. To what extent has enhanced climate variability affected pasture availability (*probe to get impacts and trend)*

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2. To what extent has enhanced climate variability affected water availability (*probe to get impacts and trend)*

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Part 5: Indigenous Response Strategies to Climate Variability

1. Can you recall any weather-related emergency event which your community experienced during the last three years? (stress period which required extra ordinary effort)
    a. Yes ☐
    b. No ☐
2. If yes to (1) above what were measures used by your family to cope with the that stress
    a. Move with their herd from hinter land to delta during dry season ☐
    b. Herd separation, stronger dry animals moved away from homestead ☐
    c. Supplementary pasture and browse including falling trees and digging out of tubers
    d. Provide hay and other feeds supplements ☐
    e. Others. ☐

    Explain……

    ……

    ……..
3. Was there loss of livestock?
    a. Yes ☐
    b. No ☐
4. If yes to (5) above what measures did your family undertake to cope?
    a. Move with their herd from hinter land to delta during dry season ☐
    b. Herd separation, stronger dry animals moved away from homestead ☐
    c. Supplementary pasture and browse including falling trees and digging out of tubers
    d. Provide hay and other feeds supplements ☐
    e. Others ☐

    Explain……

    ……

    ……..

5. Change livestock management practices with possible long-term solution?
   (*Probe to get fundamental changes in practices, which enable community to adapt, reducing risk associated with enhanced climate*).

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Appendix 4: Plates with sampled pictures

Plate 1 : Erosion of Coast Line

The point is where River Tana enters the Indian Ocean, several households have moved in- land as sea claims more land.

Plate 2 : Water Pan in Wet season Grazing Area

Source: Researcher; one of water pans in Assa During wet season Orma pastoralist, graze their herd in areas with no permanent water source. Water pan which often dry after some time are the main source of water in this zone.

Plate 3: A Dried Water Pan in Wet Season Grazing Area in Assa

Once the pans dry animals are moved to areas close to seasonal rivers which has underground water potential

Plate 4: Watering of Goats at one of Shallow Wells in Assa

Zones close to seasonal rivers area used as dry season grazing areas, during dry period community members excavate wells to water their animals.

Plate 5: Herders Moving Goats and Sheep Across the River in Delta Zone

Delta zone/areas close to the river are utilized traditionally when there is an extra-ordinary situation. The zone infested with more tsetse fly and other biting insect are used during extreme weather conditions like drought.

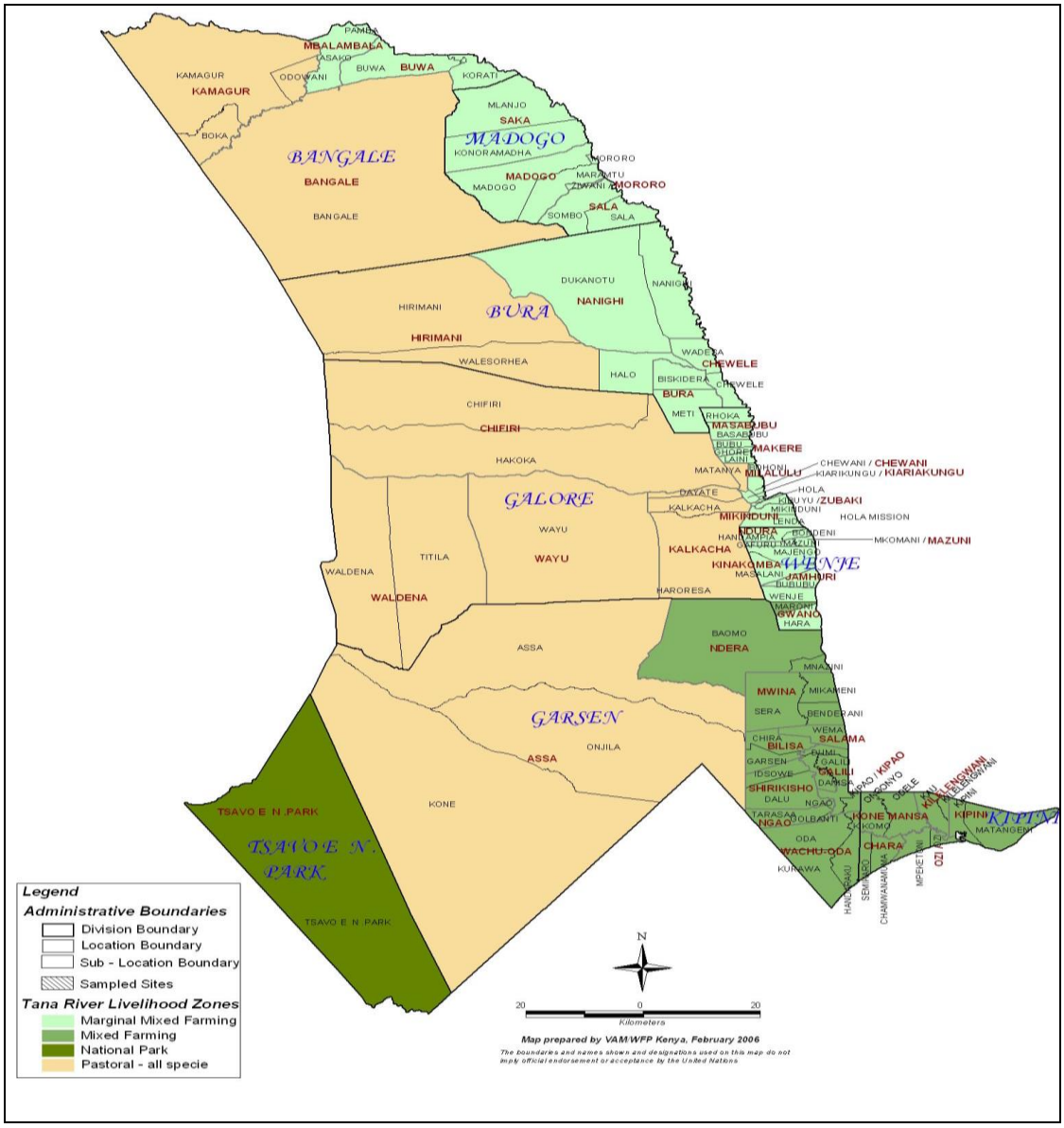

Plate 6: Tana River County Livelihood Zones

Source: NDMA Maps

Plate 7: Commercialization of Acacia Pods

Business men and women from Kitui County actively marketing acacia pods, these are indicators of commercialization of the pods.

Plate 8: Distribution of Drought Pellets During Drought