

**HARAMAYA UNIVERSITY
POSTGRADUATE PROGRAM DIRECTORATE**

**DROUGHT SEVERITY ANALYSIS AND COPING STRATEGIES OF
PASTORAL HOUSEHOLDS IN GODE DISTRICT, SHABELLE ZONE,
SOMALI REGION, ETHIOPIA**

MA THESIS

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**Drought Severity Analysis and Coping Strategies of Pastoral Households in
Gode District, Shabelle Zone, Somali Region, Ethiopia**

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MANAGEMENT)**

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DEDICATION

This thesis is dedicated to my Mother Asha Ismail Ibrahim, my father Ahmed Ismail Ibrahim and my wife Miski Mohamed Abdulahi for their unconditional and unbounded love, patience and strength that helped me to complete this work.

STATEMENT OF AUTHOR

I certify that the work in this thesis is entirely original by signing my name below. I have prepared, gathered, analyzed, and compiled this thesis in accordance with all ethical and technical scholarly standards. All academic material incorporated into the Thesis has been acknowledged via reference.

This Thesis is submitted in partial fulfillment of the requirements for Climate Change and Disaster Risk Management degree at the Haramaya University. I hereby certify that this thesis has not been submitted to any other college, university, or another organization for any academic purpose, including the awarding of a degree, diploma, or certificate.

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BIOGRAPHICAL SKETCH

The author, Abdisalam Ahmed Ismail was born on January 1, 1986, in Gode district, Somali Regional State, Ethiopia. He began his early education at a local school in Gode Sayid Mohamed Abdille Hassen primary and senior school and completed Gode high school in 2005, then advanced to Allage ATVET College, where he earned a Diploma in Animal Health in 2009. He later pursued higher education at Jigjiga University, obtaining a B.Sc. in Animal and Range Science in 2014. Building on his academic foundation, he further specialized with a M.Sc. in Animal Production and Pastoral Development from Jigjiga University in 2022. Currently, he is pursuing a M.Sc. in Climate Change and Disaster Risk Management at Haramaya University.

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With a strong background in pastoral development, disaster risk management, and education, Abdisalam remains committed to enhancing community resilience, improving food security, and advancing sustainable rangeland management in Ethiopia's pastoral regions.

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ABBREVIATIONS AND ACRONOMY

CSA	Central Statical Agency
DRM	Disaster Risk Management
EWS	Early Warning System
FAO	Food and Agricultural Organization
FGDs	Focus Group Discussions
OCHA	Office for Co-ordination of Humanitarian Affairs.
UNDP	United Nations Development Program
SNNP	Southern Nations, Nationalities and People's
WMO	World Metrology Organization

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Assessing Impacts of Drought on Pastoral Households, Local Practices and Coping Strategies: The Case of Gode District, Shabelle Zone, Somali Region, Ethiopia

ABSTRACT

This study was conducted in Gode District of the Shabelle Zone in the Somali Regional State, Ethiopia, to analysis drought severity over the past three decades, assess coping strategies used by pastoral households, and identify factors influencing their coping choices. A cross-sectional survey design was applied, integrating both quantitative and qualitative methods. A total of 396 pastoral households were selected using multi-stage sampling. Primary data were collected through structured questionnaires, key informant interviews, focus group discussions, and field observations, while secondary data comprising 30 years of meteorological records were obtained from the National Meteorological Services Agency. Rainfall variability and trends were analyzed using descriptive statistics, the Mann Kendall trend test, Sen's slope estimator, and the Rainfall Anomaly Index (RAI). A multinomial logit (MNL) model was employed to examine determinants of coping strategies. The climate analysis revealed substantial rainfall variability, increasing temperature trends, and recurrent drought episodes, with pronounced negative RAI anomalies in 2000, 2010, 2016, 2017, 2019, and 2022. Respondents perceived drought as becoming more severe and rainfall as decreasing and more unpredictable. The major impacts included livestock mortality, declining income, food insecurity, rangeland degradation, and reduced water availability. Households employed a range of coping mechanisms, including livestock mobility, herd diversification, off-farm income activities, community-based support systems such as destocking, and limited reliance on government and NGO assistance. The MNL model results indicated that age, sex, education, access to credit, income, land scarcity, climate information, and training significantly influenced the choice of coping strategies. The study recommends strengthening early warning systems, improving rangeland management, promoting livelihood diversification, and enhancing social safety nets to build long-term resilience among pastoral households.

Key words: Drought, Coping Strategies, Rainfall Anomaly Index, Pastoral Households, Gode District.

1. INTRODUCTION

1.1. Background of the Study

Drought is a natural climatic phenomenon characterized by a prolonged period of abnormally low precipitation, resulting in water scarcity and widespread environmental and socio-economic impacts. It is commonly associated with reduced soil moisture, declining surface and groundwater availability, and severe stress on agricultural production, ecosystems, and human livelihoods (Ahluwalia et al., 2021). Among natural hazards, drought is considered one of the most complex and least understood due to its slow onset, cumulative nature, and spatial variability. Unlike sudden disasters, drought develops gradually, often remaining unnoticed until its impacts become severe, thereby affecting more people globally than any other natural hazard. Its consequences include serious economic, social, and environmental losses, particularly among populations whose livelihoods are highly dependent on climate-sensitive resources, such as pastoral communities (Mutu, 2017).

Globally, pastoralism remains one of the most drought-sensitive livelihood systems. It is estimated that there are approximately 120 million pastoralists worldwide, with about 41.7% residing exclusively in sub-Saharan Africa (Abduselam, 2019). Pastoralism plays a crucial role in supporting food security, sustaining large human populations in arid and semi-arid environments, providing ecosystem services, preserving indigenous knowledge systems, and contributing significantly to subsistence and national economies (Dong, 2016; Ayele & Dedecha, 2021). Pastoral systems may take the form of nomadic pastoralism, transhumant livestock production, or pastoral farming and ranching, all of which are structured around social institutions such as clans that regulate resource use, mobility, and livestock management (Wako et al., 2017; Dong, 2016). However, recurrent droughts frequently result in massive livestock losses, undermining the resilience of pastoral households and triggering livelihood crises.

In Africa, drought has historically posed a major challenge, causing millions of deaths and extensive social, environmental, and economic damage over centuries (Tadesse, 2016). The impacts are particularly severe in sub-Saharan Africa, where rain-fed agriculture and livestock-based livelihoods dominate. Persistent rainfall failure and increasing heat stress significantly threaten food

security, human health, and household income, especially among smallholder farmers and pastoralists (Dimitrova, 2021). Some progress in early warning systems and disaster preparedness, drought response strategies across many African countries remain largely reactive, focusing on emergency relief rather than proactive drought risk management and resilience building (ICPAC, 2016). In the Horn of Africa, the frequency and intensity of droughts have increased due to climate variability and change, rapid population growth, weak institutional capacity, civil insecurity, and widespread poverty, exacerbating vulnerability among pastoral communities (Opiyo et al., 2014).

Ethiopia is widely recognized for its substantial livestock resources and pastoral potential (Shapiro et al., 2015). Nevertheless, drought has repeatedly caused catastrophic losses of livestock, the primary asset of pastoral households, leading to reduced stocking rates, increased livestock mortality, and declining household wealth (Ayal & Muluneh, 2014). The majority of Ethiopia's pastoral population resides in the lowland regions of Afar, Somali, Oromia, and the Southern Nations, Nationalities and Peoples' Region (SNNPR), with additional pastoral groups found in Gambella and Benishangul-Gumuz (Pantuliano & Wekesa, 2008). Pastoralists, particularly poorer households, are among the most food-insecure populations in the country and are increasingly dependent on external food assistance during recurrent drought periods (Catley et al., 2016).

The Somali Regional State, covering an estimated area of about 340,000 km², is predominantly inhabited by pastoral and agro-pastoral communities whose livelihoods are based on mixed herding of camels, sheep, goats, and limited numbers of cattle (Belay Zerga et al., 2018). The region has experienced repeated and severe droughts, particularly as part of wider crises in the Horn of Africa, with devastating effects on livelihoods, food security, and rangeland ecosystems. Notably, since November 2016, the Shabelle Zone of eastern Ethiopia has faced one of the worst droughts in more than five decades (Austrian Development Agency, 2023). To sustain their livelihoods and rangeland ecosystems, Somali pastoralists rely heavily on indigenous knowledge and traditional coping mechanisms, which require integration with modern rangeland management and rehabilitation practices to enhance resilience (Belay Zerga et al., 2018).

Against this background, this study aims to assess the severity of drought on pastoral households, and coping strategies, and analyze factors influencing drought response in Gode District, Shabelle Zone, Somali Regional State, Ethiopia.

1.2. Statement of the Problem

Drought remains one of the most persistent and damaging climate-related hazards in Ethiopia, particularly in arid and semi-arid regions where pastoralism is the dominant livelihood system. Pastoral households in these areas are highly dependent on rainfall variability for livestock production and rangeland productivity, making them especially vulnerable to recurrent drought events (Ayele & Dedecha, 2021). Increasing drought frequency and severity have resulted in declining livestock productivity, rangeland degradation, food insecurity, and erosion of household assets, thereby undermining the sustainability of pastoral livelihoods (Ibrahim, 2016). Despite the scale of these impacts, localized empirical evidence on drought characteristics and household-level responses remains limited.

In Ethiopia, and especially in the Somali Regional State, drought has contributed to severe ecological degradation and has progressively weakened the asset base of pastoral households (Latamo et al., 2022). While pastoral communities have traditionally relied on indigenous knowledge and mobility-based coping mechanisms to manage climatic variability, the intensification of drought events has increasingly exceeded the adaptive capacity of these traditional systems (FAO, 2017). As a result, pastoral households are compelled to adopt a range of coping strategies, some of which may be unsustainable and may further exacerbate vulnerability over time. However, the extent to which these strategies are practiced, their effectiveness, and the factors influencing their adoption are not yet well understood at the district level.

Several studies conducted in pastoral areas of Ethiopia have emphasized that drought management efforts often focus on short-term emergency responses rather than on understanding long-term drought patterns and household-level coping behavior (Dessalegn et al., 2020). Moreover, empirical evidence indicates that the choice of drought coping strategies among pastoral households is shaped by multiple interacting factors, including socio-economic characteristics, access to resources, institutional support, and exposure to drought severity (Mohammed et al., 2018). Failure to account for these determinants limits the effectiveness of drought risk management interventions and constrains the development of targeted, context-specific solutions.

In the Somali Regional State, particularly in Gode District of the Shabelle Zone, pastoral livelihoods are highly sensitive to climate variability due to heavy reliance on livestock production. Approximately 85% of the population in the zone depends on livestock for income and food security, making drought impacts especially severe (Austrian Development Agency, 2023). Although the area has experienced repeated and prolonged droughts over recent decades, systematic analysis of drought frequency and magnitude at the local level remains inadequate. (Gebremeskel et al., 2019; Funk et al., 2015). Furthermore, there is limited empirical documentation on the coping strategies employed by pastoral households and the key factors influencing their choice of responses to drought conditions in the district.

Therefore, the central problem addressed by this study is the lack of integrated, district-level evidence on drought severity, pastoral coping strategies, and the determinants shaping household responses in Gode District. Addressing this gap is essential for informing effective drought risk management, strengthening pastoral resilience, and supporting sustainable livelihood development in the Somali Regional State. Accordingly, this study seeks to analyze the frequency and magnitude of drought over the past three decades, assess the coping strategies practiced by pastoral households, and examine the determinant factors influencing drought coping strategies in Gode District, Shabelle Zone, Somali Regional State, Ethiopia.

1.3. Objectives of the Study

1.3.1. General objective

The general objective of this study was to analysis drought severity and coping strategies of pastoral households in Gode districts, Shabelle zone, Somali regional state, Ethiopia.

1.3.2. Specific objectives

This study was designed to achieve the following specific objectives

- ☐ To identify the frequency and magnitude of drought in Gode district over the past three decades.
- ☐ To assess coping strategy of pastoral households in Gode district.
- ☐ To examine determinant factors affecting drought coping strategies among pastoral

communities in the study area.

1.4. Research Questions

How is the frequency and magnitude of drought in Gode district over the past three decades?-

What are the coping strategy practiced by pastoral households in Gode district?

What are the determinant factors affecting the practice of drought coping strategies among the pastoral communities?

1.5. Significance of the Study

Understanding the indigenous coping and adaptations drought response strategies practiced by the pastoral communities would significantly assist policy makers in designing programs and formulation of policies, scheming appropriate strategies and practical steps based on their indigenous droughts response to reduce recurrent drought impacts and promote sustainable development in pastoral communities. The developmental practitioners like NGOs and researchers working on drought related aspects; can use it, as a benchmark or supplementary information for pastoral development and livelihood intervention

1.6. Scope of the Study

To manage the research work within the available time frame and resource, this study was limited geographically in the Gode districts, Shabelle zone, Somali regional state, Ethiopia. Thematically, the study aimed at investigating the impact of recurrent drought on pastoral livelihood and asses coping strategies of pastoral households in Gode district. In addition to impact of recurrent drought and drought related risk that affect the livelihood asset of pastoral households, this research was attempt to deal with indigenous adaptation mechanisms used by local community to measure the impact of recurrent drought and climate variability related risk on their livelihoods and how indigenous adaptation mechanisms inversely affected by climate change and variability mainly drought.

1.7. Limitation of the Study

It goes without saying that research cannot be completely free from constraints. One of the main drawbacks was that one of the stations (Gode) lacked long-year meteorological data. Additionally, the Districts lack a well-documented database pertaining to the impacts and extent of the drought. DeRAIte these limitations, an effort was made to ensure the analysis was as comprehensive as possible by obtaining additional relevant data from the National Meteorological Services Agency and related public and unpublished data.

1.8. Organization of the Thesis

This thesis consists of five chapters. Chapter one presents the general introduction of the thesis that includes: background of the study, statement of the problem, objectives and research questions, significance of the study, scope and limitation of the study, definition of key words and organization of the study. The second chapter devoted to a review of related literature through which various concepts relevant to the study are discussed. The third chapter deals with methodological issues, under which the general descriptions of the study area, research design, data and sources, sample size and sampling techniques, method of data collection, as well as method of data analysis, are discussed and ethical considerations. The forth chapter also devoted to results and discussion based on the processed primary and secondary data of the study. Finally, the fifth chapter is dedicated to summary and conclusions based on the findings of the study. The last chapter provides references and appendixes based on the research of the study.

2. LITERATURE REVIEW

2.1. Definitions of key Terms

Climate change: refers to shifts in the mean state of the climate or in its variability, persisting for an extended period (for three decades or longer). Climate change is inevitably resulting in changes in climate variability and in the frequency, intensity, spatial extent, duration, and timing of extreme weather and climate events (Thornton et al., 2014).

Climate variability: refers to short-term fluctuations around the average weather. It is variations in the mean state of climate on all temporal and spatial scales away from that of individual weather events. Changes in variability are often more important for communities than changes in mean quantities (Thornton et al., 2014). Every year in a specific time period, the climate of a location is different. Some years have below average rainfall, some have average or above average rainfall.

Vulnerability: is a function of exposure to climate situation, the degree to which a system is powerless to cope with adverse effect of climate change. Vulnerability is defined as ‘the extent to which biological and socio-economic and geophysical systems are vulnerable to, and incapable to survive with adverse impacts of climate change and variability. This definition lets wide conceptualization of the degree to which pastoral societies are not capable to resist the undesirable impacts of climate variability on their livelihoods. Hence, vulnerability relies on the extent to which inhabitants are susceptible to climate variability impacts, on its sensitivity to the impact and on its ability for adapting to them (IPCC, 2022). According to Marin (2011) vulnerability is the negative outcome of exposure minus the responses undertaken to counteract the impacts of climate change.

Pastoralist: is an individual or group that engages in an economic system that involves rearing, raising, and herding a lot of cattle (Buono et al. 2016).

Drought: is defined as a lack of precipitation from typical or expected circumstances that lasts for a season or longer and leaves there not enough water to support human activity needs (NRC, 2007).

Coping strategies: are tactics used to preserve a variety of household goals, such as food security, livelihood security, status, and health. In order to optimize claims on resources, long-term goals for

livelihood stability and status include bolstering assets, incomes, and social positions (Davies, 1996).

Coping: is the real, instantaneous reaction to a crisis affecting the livelihood system in the face of undesirable circumstances; it is seen as a temporary solution (Berkes and Jolly, 2001). Concept of Climate Change and Variability

Variability may result from natural internal processes within the climate system (internal variability) or to variations in natural or anthropogenic external forcing (external variability) (Collins, 2011; IPCC, 2021 and 2022). It refers to changes in regions, including precipitation, temperatures, and cloud cover and so on that includes the short-term shift in weather patterns. Climate variability as the way climate fluctuates yearly above or below a long-term average value (Keely, 2010). Climate variability as a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods. It is also as a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer (IPCC, 2022). Climate simply have the notion of “average weather” or long-term averages of climate variables such as temperature, precipitation and wind across decades (usually 30 years); i.e., it is the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years (IPCC, 2022).

2.2. Concept of Drought

Drought have been the greatest mysteries and it is one of the worst natural afflictions whose occurrence is imperceptible and become a recurrent climatic phenomenon across the world (Masih et al, 2014). Drought is complex natural hazard which affects numerous areas of life and society, particularly migration, water resources, agriculture, energy, food security, health, and conflicts over resources (Tadesse, 2016). People's access to food and means of subsistence in arid and semi-arid regions of developing nations that are vulnerable to drought face a serious danger from drought. Conventional approaches to managing droughts have primarily been reactive in nature (Abduselam,

2019). Because of greenhouse gas forcing and El Nio-Southern Oscillation, global warming models are better able to predict greater drought conditions in the future (Dai, 2012).

Droughts are complicated natural random events whose characteristics cannot be fully predicted because they are accidental in nature (Bonifacio & Gironás, 2020). The primary factors contributing to the evolving pattern of droughts are variations in the climate and human activities (Gebremedhin, et al., 2019). The drought is a natural hazard that is best described by a number of hydrological and climatological factors. To create strategies for lessening the effects of droughts, one must comprehend the connections between these two sets of factors. (Ashok & Singh, 2010). Throughout the previous millennium, there have been numerous instances of dry spells that lasted for years or decades (Dai, 2010).

To measure the intensity of meteorological, hydrological, and agricultural droughts, the most useful indicators are decreases in rainfall, total water deficits, and estimated soil moisture (Keyantash & Dracup, 2002). In recent decades, a number of drought indices have been developed. Typically, a drought index is a key statistic for determining several drought factors, such as intensity, duration, severity, and spatial extent, as well as for evaluating the impact of a drought (Ashok & Singh, 2010).

Droughts have a wide range of effects on the environment, agriculture, water resources, and people. It has been discovered that an effective method of adapting to drought circumstances is environmental rehabilitation, which includes the creation of ecosystem services, biodiversity augmentation, and soil and water conservation (Gebremedhin, et al., 2019). Drought also causes farmers and local economies to suffer greatly financially and psychologically. Some of these negative effects include decreased output, a decline in population, and trauma from seeing cattle, crops, soil, and natural plants damaged (Bogale, & Erena, 2022).

2.3. Types of Droughts

Discipline-specific definitions and classifications of drought types have been established. The definitions were divided into four groups: socio-economic, hydrological, agricultural, and meteorological. These four groups can be divided into two groups: the first three methods focus on quantifying drought as a physical phenomenon, while the fourth examines drought in terms of water

supply and demand, tracking the effects of water scarcity as it permeates socioeconomic sectors (Lameso, et al. 2022).

Ecological drought is a new kind of drought that considers the environmental, climatic, hydrological, socioeconomic, and cultural aspects of drought in addition to those that are generally recognized and taken into consideration by many studies (Martin et al., 2016). As a result of decreased groundwater levels and discharges to surface water bodies, groundwater drought is a crucial aspect of the drought phenomenon. Droughts of different sorts may coexist or occur separately because of a research that first used the term "flash drought" to highlight the unusually rapid intensification of some droughts and to better distinguish the events from regular droughts that advance more slowly (Bonifacio & Gironás, 2020).

2.3.1. Socio-Economic drought

Socio-economic drought is characterized as a circumstance in which the water supply is insufficient to meet the demand for water, leading to adverse effects on the environment, the economy, and society (Ahmed et al., 2023). When water resource systems are unable to meet demand, socioeconomic drought results. Furthermore, the function of regional reservoirs in adjusting to unequal water distribution and managing climate extremes should not be disregarded (Mergersa et al, 2014). In societies and nations that rely significantly on agriculture, the socioeconomic effects of drought are particularly acute (Guye et al., 2022).

2.3.2. Metrological drought

Meteorological drought is the earliest and most fundamental stage of drought, defined by a prolonged period of below-average precipitation. Unlike other forms of drought that focus on the effects on agriculture, water supply, or the economy, meteorological drought is purely concerned with the atmospheric conditions (Hao et al., 2018). It occurs when a region receives significantly less rainfall than the long-term average over a specific week, months, or even years. This type of drought is often influenced by broader climate patterns such as El Niño or La Niña, which can disrupt normal rainfall distribution (Oertel et al., 2019). One of the major characteristics of meteorological drought is its variability from place to place. What constitutes a drought in one region may be normal in another, depending on the climate baseline. For instance, a few weeks

without rain in a semi-arid could quickly lead to drought conditions, whereas the same in a more humid area might not have the same impact (Van & Gregor Laaha, 2015). Although it may not immediately result in visible impacts, meteorological drought sets off a chain reaction that affects all aspects of life. As rainfall decreases, the soil starts to dry out, vegetation growth slows, and the risk of wildfires rises. Over time, if the drought persists, it evolves into agricultural and hydrological droughts, impacting crops, water resources, and ultimately people's livelihoods. This type of drought is especially dangerous in pastoral and agro-pastoral communities, where the economy and food security heavily depend on seasonal rains for pasture growth and water availability (Luseno et al., 2003).

Meteorological drought also has implications for long-term climate trends. In recent decades, changes in rainfall patterns and an increase in the frequency and intensity of dry periods have been observed in many arid and semi-arid regions due to climate change. Understanding meteorological drought is crucial for early warning systems and drought preparedness, as it provides the first indication that conditions are becoming abnormally dry (Hao et al., 2018).

2.3.3. Agricultural drought

Agricultural drought occurs when there is insufficient soil moisture to meet the needs of crops and forage, especially during critical growing periods (Muthoni Masinde, 2015). It is closely linked to meteorological drought, as reduced rainfall and high temperatures eventually lead to soil drying. However, agricultural drought is more directly concerned with the impacts on farming systems, including crop production, pasture availability, and livestock well-being. It is one of the most visible and immediate forms of drought in rural areas where communities depend heavily on rain-fed agriculture and livestock (Baudoin et al., 2014).

The effects of agricultural drought ripple throughout the entire local economy (Latamo et al., 2022). Reduced crop yields can lead to food shortages and rising market prices, making it harder for households to afford basic staples (Barrett et al., 2020). In pastoralist settings, the loss of livestock assets can take years to recover, especially without support systems (Bogale, & Erena, 2022). These impacts highlight the importance of drought-resilient agricultural practices, such as improved forage production, water harvesting, crop diversification, and community-based early warning systems (Abduselam, 2019).

2.3.4. Hydrological drought

Hydrological drought refers to a significant reduction in water availability in surface and subsurface sources, such as rivers, lakes, reservoirs, and groundwater systems (Galma et al., 2017). Hydrological drought tends to appear more gradually after a prolonged period of reduced rainfall (Maru et al., 2021).

It reflects the long-term impact of insufficient precipitation on the water cycle (Irungu et al., 2022). Even after rainfall resumes, water levels in rivers and underground aquifers may take months or years to fully recover, making hydrological droughts more persistent and difficult to manage (Majekodunmi, 2018).

Hydrological drought also places significant stress on both natural ecosystems and socio-economic systems (Osano et al., 2013). Wildlife and livestock compete over shrinking water resources, increasing the risk of conflict and overgrazing around remaining water points. At the same time, crop farmers who depend on small-scale irrigation from rivers or hand-dug wells may face total crop failure, leading to food insecurity and income loss. For pastoralists, the drying of rivers and ponds can force livestock to migrate long distances, weakening their condition and increasing the risk of disease or death (Iyer, 2021).

2.4. History of Droughts in Ethiopia

Ethiopia has a vast reservoir of natural resources and great capacity to mitigate the effects of drought. Its agro-climatic zones varied, as do the seasons for rainfall. Even if there is a vast amount of rain-fed agricultural potential, it is still a blessing that there are no technologies in place to enhance agricultural production (Getachew Alem Mera, 2018). Droughts that have recently struck various regions of Ethiopia are typically associated with variations in atmospheric and oceanic circulations. It's critical to comprehend these broad-scale processes since they significantly influence Ethiopia's vegetation productivity (Yuei & Getachew, 2019).

Ethiopia's climate variability and drought frequency have increased over the last three decades, affecting agricultural and livestock activities, but government response capacity should help control environmental disasters (Suryabhadgavan, 2017). Droughts in the Awash River Basin, Ethiopia, are

most frequent in the Middle and Lower Awash Basins, with severe events occurring in the Middle Awash Basin during 1988-1998 and 1998-2000 (Desalegn et al., 2009). Ethiopia experienced the most intense drought episodes from 1952 to 2017, with the most extreme droughts occurring in 1984, 1986, 2002, and 2014/15, affecting economic and social development (Ashenafi et al., 2020).

In Ethiopia's northeastern highlands, the frequency of droughts has risen in the spring and fallen in the summer and 12-month timeframes, with the north and center regions experiencing the greatest frequency (Mohammed et al., 2018). Frequent mild-to-severe meteorological droughts in Northern Ethiopia are caused by high rainfall variability, which impacts smallholder farmers and necessitates the development of drought mitigation and adaptation techniques (Eskinder Gidey et al., 2018). The agricultural and water industries in central Ethiopia are negatively impacted by the high variability of droughts, which are more frequent and severe in the eastern portion of the region (Yirga, 2020).

According to reports, Ethiopia's economy has grown by double digits over the past ten years. Unlike in prior years, the country adapted to the 2015 and 2016 droughts with more resilience and without suffering significant casualties by using its own resources (Getachew, 2018). Sustainable pastoral development relies heavily on risk-management-enhancing vulnerability reduction initiatives (Gebru, 2023).

2.5. Concept of pastoralism

Pastoralists are communities of people who plan their settlement and mobility to accommodate the food requirements of their cattle and who rely mostly on the products of their hooved domestic animals (Gifford-Gonzalez, 2005). Moreover, Pastoralism is the movement of cattle for the purpose of production or subsistence. Pastoralism can be broadly defined as three different things. The first two are usually the transhumant rearing of domesticated animals and nomadic living. The third is pastoral farming or enclosed ranching (Dong, 2016).

Pastoralism is a way of life in which people herd tamed animals. As one advances into drier and more arid lowland areas in East Africa, pastoralists mostly rely on cattle, sheep, donkeys, goats, and camels, listed in decreasing order of resistance (Bogale, & Erena, 2022). Africa's centuries-old pastoral livestock production systems are currently under threat from shifting demographics, better

communications, and more access to modern weapons, shrinking open rangelands, global warming, and widespread migration from rural to quickly growing cities (Holechek et al., 2017).

In Ethiopia, pastoralists have a variety of economic pursuits, including as raising cattle, cultivating crops, small-scale trading, creating handicrafts, selling wood and charcoal, and doing odd jobs (Ayele, & Dedecha, 2021). Pastoralists are uniquely suited to manage large, distant, drought-prone areas because they may routinely relocate their herds to the finest grazing sites (Bogale, & Erena, 2022). The raising of pastoral livestock is essential to the economy and way of life in Africa's semiarid regions (FAO, 2023). The foundation of a pastoral organization is typically a clan, which is in charge of managing the many livestock species that are herded throughout the world and controlling the best possible territory. Women carry the lion's share of the load when it comes to pastoral activities, and in most pastoral regions in the world, empowering women still presents a barrier (Dong, 2016).

2.6. Drought and Pastoralist Communities

The Horn of Africa is seeing an increasingly severe increase in the impact of drought-related crises. The frequency of these crises is increasing, affecting a larger number of people, decreasing the amount of time that can pass between them for recovery, and making the local population more vulnerable. Pastoralists' ability to respond to drought is currently hindered by a number of factors, including population growth, a declining resource base, conflict, shifting access to land and water, and the effects of other shocks like disease outbreaks and flooding (Brooks N, 2015).

In comparison to the rest of the region, the sub-Saharan portion of the region receives significantly less rainfall and is thought to be the most drought-prone (Brooks .N,2015). In comparison to the rest of the region, the sub-Saharan portion of the region receives significantly less rainfall and is thought to be the most drought-prone (Mergersa et al, 2014). Through market integration, wage work, and economic diversification, pastoralists in East Africa are adjusting to social, political, and economic problems; nonetheless, this causes social inequality and impairs the nutrition of women and children (Fratkin, 2001). More demands than ever before are placed on the way of life of pastoralist societies in East Africa (Fratkin, 2001). The natural resources used by pastoralists are under strain from population increase and rising meat consumption because grazing areas that are spared from

encroachment or conversion to agricultural land may be overused. Frequent droughts and other changing weather patterns put further strain on the system (Workneh et al., 2013).

Although pastoral lands play a significant role in the national economy, policy makers frequently overlook them in favor of agriculture and urban areas, giving pastoral development very little thought (Abduselam, 2019). Interventions for development in pastoral areas must be grounded in an understanding of the region, its inhabitants, and the indigenous methods of adapting to changing circumstances (Hadush., 2014). Population growth, the loss of prime grazing lands, the displacement and influx of refugees, habitat degradation and constriction, the absence of complementary economic activity, and the lack of additional income sources have all had a negative impact on Ethiopian pastoralists' way of life and ability to survive. Pastoral conflicts have also been exacerbated by these threats (Barrett et al., 2020). However, It is mainly disregarded in worldwide sustainability forums and agendas, however it faces crises stemming from misunderstandings and inadequate multidisciplinary understanding (Manzano et al., 2021).

The frequency and duration of droughts are rising in all of Ethiopia's pastoral areas, with various factors like climate change and variability being blamed (DENADH, 2023). Recurrent and extended drought occurrences are posing serious challenges for pastoralist communities, making them more vulnerable and reducing the availability of vital resources like water and grazing areas (Daniel et al. 2023). Pastoralist groups, government agencies, development organizations, and other stakeholders should work together to integrate traditional knowledge and practices with contemporary scientific methodologies in order to effectively manage drought (Maru et al., 2021). The responses that pastoralists are themselves coping and adapting to the stresses and shocks that their livelihoods system has always faced should be recognized by observers and policy makers instead of declaring pastoral livelihoods unviable and implicitly endorsing policies that undermine pastoralism and turn dubious assertions into inevitable facts (Hadush., 2014).

2.7. Drought Susceptibility among Pastoral Communities

One of the disasters that millions of Ethiopian pastoralists regularly face is drought (Mekuria et al., 2021). Drought frequently affects pastoral and agro-pastoral communities in the area; susceptibility varies according to gender, age, wealth position (access to farmland and livestock endowment),

location, social networks, and history of drought exposure (Ayantunde et al., 2015). Drought vulnerability is a complicated subject with numerous angles and viewpoints, according to Nori, (2006). Dry land livestock grazing sustains pastoral livelihoods, but it is subject to several changes, including shocks like extreme droughts (Martin et al., 2016). In certain areas, drought is a common occurrence that has a negative influence on people's livelihoods, the ecosystem of rangelands, natural resources, social issues, and the production of cattle (Ahmed et al., 2023).

Drought vulnerability comprises social and biophysical components. The severity of the drought hazard and people's ability to cope will determine how severe it is; however, if coping mechanisms are not implemented and/or indigenous pastoralists' coping mechanisms are not adequately supported, the nomadic population will continue to be vulnerable. The population's ability to adapt will be solely dependent on the assets that have been amassed at the social and biophysical levels according to and OCHA (2011). Significant indicators of pastoralist vulnerability to drought include a decline of pasture lands, livestock death, water availability reduction, livestock products and prices, environmental degradation, food insecurity, and outbreaks of human and livestock diseases (Ahmed et al., 2023).

2.8. Drought Risk Management Strategies

Pastoralists can limit resource competition and adjust to changing environmental conditions by using a pastoralist drought management technique (Irungu et al., 2022). Pastoralist drought management refers to the tactics and measures used by pastoral communities to lessen the effects of drought on their cattle and means of subsistence (Maru et al., 2021). These tactics are meant to lessen pastoralists' susceptibility to drought and increase their capacity to deal with its consequences (Iyer, 2021). The development of a framework that qualitatively evaluates the relationships between these techniques and their impact on conservancies is a result of pastoralists' strategies for risk mitigation and drought coping (Osano et al., 2013). Low rainfall and recurrent droughts have had a significant impact on cattle productivity and the livelihoods of pastoralists in southern Ethiopia (Galma et al., 2017).

Proactive risk management is crucial, yet pastoralist drought management is fraught with difficulties (Majekodunmi, 2018). These difficulties include the marginalization of pastoralists on the political,

economic, and social fronts; limited access to natural resources as a result of national policies; a rise in the frequency and severity of climate shocks like droughts; and chronic conflict (Ibrahim, 2016). The diversification of livelihoods, such as implementing agricultural methods and adding cereals and grains to their diets while retaining milk as their major source of nutrition, are some typical pastoralist drought management techniques (Ibrahim, 2016).

Furthermore, pastoral and agropastoral communities ought to concentrate on strengthening their methods of coping by tackling the evolving nature of drought hazards and the inherent susceptibility of the socio-ecological environments in which they live (Bedelian & Ogutu, 2017). Increasing livestock output, putting into practice sustainable land management and biodiversity protection techniques, and creating plans to deal with the various environmental, social, and economic effects of drought are some of the steps being taken to accomplish this (Maru et al., 2021).

2.9. Drought Coping Mechanisms among Pastoral Communities

Pastoral communities have historically developed and relied upon a range of coping mechanisms to manage the impacts of drought. These mechanisms, shaped by generations of local experience and ecological knowledge, can broadly be categorized into traditional (indigenous) practices and modern, externally supported strategies (Bedelian & Ogutu, 2017). These include changing up the sources of one's income; moving livestock to follow water and forage; changing up the makeup of the herd to take advantage of different livestock species' fecundity and resistance to disease; and sending kids to school as an investment that will eventually pay for itself through employment income (Opiyo et al., 2015). Coping mechanisms, such as resilience programming and herd diversity, are essential to reducing the effects of unfavorable climate occurrences, such as drought (Maru et al., 2021).

Pastoralist regions show resilient and adaptable livestock production and marketing in RAIt of ongoing drought, unrest, and ineffective government (Catley et al., 2016). Programs for responding to drought emergencies are restricted to providing relief food, resettling impoverished pastoralists, and occasionally conducting cattle salvage operations. These initiatives frequently have ad hoc planning, which makes them lacking in long-term planning (UNDP, 2012). The safety-net programs, which are meant for human use, have given pastoralists a free supply of feed for their animals.

Slaughter of livestock when a drought hits, pastoralists may kill certain cattle but not others in order to ensure the survival of other (Catley et al., 2016).

2.10. Challenges of Drought Coping Strategies in Pastoral Area

Pastoral communities in arid regions Africa's systems are still undergoing modifications. Numerous historical causes have an impact on these systems, but little effort is made to use this knowledge to create regulations that are appropriate for the landscapes of pastoralists (Lenyeletse et al., 2017). The shifting nature of drought threats, the socio-ecological setting in which pastoralist communities' lives' vulnerability, and the loss of land and water resources to non-pastoralists, on the other hand, seriously impair these communities' resilience and management skills (Irungu et al., 2022)..

While pastoralists have considerable expertise and experience in managing their cattle and living with drought, there are definite limitations and hurdles to their tactics, as demonstrated by the study of pastoralist drought coping as a catastrophe risk reduction strategy (Lutta et al., 2020). These constraints include a lack of funding and market access for livestock products, restricted access to healthcare and education, overgrazing-related land degradation and biodiversity loss, and resource-related conflicts (Ibrahim, 2016). Additionally, the difficulties associated with the evolving form of drought threats, the susceptibility of the socio-ecological context in which they reside, and the loss of water and land resources to non-past (Irungu et al., 2022). With so many issues at play, it's critical to assess whether pastoralism as a system of production which is fundamentally out of step with current issues because it depletes the world's limited resources (Workneh et al., 2013).

2.11. Conceptual Frame work

This study focuses on the impact of drought on pastoral households and their indigenous coping strategies; there are two important concepts that recur in the literature and going to be used in the analytical frame work. These are, impact assessment and coping strategies; Impact assessment: This refers to the extent of damage imposed by droughts on the community in this study area. This study will assess the effects on the pastoral community and its inhabitants depending on trends in drought. Coping Mechanisms for the Disaster's Negative Effects: Because societies are dynamic, they employ every tactic available to lessen their susceptibility to the effects of drought. The robustness

or resilience of coping mechanisms varies based on the accessibility and availability of resources and technologies.(Mccarthy, 2001).

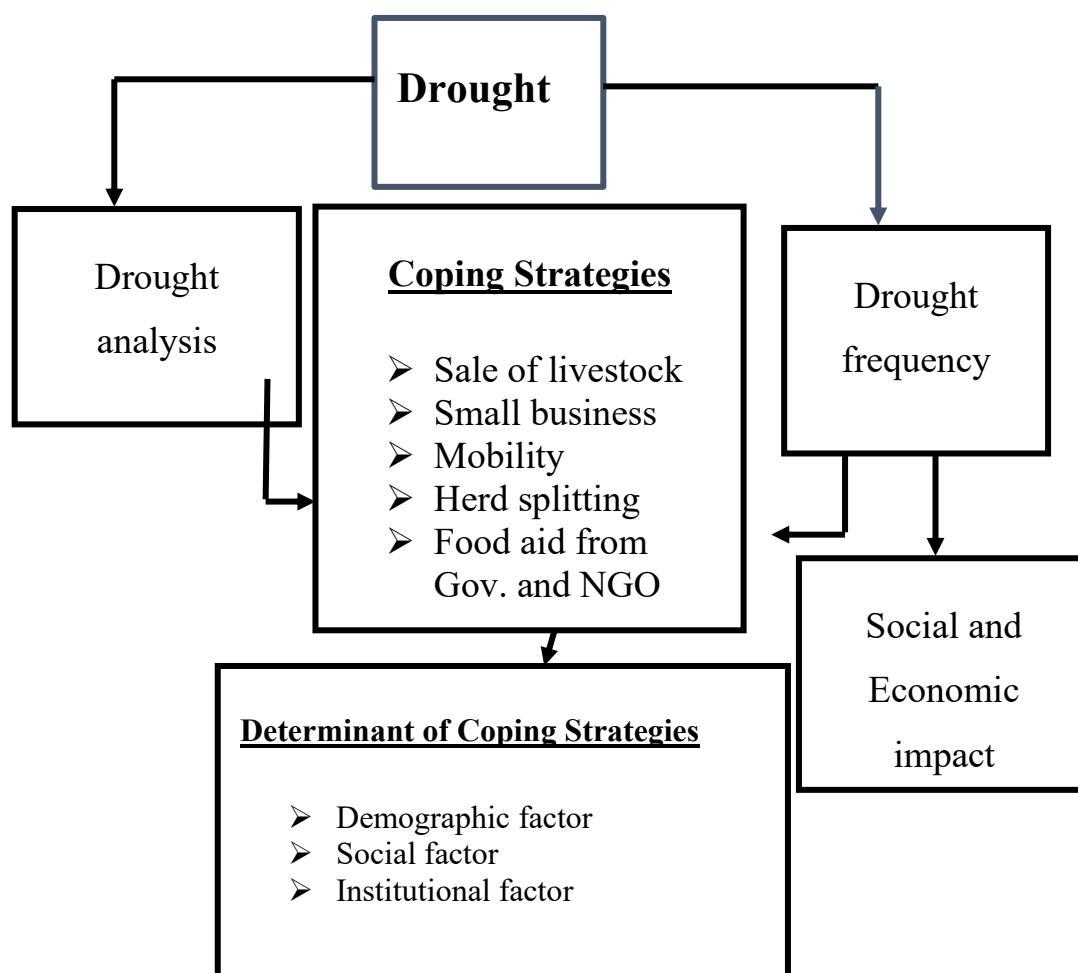


Figure 1:Conceptual frame work

3. RESEARCH METHODOLOGY

3.1. Description of Study Area

3.1.1. Location of the study area

The study was conducted at Godey District in the Somali Regional State. Godey is located about 580 km to south of Jigjiga the capital city of Somali Regional State at an elevation of 300 meter above mean sea level, with latitude of $5^{\circ}50' 0''$ - $6^{\circ}20' 0''$ N and longitude of $43^{\circ}0'0''$ - $44^{\circ}0'0''$ E. The Shebelle River positioned the southern and the eastern boundaries of the Godey District.

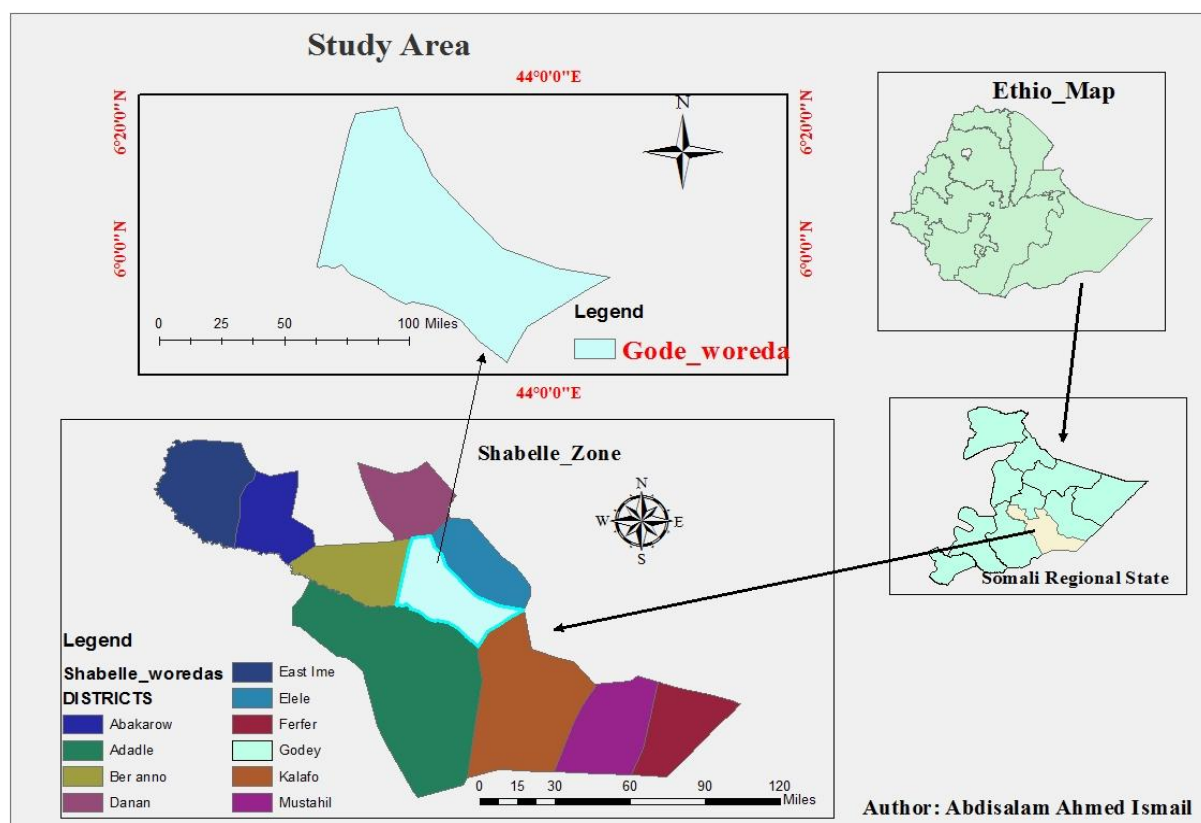


Figure 2. Location map of Study area

3.1.2. Agro-ecological and climatic condition

The climate of Godey is characterized as arid to semi-arid agro-ecology, where livestock is the main occupation, cultivation is undertaken along Shebelle riverbank, and rain fed plains. The average maximum and minimum annual temperatures are 35 and 23.6°C, respectively. The average annual rainfall of the area ranges from 150 to 340 mm, which is not sufficient for rain fed crop production. The soil texture of Godey is silt loam to silt-clay loam in the top and becoming clay with depth (SZAO, 2013).

3.1.3. The livestock population and production system

The community livelihood dependent in Godey District is mainly characterized by livestock production and crop farming practices along the riverbank of Wabi-Shebelle River. The most important crops grown by agro-pastoralists are sorghum and maize, though the former is more dominant. Further, away from the river, sorghum and maize are cultivated using the seasonal river flooding or by digging small channels from the streams to the crop production areas as well as by using irrigation systems. Godey District has an estimated livestock population is projected to be 352,000 cattle; 244,350 sheep; 135,000 goats and 45,000 camels and equines (CSA, 2023). The study District total human population is projected to be 168,116 (91,222 males & 76,894 females) (CSA, 2023). The study District has a total of 23 kebeles, from which two are urban and 21 are rural kebeles, among these rural kebeles 12 are agro-pastoralists while the remaining 9 kebeles are pastoralists. From the total human population, 23,117 are urban households and 37,840 are rural households (GWA, 2016).

3.2. Research Design and Approach

The study used cross-sectional survey design that aimed to examine as well as describe the major relationship between the impacts of recurrent drought and coping strategies in study area. Because it give better direction on the research process and also will help to determine the process to conclude the general findings. The other major reason behind such research design preference is that it requires large number of people questioned concerning attitude, experience, and different opinions on the study area on the impacts of drought on pastoral household and different coping strategies to adaption recurrent drought of study area.

The researcher employed both qualitative and quantitative research approach types which is said to be mixed research approach. Qualitative approach was used to capture data that pertain to community attitude and their past experience on the major drought risks using the semi structured questions. On the other hand quantitative data on basic information as well as demographic characteristics was collected from the sample household through the closed ended questionnaire. Secondary data will also be collected from relevant literatures, from report of the district Administration office, Zone and district prevention and preparedness office and the district pastoral office report as well as any other publications.

3.3. Type and Sources of Data

This study employed both qualitative and quantitative data to achieve its research objectives. Data were collected from primary and secondary sources to ensure a comprehensive analysis. Primary data were obtained from household heads and smallholder agro-pastoralists using structured questionnaires. In addition, focus group discussions (FGDs), key informant interviews, and field observations were conducted to capture in-depth insights and contextual information relevant to drought impacts and coping strategies. Secondary data were gathered from, relevant documents were obtained from institutions such as the Central Statistical Agency (CSA), the District Pastoral Development Office, and the Disaster Risk Management (DRM) office. The study also utilized climate data, including rainfall and minimum and maximum temperature records, spanning a period of 30 years were obtained from the Ethiopian Meteorological Institute.

3.4. Sample and Sampling Techniques

This study employed a multi-stage sampling technique to select representative respondents from the study area. In the first stage, Godey District was purposively selected from the ten districts of Shabelle Zone due to its high vulnerability to recurrent drought, frequent food insecurity, and the presence of various coping strategy interventions among pastoral communities. In the second stage, five kebeles were purposively selected from the nine pastoral kebeles found in the district. The selection was based on criteria such as the intensity and frequency of drought occurrence, severity of drought impacts, level of food insecurity, and the availability of coping strategy interventions.

This selection was made in consultation with Disaster Risk Management (DRM) experts and local development officials to ensure representativeness.

The sample size was determined using the formula recommended by Yamane (Yemane 1967) as follows:

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

Where n = sample size

N= population size

e = level of precision which is 0.05%

Since the Godey district has 37,840 rural households, the formula was applied as follows:

$$n = \frac{37,840}{1+37,840(0.05)^2} = 396$$

Thus, a total of 396 households were selected for the study. The total sample size was proportionally allocated to the selected kebeles based on their respective household populations. Within each kebele, households were selected using simple random sampling techniques to ensure that each household had an equal chance of selection. A household list obtained from local administrative offices served as the sampling frame.

Table 1: Sample Kebeles and their Sample Size Proportion

District	Sampled Kebeles	Total Household	Sample Size	Remark
Godey	Karinka	820	74	
	Bare	1050	95	
	Elani	1000	91	
	Kayane	780	72	
	Badilate	710	64	
	Total	4360	396	

Source: Godey District DRM office, 2018

3.5. Methods of Data Collection

3.5.1. Household Questionnaire

A household questionnaire was designed as a data collection tool for this study. A questionnaire is a research instrument consisting of a series of questions used to gather information from respondents. The questionnaire was developed to obtain relevant information on the impacts of drought on pastoral households and the factors that influence pastoralists' choice of coping strategies. Both closed- and open-ended questions were included. The questionnaire was initially prepared in English and later translated into the local language, as the community speaks Somali.

3.5.2. Key Informant Interviews (KIIs).

Key informants include knowledgeable people from different related sector and Elders who know about the drought severity and frequency in the study area. The checklist was used in questioning of key informant's interview, which has two major parts namely past knowledge of rainfall trend and variability together with impacts and coping strategies they have been practicing. These interviews were carried out on one-to-one basis allowing an in-depth analysis of the subject. The key informant interview was conducted with development agents, District agricultural development office representative, District agriculture natural resource office coordinator District Food security and DRM office, , and community elders from each kebele.

3.5.3. Focus group discussion (FGD).

Focus group discussions (FGDs) were conducted with groups of pastoralists comprising local elders, heads of households, and representatives of women and youth groups. In each kebele, 12 participants were purposefully selected based on their experiences with drought hazards, observed weather variability and patterns, the impacts of drought on their livelihoods, and the strategies they use to cope with these impacts. One focus group discussion was held in each kebele, and each group consisted of 3 female-headed households, 3 male-headed households, 1 development agent, 2 kebele food security task force representatives, and 3 kebele administrators. The main purpose of the FGDs was to understand the factors influencing the choice of coping strategies to drought and to assess the effectiveness of these strategies among pastoral households. Participants were selected based on

their past experiences, levels of vulnerability, and the extent to which their households had been affected by drought.

3.5.4. Field observation.

The objective of field observation by the researcher is to create self-acquaintance with community representatives, understand the agro-ecologies, topography, type's pastoralist, land use and land cover, water points, livestock types and composition land holding, natural resources base and management, livelihood bases, rainfall and related aspects deemed necessary for undertaking the study. It will help to picturize the local context in relation to drought, drought impacts and coping strategies.

3.6. Method of Data Analysis

3.6.1. Descriptive statistics

The data was gathered through both qualitative and quantitative methods are subject to interpretations with the help of appropriate methods. Primarily, information from both open-ended and closed ended response options including secondary sources used to briefly analysed the impacts of drought and coping strategies by discussing and using simple statistical tools such as frequency, percentage, mean, and average. Statistical Package for Social Sciences version 25 (SPSS 25) was used for the analysis of the data. Descriptive statistics such as frequency, means, standard deviation, range, percentages, were used to analyze the collected data.

3.6.2. Coefficient of rainfall variability analysis

To analyze the variability of rainfall, the study was applied Coefficient of variation (CV) to analyze the inter annual and seasonal variability of rainfall pattern using the following formula:

$$CV (\%) = \frac{\sigma}{\mu} \times 100 \quad (2)$$

Where, CV= coefficient of variation σ = standard deviation and μ = mean.

According to Hare (2003), the degree of variability of rainfall events can be classified as low ($CV < 20$), moderate ($20 < CV < 30$), and high $CV > 30$ = high variability.

3.6.3. Rainfall anomalies index (RAI) analysis

The RAI is used for assessment and monitoring interannual drought frequency and severity by identifying the record wet and dry years in the long-term conditions for a specific time scale that is used for the early warning system. It also assesses deviations from average rainfall patterns in which positive values indicate greater than long-term mean rainfall, while negative anomalies indicate decreasing mean rainfall tendency. It was computed following suggested by (Agnew and Chappell, 1999).

$$RAI = \frac{P_t - P_m}{\sigma} \quad (3)$$

In this study, drought and wetness conditions were assessed using the **Rainfall Anomaly Index (RAI)** instead of the Rainfall anomaly index (RAI), as the two indices differ in concept and interpretation. RAI measures deviations of observed rainfall from the long-term mean and is suitable for identifying dry and wet periods based on rainfall anomalies. P_i is rainfall of each year and P_m average rainfall of long year, while sigma is standard deviation

Accordingly, rainfall conditions were classified using the following RAI thresholds: RAI values greater than +0.5 indicate a wet season, RAI values between −0.5 and +0.5 represent normal rainfall conditions, and RAI values less than −0.5 indicate a drought season. This classification was applied consistently throughout the analysis to identify drought occurrence and seasonal rainfall variability in Gode District.

The Value of RAI index and drought severity class applied in this study indicated as Table 2

Table 2: RAI-Based Rainfall Condition Classification

RAI Value Range	Rainfall Condition
$RAI > +0.5$	Wet season
$-0.5 \leq RAI \leq +0.5$	Normal season
$RAI < -0.5$	Drought season

Source: Adapted from Mondol *et al.* (2015)

3.6.4. Analysis of rainfall and temperature trend

The trend of seasonal and annual rainfall was analyzed using Mann Kendal trend test. Mann-Kendall test and the method of Sen's are important non-parametric tests and powerful, since they are not affected by outliers (Salmi *et al.*, 2002). The Mann-Kendall Statistic (S) measures the trend in the data. Positive (+) values indicate an increase in constituent concentrations over time, whereas negative (-) values indicate a decrease in constituent concentrations over time. The Mann-Kendall Statistic's magnitude directly relates to the trend's strength (where large magnitudes indicate a strong trend). However, temporal sequential order should be maintained for the data utilized in the Mann-Kendall analysis. The MK statistic (S) is defined as the sum of the number of positive differences minus the number of negative differences (Sneyers 1990) as follows:

Mann–Kendall (MK) test has been used to detect the presence of monotonic (increasing or decreasing) trends of rainfall and temperature in the study area whether the trend is statistically significant or not. The Software will be used for performing the Mann Kendall and trend statistical test will be R software Kendall, trend package. Since, the Mann–Kendall statistical test has been frequently used to quantify the significance of trends in climatic parameters time series (Silva *et al.*, 2013). The Mann–Kendall test (Mann 1945; Kendall.1975) Tau statistic is calculated as

$$S = \sum_{i=1}^{n-1} \sum_{j=i+1}^n \text{sgn}(X_j - X_i) \quad (4)$$

$$\text{sgn}(x_j - x_i) = \begin{cases} +1, & x_j - x_i > 0, \\ 0, & x_j - x_i = 0, \\ -1, & x_j - x_i < 0, \end{cases} \quad (5)$$

Where n is the length of the time series($x_1, x_2, x_3, \dots, x_n$), X_i and X_j are the data values in the time series i and j ($j > i$), respectively, and $\text{sgn}(X_j - X_i)$ is the sign function.

And the variance $V(S)$ of statistics S is computed as

$$\text{Var}(S) = \frac{n(n-1)(2n+5) - \sum_{i=1}^p t_i(t_i-1)(2t_i+5)}{18} \quad (6)$$

“ t_i ” is the number of ties of extent i.

Where n is the number of data points, p is the number of tied groups, the summation sign (Σ) indicates the summation over all tied groups t_i the number of data values in path group. If there are no tied groups, this summation process can be ignored based on (Kisi and Ay. 2014). A tied group is a set of sample data that have the same value. In cases where the sample size $n > 30$, the standard normal tests statistical Z_s is computed as follows:

$$Z_s = \begin{cases} \frac{S-1}{\sqrt{\text{Var}(S)}}, & \text{if } S > 0 \\ 0, & \text{if } S = 0 \\ \frac{S+1}{\sqrt{\text{Var}(S)}}, & \text{if } S < 0 \end{cases} \quad (7)$$

Positive values of Z_s indicate increasing trends, while negative Z_s values show decreasing trends. Testing trends is performed at the specific α significance level. When $|Z_s| > |Z_{1-\alpha/2}|$, the null hypothesis is rejected, indicating that a significant trend exists in the time series. $Z_{1-\alpha/2}$ is obtained from the standard normal distribution table. The significance level of Mann–Kendall test has proven to be useful in determining the possible existence of statistically significant trends assuming a 95% probability level (Dufek AS and Ambrizzi T, 2008) which is P value ≤ 0.05 . At the 5 % significance level, the null hypothesis of no trend is rejected if $|Z_s| > 1.96$.

Sen's Slope estimation test computes both the slope (i.e. the linear rate of change) and intercept according to Sen's method. The magnitude of the trend is predicted by Theil (1950) and Sen (1968) slope estimator methods. A positive value of β indicates an 'upward trend' (increasing values with time), while a negative value of β indicates a 'downward trend'. Here, the slope (T_i) of all data pairs is computed as (Sen, 1968). Teil-Sen's estimator is used to quantify the magnitude of trends and has been widely used in analyzing hydrological time series data (H. T and Aghajanloo M.2013). The magnitude of the trend is estimated by Sens slope method (Sen, P.K. 1968) which is proceeds by calculating the slope as a change in measurement per change in time,

$$Q = \frac{x_j - x_i}{j - i}, \quad i < j, \quad (8)$$

Where X_j and X_i i th and j th data point in time series ($j > i$), respectively. Teil-Sen's estimator's main advantage lies in the global median used, which makes it more resistant to the effect of

extreme values in the time series (H. T and Aghajanloo M.2013). And Q is the slope between data points X_j and X_i , Sens slope estimator is simply given by the median slope,

$$\beta = \begin{cases} Q'_{\frac{N+1}{2}}, & N \text{ is odd} \\ \frac{1}{2} \left(Q'_{\frac{N}{2}} + Q'_{\frac{N+2}{2}} \right), & N \text{ is even} \end{cases} \quad (9)$$

Where, N is the number of calculated slopes. A positive value of β indicates an increasing trend and a negative value indicates a decreasing trend in the time series.

3.7. Analysis Econometric Model

3.7.1. Multinomial logit model

This study employed a multinomial logit (MNL) model to analyze determinant of pastoral households on choice of Coping strategies to drought in the study area because multinomial model is appropriate as it exhibits superior ability to predict occupational choices (Mohammed, 2007; Sosina *et al.*, 2009). The main advantage of the MNL model has been its simplicity in terms of both estimation and interpretation of the resulting choice probabilities and elasticities. On the one hand, the MNL has a closed-form choice probability and a likelihood function that is globally concave (for a complete overview of MNL and its properties, see Train 2009). MNL estimation is thus straightforward using the maximum likelihood estimator (MLE).

This study used the multinomial logit (MNL) model to analyze the factors affecting pastoral household' respond to drought coping strategies because it is widely used in studies involving multiple choices and is easier to compute. The advantage of using a MNL model is its computational simplicity in calculating the choice probabilities that are expressible in analytical form. The main limitation of the model is the independence of irrelevant alternatives (IIA) property, which states that the ratio of the probabilities of choosing any two alternatives is independent of the attributes of any other alternative in the choice set.

The MNL model allows household characteristics to have different effects on the relative probabilities between any two choices. Let A_i be a random variable representing the response of farming household. It assume that each household faces a set of discrete, mutually exclusive choices

of response. These responses are assumed to depend on a number of climate attributes, socioeconomic characteristics and other factors X (Greene, 2003). The MNL model specifies the following relationship between the probability of choosing option A_i and the set of explanatory variables X as:

$$Pr(A_i = j) = \frac{\exp \beta_i X_i}{\sum_{k=0}^J \exp \beta_i X_i}, j = 0, 1, \dots, J \quad (10)$$

Where β is a vector of coefficients on each of the independent variables X . Equation (1) can be normalized to remove indeterminacy in the model by assuming that and the probabilities can be estimated as: $\beta_0 = -\beta$

$$Pr(A_i = j/x_i) = \frac{\exp \beta_i X_i}{1 + \sum_{k=0}^J \exp \beta_i X_i}, j = 0, 1, \dots, J; \beta_0 = 0 \quad (11)$$

Estimating equation (2) yields the J log-odds ratios

$$\ln(P_{ij}/P_{ik}) = X'_i(\beta_j - \beta_k) = X'_i\beta_j, k = 0 \quad (12)$$

The dependent variable is therefore the log of one alternative relative to the base alternative.

$$\alpha_i = \frac{\alpha_{pj}}{\alpha_{Xj}} = P_i \left[\beta_i - \sum_{k=0}^j P_k \beta_k \right] = P_j [\beta_i - \beta'] \quad (13)$$

The marginal effects measure the expected change in probability of a particular choice being made with respect to a unit change in an explanatory variable (Long, 1997; Greene, 2003). The signs of the marginal effects and respective coefficients may be different, as the former depend on the sign and magnitude of all other coefficients.

3.7.2. Dependent Variables

The dependent variables in this study are coping strategies that are chosen by the sample households. These are crop /livestock diversification, off farm.

3.7.3. Independent variables

The choice of independent variables used in the study is influenced by literature reviewed on factors that influence farmers' decisions to coping strategies to drought, previous research findings and the knowledge about coping to drought.

The explanatory variables considered in this study consist of household characteristics, socioeconomic factors, cultural factors and institutional characteristics. The below explanation summarizes the explanatory variables used for empirical estimation and develops some hypotheses about their expected influence on farmer's response on drought early warning system and coping strategies.

Sex of households head: Gender is a dummy variable which indicate 1 if male household head and 0 otherwise. The expecting sign of this variable had been both positive and negative, i.e. unknown.

Age of households head: It is a continuous explanatory variable measured in the number of years of the household head. A study by Abrham *et al.* (2017) indicated that age is positively influencing changing the planting date. In contrast, the age of farmers is negatively influencing diversifying to improved crop varieties, mixed farming and adjusting planting date's adaptation strategies (Obayelu *et al.*, 2014). Therefore, the study hypothesizes the relationship between age of household head and choices of coping strategies to drought may be indeterminate a prior.

Education level of households head: Education is a continuous explanatory variable, which can be measured formal years of schooling. Farmers' years of education is positively and significantly increases use of soil and water conservation practices, improved crop varieties (Ababew, 2016). Gebre *et al.* (2014) stated that formal years of education are positively related to irrigation. Abrham *et al.* (2017) also indicated that it is positively influencing changing planting date and tree planting as adaptation strategy. In this study, it is expected that formal years of education determine positively the use of coping strategies.

Access to credit service: The availability of credit is important for the farmers' in order to develop coping strategies. Credit can be use as for the farmers to introduce new technology, to buy improved crop seed, fertilizers and oxen. Therefore, it was expected a positive sign for the farmers' who was

used coping method to redundant drought happen and is a dummy variable indicating 1 if the farmers have access to credit 0 otherwise.

Access to rainfall information: This is dummy variable indicating 1 if the household head access to rainfall information 0 otherwise. This variable expects positive sign for the farmers' who used coping strategies to redundant drought happen.

Access Market information: This is a dummy independent variable taking the value 1 if a household had access to market information services and 0 otherwise. Households marketing decision is based on market price information. Therefore, the variable is hypothesized to affect adoption drought copying strategy positively.

Farm Experience: It is the total number of years a farmer stays in production of farm commodity or stayed in farming activities. A household with better experience in farming is expected to adapt drought copying strategies. Farmers with longer farming experience are expected to be more knowledgeable and skillful. Therefore, this variable is hypothesized to positively influence drought copying strategies.

4. RESULTS AND DISCUSSION

4.1. Socio-Economic Characteristics of Respondents

The study revealed that 69.9% of participants were male and 30.1% female Table 3. Male household heads tend to access information earlier than females (Ibrahim, 2016), so this gender imbalance may limit female perspectives crucial for understanding community resilience. Most respondents (63.4%) lacked formal education, 26.5% completed primary school, and only 10.1% reached secondary education Table 3. Low education levels may hinder access to diverse drought coping strategies, awareness of support programs, or adoption of new technologies (Eskinder Gidey et al., 2018). Pastoralism was the primary livelihood for 86.6% of respondents, with only 13.4% engaged in other activities like trade or farming. This reliance on pastoralism means droughts directly threaten income and food security, shaping specific coping strategies such as livestock mobility, water use, and income diversification.

The majority of households (42.4%) have between 4-7 members, followed by 8-12 members (34.8%). Smaller households of 1-3 members make up 13.6%, and only 8.8% have more than 13 members Table 3. Household size can impact the choice of coping strategies. Larger households may need to employ diverse strategies to meet the needs of all members, whereas smaller households might have fewer options or may depend more heavily on certain resources. Larger households might also face more pressure on available resources, affecting how they cope with drought-related stress. Livestock is the primary income source for 84.8% of respondents, aligning with the predominant pastoral lifestyle Table 3. Small percentages rely on trade (9.1%), farming (3.0%), and remittances (3.0%) as alternative income sources. With the majority dependent on livestock, drought conditions that affect pasture or water availability could severely impact income. Households with alternative income sources, like trade or remittances, might be better positioned to cope with drought since they have a degree of financial diversification, potentially making them less vulnerable to the immediate effects of drought on pastoral resources.

Variables	Category	Frequency	Percent
Sex	Female	119	30.1
	Male	277	69.9
Education Level	Primary	105	26.5
	Secondary	40	10.1
	No formal education	251	63.4
Livelihood	Pastoralism	343	86.6
	Other (Specify)	53	13.4
Household Size	1-3	54	13.6
	4-7	168	42.4
	8-12	138	34.8
	More than 13	35	8.8
Income Source	Farming	12	3.0
	Livestock	336	84.8
	Trade	36	9.1
	Remittances	12	3.0

Table 3 : Democratic characteristics

4.2. Rainfall Pattern and Distribution of the Study Area

The area experiences a bimodal rainfall pattern, meaning there are two distinct rainy seasons each year (Figure 3) The first rainy season typically occurs during April and May, while the second rainy season takes place in October and November. These two periods of rainfall are separated by relatively drier intervals (Figure 3).

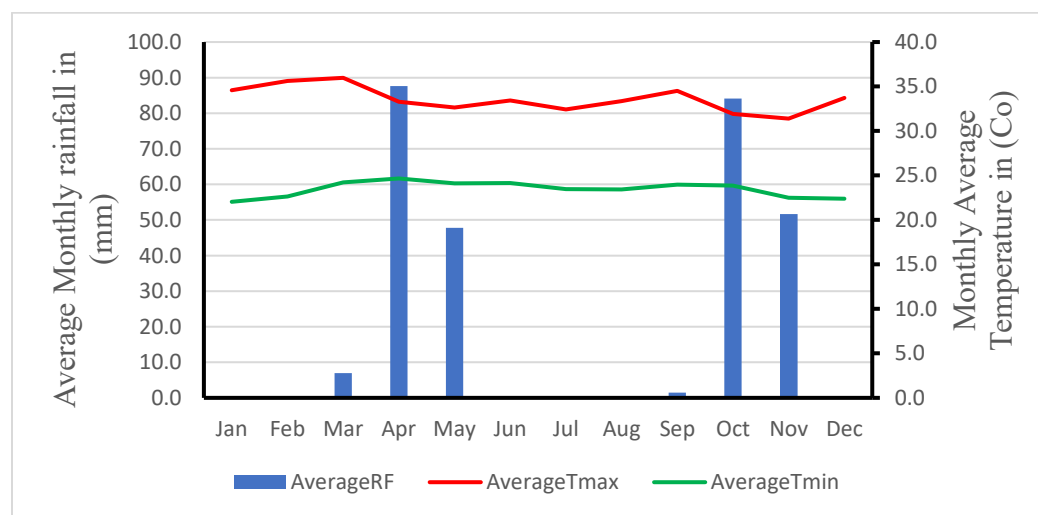


Figure 3: Rainfall pattern and distribution

The rainfall anomaly during the first rainy season from April to May shows wet conditions, with rainfall anomaly values greater than 0.5 recorded in 1995, 1998, 2006, 2013, 2015, 2016, 2018, and 2020. On the other hand, several years—particularly 1999 to 2002, 2008 to 2012, 2017, 2019, and 2022—recorded strong negative RAI values, indicating severe drought episodes that reduced forage productivity, weakened livestock health, and contributed to economic and food insecurity among pastoralists. The dominance of negative or near-zero values across the time series reflects the prevalence of drought as a recurring challenge in Gode, creating cycles of asset loss and recovery that strain traditional coping mechanisms.

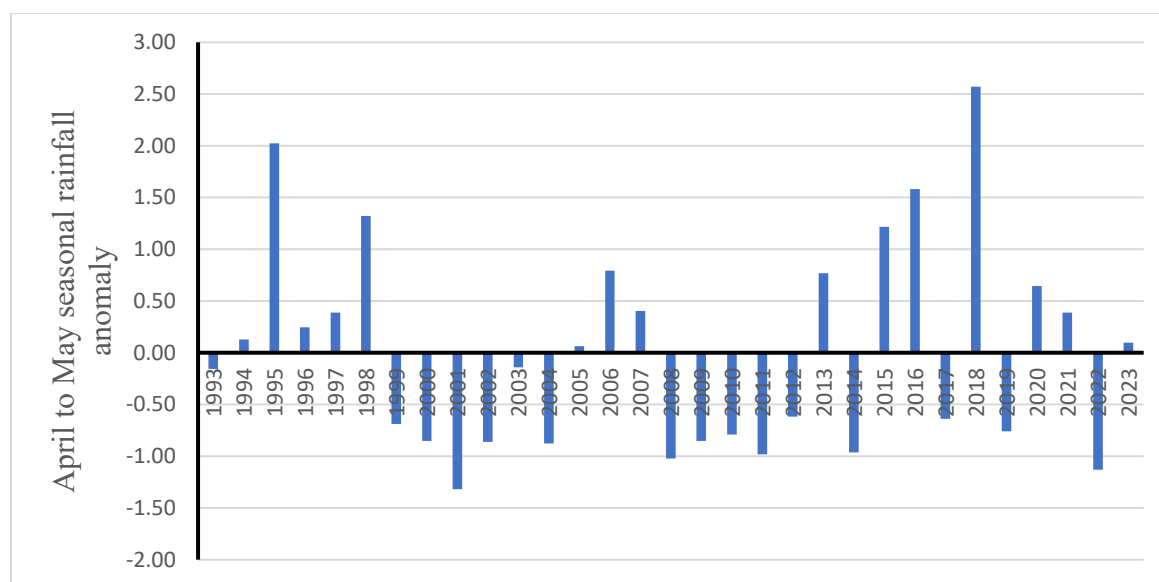


Figure 4: Annual Rainfall Anomaly Index for April to May at Gode station.

The RAI values fluctuate significantly across the years, showing alternating wet and dry conditions. Periods such as **1996, 1998, 2013, and especially 2015** show strong positive RAI values, indicating wetter-than-average conditions, with 2015 being the wettest year (above +0.5 RAI). Conversely, years like **2000, 2003, 2008, 2011, 2017, 2019, and 2021** record negative RAI values, reflecting drought episodes, with 2000 and 2017 showing more severe dryness (below -1.5 RAI). The data demonstrates that Gode experiences high rainfall variability with recurrent droughts and occasional wet extremes and the result in line with Gameda *et al.*, (2021). This variability strongly affects pastoral livelihoods, as drought years correspond to forage and water scarcity, while wet years support better grazing and livestock recovery.

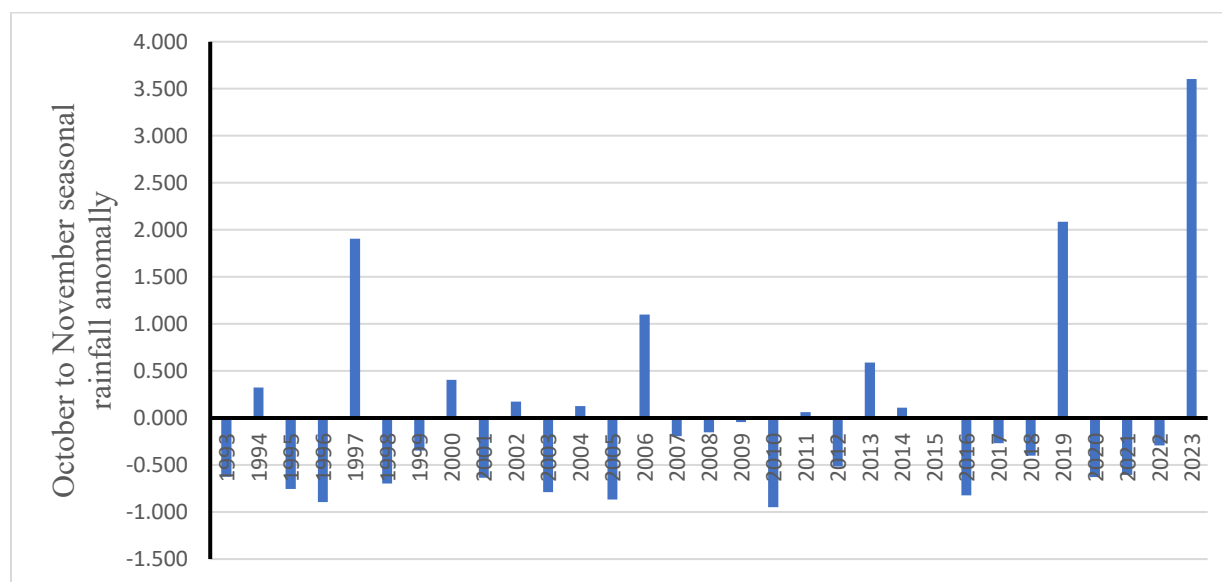


Figure 5: Rainfall anomaly for October to November (1993–2023)

The annual RAS values for Gode area are presented in Figure 5 from 1993 to 2023 highlights the persistent climatic variability that pastoral households face, with alternating wet and dry years shaping livelihood conditions Figure 5. This data shows that several years, such as 1997, 2006, 2013, 2019, and 2023, experienced positive RAI values, indicating wetter conditions that may have temporarily improved pasture and water availability.

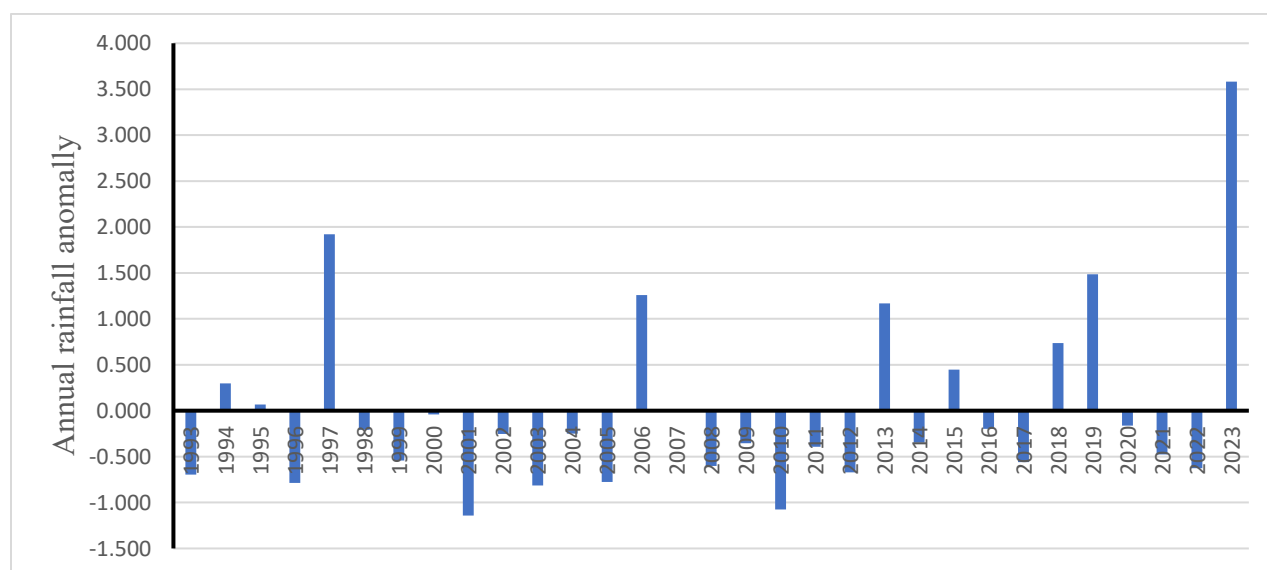


Figure 6: Annual rainfall anomaly at Gode station

Similar result were reported by (Duba, 2022), who noted an increasing tendencies of drought during main rainy season in Yabello and Eel-wayye Station, Southern Ethiopia. This variability of affected by the wind direction for rain bearing southeasterly trade winds from the Indian Oceans that shows the total amount of rainfall tends to increases towards Jigjiga to then decline towards Shinile (Tekalign, 2017). Despite this fact, the total amount of rainfall received in Shinile area is in the intermediates

4.3. Climate Change Trend and Rainfall Variability

The findings of the Mann-Kendall and Sen's slop estimation trends, showed that the monthly rainfall varied by month and season with some decreasing rainfall trajectories were observed. Most of monthly rising and falling trends, were not statistically significant ($P < 0.05$) in analyzed regions (Table 4). In Adadle district, the months of January did not receive any rainfall for the last three decades. This implies January is the driest month following by July and August (Table 4). This also months the lowest variation, suggesting more stable and consistent rainfall during that month.

Table 4: Trends of minimum and maximum temperature during 1993-2023 at Gode.

Time series	Minimum temperature			Maximum temperature		
	MKST	Sen's slope	p-value	MKST	Sen's slope	p-value
Jan	-0.409	-0.005	0.682	3.1081	0.022	0.001**
Feb	0.715	0.015	0.4746	1.986	0.017	0.046*
Mar	0.357	0.004	0.720	0.646	0.011	0.517
Apr	1.34	0.025	0.1784	1.41	0.046	0.158
May	2.349	0.03	0.018*	2.026	0.05	0.042*
Jun	3.34	0.031	0.0008***	3.001	0.038	0.0026**
Jul	2.374	0.025	0.0175*	1.942	0.03	0.052
Aug	3.55	0.029	0.0003***	3.856	0.05	0.0001***
Sep	3.90	0.033	0.0006***	3.74	0.035	0.0001***
Oct	1.994	0.033	0.046*	1.548	0.044	0.121
Nov	1.927	0.035	0.053*	1.173	0.039	0.240
Dec	0.63	0.012	0.528	2.831	0.0272	0.005**
AM	2.882	0.033	0.0039**	2.48	0.055	0.0127*
ON	2.662	0.036	0.007**	1.310	0.044	0.1901
Annual	3.632	0.026	0.0003***	3.768	0.033	0.00016***

Note: AM: April-May, ON: October to Novemebr, MKST: Mann-Kendal trend text, * and **: *** statistically significant at 0.05 and 0.001 and 0.0001probability level, respectively.

In line with this (Gebbisca & Bacsı, 2025) observed significant rainfall increases in September, October, and November, with high winter variability and an upward autumn trend using Mann–Kendall test, Sen’s slope estimator, and coefficient of variation. Tekalign (2017) observed the temporal distribution of the total number of rain days with negative trends of both Jigjiga and Shinile stations. Similar result were reported by (Dubā, 2022). Accordingly, there is a need to reframe policy towards responses that shift, rather than reproduce, the development paradigm causing the climate problems and vulnerability in the first place (Marin, 2011). A general decreasing trend in rainfall is quite evident (Ogalló et al., 2017). October had the most pronounced upward trend, with a Sen’s slope of 1.284 mm/year. March and August also showed an upward trend in rainfall, with increases of 0.136 mm and 0.067 mm per year, though these were not statistically significant. Similarly, January, February, April, May, June, July, and December showed decreasing trends in rainfall, but none of these trends were statistically significant (Gebbisca & Bacsı, 2025).

The results of Mann-Kendall trend estimation indicated that all months and seasons rainfall trend are not significantly increasing or decreasing trend (Table 5). In contrast, April and May have experiences relatively low rainfall variability, reflecting more consistent and stable rainfall patterns (Table 4). Despite this stability, there is no significant trend in rainfall trend, as shown by a Sen’s slope 1.214 mm/year (Table 5).

Similar reports by Kassie *et al.* (2013) and Getachew and Tesfaye (2015) also confirmed the presence of a rainfall shortage and drought vulnerability in the area due to seasonal rainfall variability. This is because the rainfall received during the long rainy season is a consequence of the convergence of the low-pressure system and the Inter- tropical merging zone (Tabari *et al.*, 2015), and this might have been affected by the ongoing climate change. Similar results have been reported for northern Ethiopia by (Abegaz and Abera, 2020). Other also reported recurring failures in seasonal rainfall in the past with severe drought (Lyon & DeWitt, 2012; Connolly-Boutin & Smit, 2016).

Monthly, seasonal, and annual rainfall coefficients of variation exceed 30% in the study area (Table 5). According to Samy et al. (2019) and Alemu and Dioha (2020), higher values of annual and seasonal coefficients of variation ($CV > 30\%$) indicate high variability in rainfall amounts, which can lead to extreme drought.

Table 5: Descriptive statistics and trends of annual and seasonal rainfall at Gode station.

Time series	Min	Max	Mean	SD	CV (%)	MKST	Sen's slope	p-value
Jan	0	0.5	0.1	0.1	91.0	1.20	0.0	0.228
Feb	0	3.9	0.5	1.1	235.7	1.388	0.00	0.165
Mar	0	48.6	7.0	12.2	175.0	1.418	0.0	0.156
Apr	27.5	202.5	87.6	39.8	45.4	0.101	0.109	0.918
May	15.6	117.1	47.8	23.2	48.5	0.441	0.178	0.658
Jun	0	9.3	0.3	1.7	508.4	0.803	0.00	0.421
Jul	0	1.1	0.1	0.2	197.6	1.285	0.00	0.198
Aug	0	1.4	0.1	0.3	446.4	1.044	0.00	0.296
Sep	0	15.3	1.5	3.4	232.8	1.19	0.00	0.233
Oct	22.5	237.6	84.1	53.1	63.1	0.373	0.348	0.708
Nov	11	337.3	51.7	61.8	119.6	1.274	0.433	0.2023
Dec	0	2.5	0.1	0.5	470.1	-1.20	0.00	0.2281
AM	79.1	245.3	135.5	42.7	31.5	0.475	0.616	0.634
ON	39.6	500.9	135.8	101.3	74.6	0.611	1.109	0.54
Annual	150.5	689.1	280.8	114.0	40.6	0.883	1.214	0.376

Note: SD: Standard deviation, CV: Coefficient of variation, AM: April-May, ON: October to November, MKST: Mann-Kendal trend test, * and **: statistically significant at 0.05 and 0.01 probability level.

4.4. Pastoral Livelihood Vulnerability Index to Climate Variability

A high proportion of respondents (56.6%) perceive drought as “much more severe” than in the past, and another 31.3% consider it “slightly more severe.” Only a small fraction believes drought severity has remained the same (9.1%) or become less severe (3.0%) (Table 6). When discussing drought severity, respondents reported an increase in livestock mortality during recent droughts, indicating a shift in the environmental conditions that threaten their traditional livelihoods table 6. To cope with these challenges, community members employ various strategies such as herd and household splitting, labor migration to urban areas, and engaging in charcoal and fuel-wood selling table 6. However, they acknowledged that these coping mechanisms are becoming increasingly strained due to compounded pressures from environmental degradation

The perception of increasing drought severity is likely to intensify the sense of urgency around finding effective coping strategies. Households experiencing more severe droughts may be compelled to adopt more intensive or diverse coping mechanisms, such as livestock migration, water conservation techniques, or seeking alternative livelihoods (Abdusalam, 2019).

Table 6: Drought Severity

Level	Frequency	PercentValid Percent	Cumulative Percent
Valid Much more severe	224	56.6	56.6
Slightly more severe	124	31.3	87.9
About the same	36	9.1	97.0
Less severe	12	3.0	100.0
Total	396	100	100

4.5. Pastoralist Perception of Rainfall Patterns

Most respondents (66.7%) perceive that rainfall has decreased, while 22.2% believe it has become more unpredictable as shown in (Table 7). A minority think it has stayed the same (7.3%) or increased (3.8%) (Table 7). Participants overwhelmingly noted a significant decline in rainfall and an increase in unpredictability over the past few decades, leading to the disappearance of vital vegetation such as palatable grasses. This decline has adversely affected livestock reproduction and overall food security within the community, highlighting a direct correlation between climate change and agricultural viability. The study supports the study by Chala et al., (2016) & Maregn et al., (2019).

Decreasing and unpredictable rainfall can directly impact pastoral and agricultural activities, leading to increased vulnerability and a need for adaptation (Abdusalam, 2019). The perception of reduced rainfall suggests that households may prioritize strategies that address water scarcity, such as rainwater harvesting, better pasture management, or diversification of water sources. This aligns with exploring coping strategies in the face of perceived climatic shifts.

These findings provide valuable insights into how local perceptions of climate change, drought severity, and rainfall patterns may shape coping responses in Gode. They also highlight potential areas for intervention, as understanding these perceptions can guide support programs to align with community concerns and encourage sustainable adaptation strategies.

Table 7: Perception of Rainfall Patterns

Level	Frequency	PercentValid Percent	Cumulative Percent
Valid Rainfall has decreased	264	66.7	66.7
Rainfall has become more unpredictable	88	22.2	88.9
Rainfall has stayed the same	29	7.3	96.2
Rainfall has increased	15	3.8	100.0
Total	396	100.0	100.0

4.6. Livelihood Diversification

Nearly half of the respondents (47.0%) have diversified by shifting from livestock to crop production. A significant number (24.7%) have moved to non-farm activities, while smaller proportions have either commercialized livestock production (16.2%) or migrated to towns (12.1%) as shown in (Table 8).

The high rate of diversification from livestock to crop production and non-farm activities suggests a strong adaptive response to the challenges posed by drought. Crop production and non-farm work can reduce dependence on livestock, which is particularly vulnerable during droughts. The move toward crop production may also be a strategy to cope with declining grazing resources and water scarcity. To support this finding, Aymone (2009), suggested that expanding smallholder farmers' access to off-farm sources of income increases the probability that they will invest in farming activities. Therefore, Households engaging in non-farm activities or commercializing livestock production might be aiming for more stable income sources, given the uncertainties in pastoralism under changing climate conditions.

Table 8: Livelihood Diversification

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Commercialization of livestock production	64	16.2	16.2	16.2
	Migrating to towns	48	12.1	12.1	28.3
	Shift from livestock to crop production	186	47.0	47.0	75.3
	Shift from livestock to non-farm activities	98	24.7	24.7	100.0
	Total	396	100.0	100.0	

4.7. Pastoralists Community Support and Cooperation

Majority (57.1%) of respondent's report receiving community support or cooperation, while 42.9% do not (Table 9). Community support can be a critical factor in coping with drought, as cooperative efforts can enhance resource sharing, provide mutual aid, and facilitate knowledge exchange on effective strategies. However, nearly half of the respondents lack this support, which may limit their resilience. Households without community backing might rely more heavily on individual or household-based strategies, potentially reducing the effectiveness of their responses to drought impacts. This could indicate a need for strengthening community networks or support mechanisms to enhance collective resilience.

These interpretations reflect the adaptive measures in the Gode district, showing both individual and community-level strategies for coping with drought. This diversification and the role of community support can be critical in shaping sustainable resilience against climate impacts in the region.

"In focus group discussions, the community shared a cultural practice called xoolo-goyn in Somali. When a person loses livestock due to drought, their relatives contribute by providing breeding animals to help them rebuild their herd. This practice serves as a form of rehabilitation and community support, strengthening resilience within the community."

Table 9: Community Support and Cooperation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	226	57.1	57.1	57.1
	No	170	42.9	42.9	100.0
	Total	396	100.0	100.0	

4.8. Awareness of Government or NGO Programs

A large majority of respondents (77.8%) are aware of government or NGO programs, while 22.2% are not (Table 10). Participants expressed awareness of government and NGO programs designed to assist families affected by drought, but noted a recent decline in the availability of these programs. For those who had received assistance, such as food aid and livestock feed, the support was crucial for survival, highlighting the need for consistent and effective aid systems.

Awareness of external programs is essential for effective drought response, as it can provide access to additional resources, training, or financial assistance. Those who are aware may benefit from more diverse coping options and may be more likely to adopt sustainable strategies promoted by these programs. In contrast, the 22.2% who lack awareness could face limitations in accessing external support, relying mainly on traditional or local strategies.

Table 10: Awareness of Government or NGO Programs

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	308	77.8	77.8	77.8
	No	88	22.2	22.2	100.0
	Total	396	100.0	100.0	

Only 42.4% of respondents have access to financial or food assistance, while the majority (57.6%) do not (Table 11). The focus group identified significant challenges faced during drought, including livestock loss, water shortages, and decreasing livestock production, which collectively exacerbate food insecurity. Participants pointed out a lack of adequate support, noting that while they occasionally receive small animal feed and food aid from organizations like the World Food Programme (WFP) and the government, this support is insufficient and not guaranteed. Productive safety net program which is an extension of “food for work” program is practiced by Ethiopian

government to help extremely affected society during impacts of climate variability and drought (Masfin, 2015).

Limited access to assistance may exacerbate the impact of drought on the most vulnerable households, especially those with fewer resources. This lack of support could push households to use coping strategies that are not sustainable, such as selling assets or reducing food intake, which could further weaken their resilience to future droughts.

Table 11: Access to Financial and food Assistance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	168	42.4	42.4	42.4
	No	228	57.6	57.6	100.0
	Total	396	100.0	100.0	

4.9. Preferred Livestock for Coping Strategies

Camels are the preferred livestock for coping strategies (60.9%), followed by goats (35.6%) and donkeys (3.5%) (Table 12). The choice of livestock types also came into focus, with respondents explaining that camels and goats are preferred due to their drought resilience, as they can survive longer without water compared to cattle. This reflects an adaptive response to changing environmental conditions, suggesting that livestock selection is informed by survival strategies rather than mere preference.

Camels' popularity likely stems from their resilience in arid environments, as they are highly drought-resistant and able to survive with minimal water. Goats are also hardy animals and well-suited for drought-prone areas. This preference suggests a strategic adaptation to environmental conditions, where households favor livestock that can withstand drought, ensuring some continuity of income and sustenance during dry periods.

Table 12: Preferred livestock for Coping Strategies

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Camel	241	60.9	60.9	60.9
	Goat	141	35.6	35.6	96.5
	Donkey	14	3.5	3.5	100.0
	Total	396	100.0	100.0	

4.10. Preferences in Livestock Characteristics

Households prioritize livestock with higher economic value (48.0%) and those that are drought-resistant (38.9%). Disease resistance (9.8%) and low input requirements (3.3%) are less prioritized. The emphasis on economic value and drought resistance suggests that households seek livestock that can provide reliable income during adverse conditions and require minimal resources to survive. This strategic selection can enhance resilience, as households are choosing animals that are both economically advantageous and suited to drought conditions.

Table 13: Prefer the one at the first rank above all

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Higher economic value	190	48.0	48.0	48.0
	Drought resistant	154	38.9	38.9	86.9
	Disease resistant	39	9.8	9.8	96.7
	Need low input	13	3.3	3.3	100.0
	Total	396	100.0	100.0	

4.11. Severity of Drought on Family and Community Well-being

Drought has led to reduced income for nearly half of respondents (49.7%), and food insecurity for 35.6% (Table 14). A smaller percentage (7.3%) reported migration of family members and increased stress/anxiety (7.3%) (Table 14). Community dynamics have been affected by drought, with respondents indicating a deterioration in relationships and support systems compared to the past when resources were more abundant. This shift suggests that the community is becoming increasingly strained under the pressure of resource scarcity. Reduced income and food insecurity are the most immediate impacts, underscoring the direct economic and nutritional challenges households face due to drought. Migration and increased stress indicate secondary social and psychological impacts, which could affect community cohesion and mental health. These findings highlight the need for both economic support and programs addressing food security to help mitigate the broader impacts of drought. These interpretations provide insights into the community's approach to coping with drought, emphasizing a blend of cultural practices, strategic choices in livestock, and reliance on external support where available. This analysis could help in identifying areas where support interventions can be improved or more targeted.

Table 14: Severity of Drought on Family and Community Well-being

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Reduced income	197	49.7	49.7	49.7
	Food insecurity	141	35.6	35.6	85.4
	Migration of family members	29	7.3	7.3	92.7
	Increased stress/anxiety	29	7.3	7.3	100.0
	Total	396	100.0	100.0	

4.12. Determinants of the Choices of Drought Coping Strategies

The results are shown in Table (15), the factors affecting pastoral's decision of implementing coping measures to drought. The pastoralists in the study area used livestock diversification, off farm (selling livestock and livestock product), Relief support from government support and mobility/migration as major coping strategies. But, choice of a coping strategies determined by a number of factors. The interpretation of a parameter estimates from Multinomial Logit model shows how the probability of the outcome changes when the corresponding variable changes by one unit from its mean while the rest of explanatory variables held constant at their means. Other factors which are not controlled in this study may have an influence on choice of adaptation (Table 15).

Table 15: Parameter estimates of explanatory variables from multinomial logit model

Variable	Off-farm	Livestock diversification	Govt. support	Mobility/Migration
Age	0.272 (0.329)	0.535** (0.049)	0.015 (0.915)	-0.827 (0.301)
Sex	0.428*** (0.002)	0.174 (0.283)	0.017 (0.954)	0.205 (0.258)
Education	0.020** (0.021)	0.352 (0.246)	0.075 (0.640)	0.088 (0.789)
Income	0.023 (0.868)	0.085 (0.538)	0.164 (0.587)	0.298* (0.054)
Training	0.086 (0.677)	-0.420** (0.042)	0.410 (0.135)	0.237*** (0.009)
Credit	0.031 (0.864)	0.014 (0.939)	0.612** (0.040)	0.257** (0.023)
Land scarcity	0.698 (0.949)	0.069 (0.811)	0.539** (0.029)	0.088*** (0.000)
Climate info	0.282 (0.348)	0.468 (0.113)	0.373 (0.200)	0.827** (0.019)

Coefficients are p-values in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Results indicate that sex ($p<0.01$) and education ($p<0.05$) significantly influence engagement in off-farm activities. For livestock diversification, age has a positive and significant effect ($p<0.05$), while training negatively affects diversification ($p<0.05$). In terms of government support, access to credit and land scarcity are significant at 5% level. Mobility/migration is significantly influenced by training ($p<0.01$), credit ($p<0.05$), land scarcity ($p<0.01$), and climate information ($p<0.05$). Income shows marginal significance at 10% level in influencing mobility decisions.

As can be seen on Table (16), Access to credit, Training services, and climate information factors significantly impact mobility as an adaptation option at a 5% level of significance. Level of education and sex greatly positively affected off farm like selling livestock and livestock product as a coping strategy in the study area, whereas age of farmers was identified as significant factors that negatively impacted diversification like raising new livestock species as a coping strategy. According to Delgelo *et al.* (2021), the increment ages of household decrease the probability of involving in livestock and crop diversification. As the increase in the age of the household head, increases the likelihood of the household to manage the livestock at the same time with life experiencing. Age negatively influenced the decision to adopt options related to technology because older pastoralists are more risk-averse and less likely to be flexible.

In addition to the aforementioned results, land scarcity, lack of access to credit, and income have a statistically significant relationship with government support. This finding is consistent with the finding of Galma Wako, et al. (2017), which indicate that resource constraints and financial access are key determinants of institutional support utilization among pastoral households. Some explanatory variables exhibit a stronger influence on the selection of specific coping strategies, while others remain insignificant across different adaptation options. This suggests that households' decisions regarding drought coping mechanisms are heterogeneous and influenced by varying socio-economic and environmental factors at different levels of significance. Similar findings have been reported in studies on pastoral adaptation, where household characteristics and access to services shape coping strategy choices differently. Furthermore, marginal effects are essential for interpreting the impact of independent variables on the dependent variable in terms of probabilities. They measure the expected change in the probability of selecting a particular coping strategy given a unit change in an explanatory variable.

This indicates significance at 1%, 5% and 10% probability levels, respectively (Table 16). Table 16 results indicated that Access to credit affect positively the mobility coping choice and for a unit increase in lack of access to credit would increase the mobility coping choice by 0.57% in the pastoral community. Accesses to credit have a positive effect on the likelihood of using diversification to cope drought. If a pastoralist has an access to credit then his/her probability of coping and diversification would increase by 1.7 %. Access to affordable credit increases the financial resources of farmers and then their ability to come across transaction costs associated with various adaptation options that they might want to take (Berman, 2014). As it is indicated in Table 16 Land scarcity has significant and positive effect on coping strategies to drought. For a one unit increase in land scarcity and climate information, the probability of pastoral community's use of mobility coping methods increase by 23.5 % and 2.15% respectively, keeping other variables constant.

Table 16: marginal effects of explanatory variables from multinomial logit model

Variable	Off farm (eg selling livestock)	Diversification	Govt. support	Mobility/Migration
Age	0.00392	-0.0563597	-.068745	-.0526134
Sex	0.07129	0.0066574	-.054559	.0359775
Level of education	-0.0496239	0.090527	-.069322	.0952168
Income	0.003677	-0.004241	.012515	.0035823
Training Services	0.054882	0.0643558	-.001633	-.0717447
Access to credit	-0.037021	0.018792	.024112	0.005722
Land Scarcity	0.017303	0.0496881	.08083	0.23509
Climate information	-0.009192	0.028102	-.009710	0.02155

Age of the household head, represents experience, affected coping to the drought impact (Table 16). For instance, a unit increases in age of the household head results in a 5.6% decrease in livestock diversification. Because, the increase in the age of the household head, increases the likelihood of the household, to manage the livestock at the same time with life experiencing. This study support with other findings Indris and Adam (2013) stated age of the household head gets older, the burden on availability of labour force would increase and the household may have to carry out livestock production and other income generating activities.

The result indicates gender has significant and positive effects of choosing coping strategy for drought impact. Male headed households cope more readily to the impact, 7.1% more likely chooses off farm activities. This can be due to the fact that women are culturally assigned for domestic activities and even have limited access to critical resources (land, cash, and labor), which often undercuts their ability to carry out labour-intensive activities. This finding is thus in line with Kebede (2013), affirming that male farmers are more likely to access information on climate change and pleased to take risks than their counterparts.

Climate information affects significantly the diversification coping strategy by the probability of 2.8% and 2.1% of mobility. Diversification of livestock is more vulnerable to climate risks (Harvey *et al.*, 2014). Income was also identified by pastoralists as a determinant of government support coping to drought. Limited access to resources such as land also contributed significantly toward looking for Diversification in Livestock type as coping capacity. Moreover, Land scarcity was identified as significant factor for government support by 8.0% for a unit increase in land scarcity, keeping other variables constant.

5. SUMMARY, CONCLUSION AND RECOMMENDATION

5.1. Summary

The main objective of this study was to examine drought severity and coping strategies of pastoral households in Gode District, Shabelle Zone, Somali Regional State, Ethiopia. The research aimed to analyze the frequency and magnitude of drought over the past three decades, assess the coping strategies practiced by pastoral households, and identify the key determinants influencing the choice of these strategies.

A cross-sectional research design integrating quantitative and qualitative approaches was employed. Primary data were collected from 396 pastoral households through structured questionnaires, focus group discussions, and key informant interviews, while secondary climate data covering a 30-year period were obtained from the National Meteorological Services Agency. Drought severity and variability were analyzed using descriptive statistics, the Mann–Kendall trend test, Sen’s slope estimator, and the rainfall anomaly analysis (RAI). A multinomial logit model was applied to identify factors influencing households’ coping strategy choices.

The climate analysis revealed high rainfall variability, increasing temperature trends, and recurrent drought events, with severe and extreme drought episodes recorded in several years. Pastoral households perceived drought severity as increasing, accompanied by declining and unpredictable rainfall patterns. The major impacts of drought included livestock mortality, reduced household income, food insecurity, rangeland degradation, and water scarcity.

Pastoral households employed a range of coping strategies, including livestock mobility, herd diversification, livestock sales, engagement in off-farm income activities, and reliance on community-based social support mechanisms. However, dependence on external assistance from government and NGOs remained limited. The econometric results showed that socio-demographic and institutional factors such as age, sex, education level, access to credit, income level, access to climate information, training, and land scarcity significantly influenced the choice of drought coping strategies.

5.2. Conclusion and Recommendation

The study concludes that drought in Gode District is a recurrent and intensifying phenomenon characterized by increasing temperature trends, high rainfall variability, and frequent negative RAI anomalies. These conditions have severely affected pastoral livelihoods by undermining livestock production, degrading rangeland resources, and exacerbating food insecurity and poverty among pastoral households.

Although pastoral communities in the study area employ diverse indigenous and adaptive coping strategies, the increasing frequency and severity of drought events have exceeded the capacity of traditional systems alone. The effectiveness of coping strategies is strongly influenced by household socio-economic characteristics and access to institutional support services. Limited access to credit, climate information, training, and alternative income opportunities constrains the ability of many households to adopt more resilient and sustainable coping mechanisms.

Therefore, strengthening drought resilience in Gode District requires a shift from reactive emergency responses to proactive drought risk management. Integrating indigenous coping practices with improved rangeland management, early warning systems, livelihood diversification, and enhanced institutional support is essential. Addressing the key determinants identified in this study will contribute to improving adaptive capacity and ensuring the long-term sustainability of pastoral livelihoods in the Somali Regional State.

Based on the findings of this study, the following key recommendations are proposed to enhance the resilience of pastoral households in Gode District against recurrent drought:

- Strengthening climate resilience and early warning systems should be prioritized through improved climate monitoring, analysis, and dissemination of drought information. Establishing community-based early warning mechanisms will enable pastoral households to anticipate drought conditions and make timely decisions related to livestock mobility, grazing management, and resource use.
- Sustainable rangeland management interventions need to be enhanced by promoting rangeland rehabilitation, improved forage production, and the protection of degraded grazing areas.

These efforts should be integrated with and strengthen traditional grazing management practices such as deferred grazing, flexible grazing systems, and seasonal mobility to ensure sustainable forage availability and ecosystem health.

□ Livelihood diversification should be promoted to reduce overreliance on livestock-based livelihoods. Supporting alternative income-generating activities and improving access to credit and microfinance services will enhance household income stability and increase adaptive capacity during recurrent drought periods.

□ Institutional and social support systems must be strengthened through improved access to water infrastructure and veterinary services, alongside reinforced social safety nets. Policy frameworks should support sustainable pastoralism, secure equitable access to grazing and water resources, and promote coordinated action among government institutions, NGOs, and community leaders to implement integrated drought mitigation and adaptation strategies.

6. REFERENCE

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7. APPENDIX

Appendix I

Questionnaire to be completed by Household Heads

General Information:

My name is Abdisalam Ahmed, I am postgraduate student at Haramaya University. As part of the study programme, students are expected to engage in a field research and produce a thesis covering their areas of interest. I am, therefore, conducting a study on Impacts of Drought on Pastoral Households, Local Practices and Coping Strategies in Gode District, Shabelle Zone, Somali Region, and Ethiopia. College of Social Sciences and Humanities, School of Geography and Environmental Studies, Haramaya University) under the supervision of Dr Solomon Asfew. I guarantee that the information gathered in this exercise will be strictly used for academic purposes, and the respondents' confidentiality will be respected. I would like to request for your participation in this exercise

Enumerator's Name..... Date of Interview.....
Starting time.....

1. Name (Optional) -----

2. Address (Optional) -----

Region_____Zone_____District_____Village_____

No	Question	Category	Code	Remark
1.	Age of respondent	20—30 years	1	
		31—45 years	2	
		46—64 years	3	
		>65 years	4	
2.	Sex of household head:	Female	1	
		Male	2	
3.	Education Level of household head	Primary	1	
		Secondary	2	
		Higher	3	
		No formal education	4	
4.	Livelihood	Farming	1	
		Pastoralism	2	
		Other (Specify)	3	
5.	Household Size	1-3	1	
		4-7	2	
		8-12	3	
		More than 13	4	
6.	Income Source	Farming	1	
		Livestock	2	
		Trade	3	
		Remittances	4	
		Other (Specify	5	

Part I. Questions on household head Demographic and Socio-economic Characteristics

Part II. Questions related to Climate Trends in Gode District (Expanded)

Please put this (✓) mark on the space provided for the answer that meets your choice and fill on the blank space for related extra answers

No	Question	Category	Code	Remark
7	What do you believe are the main causes of the climate changes you observe?	Natural cycles	1	
		Human activities	2	
		Don't know	3	
		Other (Specify	4	
8	How would you rate the severity of droughts over the past decade compared to previous years?	Much more severe	1	
		Slightly more severe	2	
		About the same	3	
		Less severe	4	
9	How have rainfall patterns changed over time?	Rainfall has decreased	1	
		Rainfall has become more unpredictable	2	
		Rainfall has stayed the same	3	
		Rainfall has increased	4	

Part III. Questions relate Local Practices on Drought Coping Strategy

Please put this (✓) mark on the space provided for the answer that meets your choice and fill on the blank space for related extra answers

No	Question	Category	Code	Remark
10	Have you or your community members started new activities to supplement income due to drought?	Commercialization of livestock production	1	
		Migrating to towns	2	
		Shift from livestock to crop production	3	
		Shift from livestock to nonfarm activities	4	
11	Do you and your neighbors cooperate on resources (e.g., water sharing, food storage) during drought periods?	Yes	1	
		No	2	

Part IV. Questions on related Factors Affecting Choice of Coping Strategies

Please put this (✓) mark on the space provided for the answer that meets your choice and fill on the blank space for related extra answers.

No	Question	Category	Code	Remark
12	Are you aware of any government or NGO programs providing drought relief in your area?	Yes	1	
		No	2	
13	Do you have access to loans or financial or food assistance during drought periods?	Yes	1	
		No	2	
14	Which livestock do you prefer to raise most in current situation?	Cattle	1	
		Camel	2	
		Sheep	3	
		Goat	4	
		Poultry	5	
		Donkey	6	
15	Why do you prefer the one at the first rank above all?	Higher economic value	1	
		Drought resistant	2	
		Disease resistant	3	
		Need low input	4	
		More productive	5	
		Give birth in short period	6	
		Other, specify_____	7	
16	How does drought impact your family's wellbeing? (Select all that apply)	Reduced income Food insecurity	1	

Thank you very much for your time & professional support!

Appendix 2: Guideline for Key Informant Interview

Dear respondent,

The main objective of this KII guide is to collect primary or first hand data to conduct an assessment on impacts of drought on pastoral households, local practices and coping strategies in Gode district. Your responses are valuable and will be held in utmost confidentiality to be used for the analysis of this research. You will not be identified by name in any case. If you accept to participate in this research, you will be doing so voluntarily and there will not be any monetary returns. You are also free to refuse to respond to any questions you do not feel comfortable answering or to withdraw from the research all together. This interview will take about an hour of your time to respond to the questions.

Thank you in advance for your cooperation!

Part II: - Background of Respondent

Age Sex

Level of education..... Your position in this Office.....

Year of services in this Office.....

1. From your perspective, how has the frequency and severity of droughts changed in this area over recent years?
2. What specific government or NGO programs are currently available to assist households affected by drought in the Gode district?
3. What are the main coping strategies you have observed within the community during drought periods?
4. What challenges do pastoral households face in accessing resources like water, grazing land, or financial support during prolonged droughts?
5. In your view, what are the most important steps that could be taken to strengthen drought resilience in this community, especially for future generations?

Appendix 3: Guideline for Focus Group Discussion

Dear respondent,

The main objective of this FGD guide is to collect primary or first hand data to conduct an assessment on impacts of drought on pastoral households, local practices and coping strategies in Gode district. Your responses are valuable and will be held in utmost confidentiality to be used for the analysis of this research. You will not be identified by name in any case. If you accept to participate in this research, you will be doing so voluntarily and there will not be any monetary returns. You are also free to refuse to respond to any questions you do not feel comfortable answering or to withdraw from the research all together. This interview will take about an hour of your time to respond to the questions.

Thank you in advance for your cooperation!

Background of Respondent

Age

Sex

Level of education.....

Your position in this Office.....

Year of services in this Office.....

1. How have you seen the climate change in this area over the past few decades?
2. Have you noticed any differences in the severity or frequency of droughts?
3. What are the common ways families here cope with drought?
4. What are the biggest challenges your household faces during a drought?
5. Are there any specific resources or support you lack that would help you manage drought better?
6. How has the shift from livestock to other activities (like farming or trade) helped or not helped families?
7. Are you aware of any government or NGO programs that support families affected by drought?
8. For those of you who have received assistance, how helpful has it been?
9. Why do some families choose certain livestock (like camels or goats) over others?
10. In what ways has the drought affected community relationships and support systems?
11. What would you like to see change to help families cope with future droughts?
12. How can younger generations prepare for more severe or frequent droughts in the future?